GREAT SMOKY MOUNTAIN INSTITUTE AT TREMONT: A CASE STUDY OF CITIZEN SCIENCE IN AN ENVIRONMENTAL EDUCATION CONTEXT

by

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(Under the Direction of Deborah J. Tippins)

ABSTRACT

In recent years citizen science has emerged as an influential avenue of inquiry with both educators and professional researchers. Traditionally, citizen science has been considered to be the process by which non-professional scientists participate in scientific research; although, this definition is expanding. This dissertation examines the use of citizen science as an educational context at Great Smoky Mountain Institute at Tremont to gain a greater understanding of how it may be incorporated into science teacher education and secondary science education. This study was framed by theoretical understandings of ecojustice and place-based education. Ecojustice philosophy includes attempts to balance the tensions between cultural and environmental systems by analyzing what resources should be conserved and how the use of these assets can be less damaging. Place-based education connects the ontological sense of place to educational constructs. The methodological framework for this study consisted of interpretive research design through the utilization of case study, interview, oral history and observation methods of study. Following thematic analysis using analytic induction three main themes emerged from the cross-case pattern analysis of the within case analysis and oral histories. The first theme was

"place as a fluid construction of the lived experience of occupants and visitors." GSMIT strives to enable each citizen science participant to develop his or her own unique relationship with Tremont and the park. The second theme was "place as undergoing transition." While the physical location of GSMIT is the same for all visitors, over the years each of them will have had different instructors, classes, etc. The place of GSMIT is continually changing and as such individual interpretations and understandings of the "place" of Tremont will be different for every person. The third theme to emerge was that of "citizen science contributes to an illusion of democratization." While some scholars have proposed that participation in citizen science programs will increase the democratization of science this study found that a clear divide remains between those who consider themselves scientists and those that don't. It seems as though citizen science participants continue to identify as technicians even if they have years of experience.

INDEX WORDS: Citizen science; pre-service science teacher education; secondary science education; ecojustice; place-based education; interpretive research; environmental literacy; science literacy; democratization of science

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DEDICATION

I would like to dedicate this dissertation to my mother, Jeanne Henderson Jenkins. She was a women who as ahead of her time. She taught all of her children to be careful observers and critical thinkers. She taught us that we could do and be anything that we wanted. She was someone that her children could count on without fail. Most importantly, she valued education. She often told me that education is the one thing that cannot be taken away from you. Long before I could appreciate this sentiment she would tell me that it is a sad day when you don't learn something new. Now I find myself sharing that thought with my students. She would be very pleased with my pursuit and completion of this degree. I hope that she would be proud.

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CHAPTER 1

INTRODUCTION AND DISCUSSION OF RESEARCH DESIGN

Chapter one begins with a discussion of the background related to Great Smoky Mountain National Park and citizen science. Chapter one also includes the rational and need for the study, theoretical and methodological perspectives, the purpose and research questions, and researcher subjectivities and assumptions. Chapter one concludes with the salient terms that appear frequently in this document.

Background

Great Smoky Mountain National Park. This study examines the use of citizen science as an educational context at Great Smoky Mountain Institute at Tremont (GSMIT). This institute is an environmental education center that is located within Great Smoky Mountain National Park near Townsend, Tennessee (Tremont website, 2011). This study was conducted in order to gain a greater understanding of how citizen science may be incorporated into science education curricula. This study is of particular interest in terms of the potential impact of citizen science participation in fostering the development of students who are involved in the decision-making processes in their communities. To understand the role of citizen science at GSMIT fully, it is first necessary to appreciate the uniqueness of the facility's geographical location.

Great Smoky Mountain National Park is the largest National Park (521,257.24 acres) east of the Mississippi river and is located at the southern end of the Appalachian mountain chain. The park is shared between the states of Tennessee and North Carolina (Fig. 1). The location of the park is key to it biological diversity. The park has significant variation of climatic conditions

due to its location within the Appalachian Mountains, and the elevation changes found there (Linzey, 2008). According to the National Park Service website, elevations within the park vary from 876 feet at Abrams Creek near Townsend, Tennessee to 6,643 feet at Clingmans Dome. This elevation change creates significant temperature variation within a relatively small geographical area. Annual average temperatures at Clingmans Dome vary between an average low of 18^0F in February and an average high of 65^0F in July. In Gatlinburg, which is at a much lower altitude, the annual average temperatures vary between 28^0F in December/January and 88^0F in July. In addition, Great Smoky Mountain National Park is also designated as a temperate rainforest as it has large amounts of rainfall every year. A temperate rainforest is characterized by having at least 200cm of precipitation annually (Withgott & Brennan, 2010). In fact, the park has more annual rainfall than anywhere else in the contiguous United States except for the Pacific Northwest. Annually in the park, July typically has the highest average rainfall totals with Clingmans Dome often having more than eight inches of rainfall (Linzey, 2008).

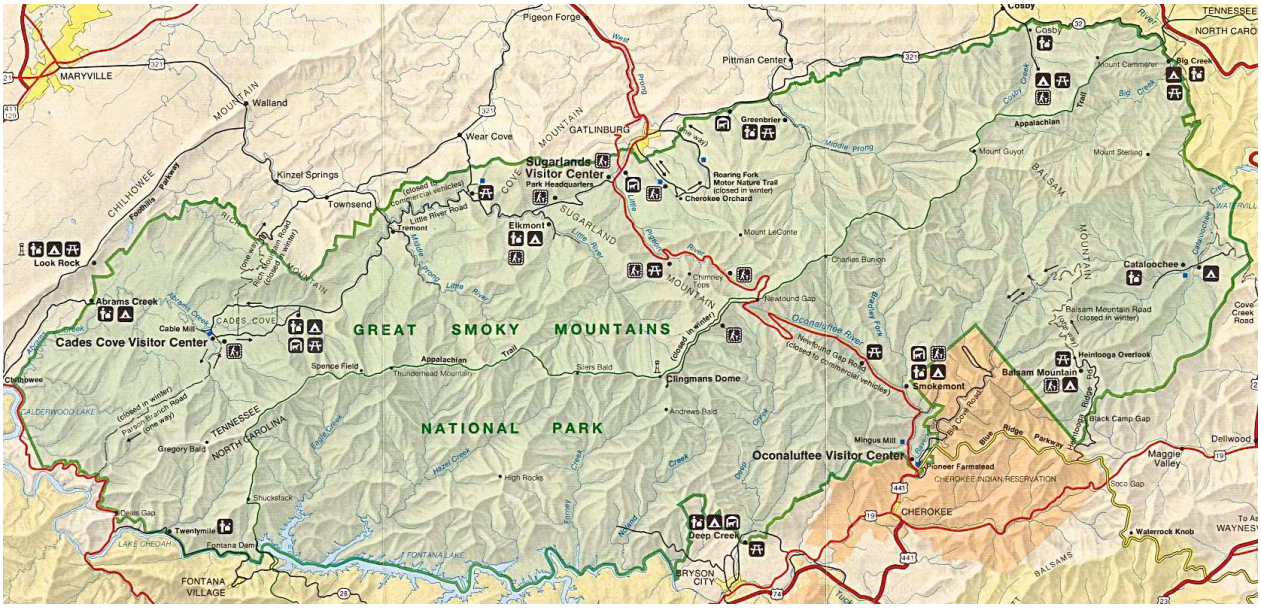

Figure 1. Map of Great Smoky Mountains National Park.

Great Smoky Mountain National Park is also widely recognized for its biodiversity. In fact, one would have to travel to a tropical rainforest to find biodiversity as abundant as is found there. The variety of climatic conditions and elevations within the park are the environmental factors that allow for this species diversity. The temperature and rainfall fluctuations within this geographical region have resulted in the formation of a large number of different ecosystems within a relatively small area. In fact, there are at least five (some scholars claim as many as seven) major forest communities within the park. These different communities are dependent on the varying climatic conditions (temperature and growing season) and soil conditions (soil depth and moisture content), and these are influenced by altitude and the topographic characteristics where the different forest types are located. The five community types, according to Linzey (2008), are spruce-fir forest, northern hardwood forest, cove hardwood forest, pine-oak forest, and hemlock forest. The spruce-fir forest is found at the highest elevations, and while it can be found anywhere above 4,500 feet it does best above 5,500 feet. The primary trees that form this forest community are the red spruce and Fraser fir. The northern hardwood forest is found above 4,500 feet and primarily consists of yellow birch trees and American beech. Cove hardwood Forest is found in the valleys between the mountain ridges and is considered the park's most diverse ecosystem. There are numerous tree species that are found within this ecosystem, but some of the primary ones are basswood, eastern hemlock, yellow birch, yellow buckeye and yellow poplar. As the name suggests, pine-oak forest consists mostly of pine and oak species. This forest type is found on rocky slopes and ridges within GSMNP that are surprisingly dry despite plentiful rainfall in the area. Hemlock forests are common along streams and shady wet slopes. In this forest community, American beech, American holly, sugar maples, yellow poplars and yellow birch are found along with the hemlocks. Of course, these are but a few of the many

species that are found within these ecosystem types. In fact, over 10,000 species have been identified within the park and scientists predict that there may be as many as 90,000 additional species present (Linzey, 2008). According to Brown (2000) and Linzey (2008), among the species that have already been identified are 2,200 species of mushrooms, 1,600 species of vascular plants, 243 species of birds, 40 species of reptiles, and approximately 70 species of mammals (Brown, 2000; Linzey, 2008). Great Smoky Mountain National Park claims to be the "salamander capital of the world" due to its 31 species of salamanders (24 species of lung-less salamander alone) that are found within the park boundary (Brown, 2000). As such, it is fortuitous that this area was designated as a National Park to protect the species richness of the southern Appalachians.

The establishment of Great Smoky Mountain National Park was approved by congress in 1926; however, the federal government mandated that the states involved (North Carolina and Tennessee) would have to share the responsibility of acquiring the land that was required. This meant that members of the local communities had to organize and begin local acquisition of privately held lands, delaying the official opening of the park until June 15, 1934 (Pierce, 2000). Fortunately, there was great public interest surrounding the establishment of a national park in the east; although, the primary motivation was not as altruistic as one might think. The civic leaders of both Knoxville and Asheville felt that a national park in the region would increase tourism and create long-term economic benefits for the area. It is interesting to note that while the creation of the park was largely valued for its potential economic impact, one of the justifications for its creation in the North Carolina and Tennessee highlands was to protect the great biodiversity from the abundant logging that was occurring in the region. In fact, according

to Pierce (2000), much of what became Great Smoky Mountain National Park was privately owned by logging companies at the time the park was approved.

The perceived abundance of species diversity within Smoky Mountain National Park led to the creation of the All Taxa Biodiversity Inventory (ATBI) in the late 1990s by Park Service employee Keith Langdon (Sharkey, 2001). Brown (2000) noted how the idea to conduct such a biological survey in the park came from Dan Janzen, a professor at the University of Pennsylvania, who had earlier attempted a similar project in Costa Rica. The objective of this ATBI in the Smoky Mountains was, at its simplest, to identify every species that is located within the park boundaries in a period of approximately ten years. In addition to cataloging all of the species found within the park, the goals of the ATBI also included determining the distribution and density of each species, as well as the seasonality and relationships amongst different species (Linzey, 2008). Today hundreds of scientists are participating in this project by either collecting specimens when visiting the park or by identifying specimens that were collected by others. The ATBI results are then published on the website Discover Life in America. As the ATBI was getting started GSMIT hired their first staff person related to citizen science. It was around this time that the new Citizen Science Director at GSMIT realized that researchers were only able to be in the park for very short visits while students visited their program year round, and that researchers could benefit from the data collection by these individuals. As such, the influx of researchers into the park proved to be a beneficial catalyst for expanding the participation in citizen science at GSMIT.

Citizen science. Citizen science projects have, historically, been initiated to meet the needs of scientists desiring to collect copious amounts of data from large geographical areas (Bonney et al, 2009). The vastness of this task would be too much for one researcher or research

team to accomplish on their own; therefore, scientists have frequently relied upon citizen volunteers in their areas of interest to collect much of the data for them. While this type of data collection is beneficial to the researcher, it is critical that scientists have confidence that the data they are receiving from volunteers is of the highest quality. To accomplish this goal, researchers typically write easy to follow experimental protocols to ensure that the data collected is reliable and of high quality so that is usable by research teams. Once the protocol is established participant data is then collected, recorded and sent to the researchers for analysis, interpretation, and publication. The number of citizen science projects worldwide is large. It has been estimated by Cornell lab of Ornithology and the 2008 Citizen Science Toolkit (Cornell Lab of Ornithology, 2012) that there are currently more than 200 citizen science projects worldwide.

While citizen science methods have been utilized by scientists since the 1800s, the term "citizen science," to describe scientist-driven public research projects, was not coined until 1995 by Rick Bonney, the Director of Program Development and Evaluation at the Cornell Laboratory of Ornithology (CLO) (Bonney et al, 2009). Even though this term was not applied to such projects until late in the twentieth century, citizen science, in this context, has a much longer history. For example, in the 1880s the American Ornithologists' Union asked lighthouse keepers to count the number of birds that hit the lighthouses (Droege, 2007). A migration study was established by Wells Cook, also in the 1880s, where he asked individuals to record when birds arrived in the spring, when they left in the fall, and when they were the most abundant. This project ran until the 1950s and during that time other organizations and the United States government also picked it up. Droege (2007) asserts, that while these are some of the earliest organized citizen science projects, it is highly plausible that volunteers collected weather data long before these projects came into being. The longest running citizen science project to date,

the Audubon Christmas Bird Count (CBC), is over 100 years old (National Audubon Society, 2011). Every year, during the weeks surrounding Christmas, CBC volunteers from across the Americas conduct field surveys of the birds located within their assigned area and report their counts back to the Audubon society. These counts have allowed researchers to study the overall health of numerous bird populations as well as how their numbers have changed over-time, providing critical insights into the population dynamics of these groups.

Another well-known citizen science project in many regions of the United States is the *Adopt-a-Stream* program (Adopt-a-Stream, 2008). This program utilizes citizen volunteers to monitor overall water quality of streams within their communities and to report to the Georgia Environmental Protection Division (EPD). The data they collect are important for determining what conservation efforts should be undertaken (if any), as well as whether any public notices regarding the safety of swimming, fishing, or consuming that water need to be posted. Adopt a stream volunteers collect data regarding the chemical (dissolved oxygen, pH, nitrogen content, phosphate content, and conductivity), and biological health of water. This is critical data as chemistry is intimately linked to the biotic makeup of water. In terms of biological health, volunteers conduct microinvertebrate (dragonfly larvae, crane fly larvae, caddisfly larvae, etc) sampling to determine a biotic index of specific water bodies. This biotic index is then used to determine the overall health of streams. Data is reported to the *Adopt-A-Stream* organization and any data that raises concern regarding stream health are reported to the state Environmental Protection Division (EPD). This allows the state to investigate any issues as they arise. One could argue that the EPD should be monitoring all of Georgia's waters regardless, but that is akin to saying that a single researcher should be able to collect data over an entire state. By having a network of volunteers that collect and report data the EPD can gather significantly more

information than they would be able to if their employees were the only ones monitoring the state's waters. This is one of the biggest advantages for citizen science from a researcher's or organization's perspective. They are able to collect large amounts of data, over large geographical areas (sometimes spanning continents) by using volunteers.

The increasing number of citizen science projects seems to indicate that this approach is an effective means for data-acquisition by researchers. Does something that is beneficial to researchers necessarily translate into being an effective tool for teaching science? Educational researchers are beginning to see that citizen science has the potential to be beneficial for the teaching and learning of science in addition to being a means for data collection. This is a critical development according to Aschbacher, Li, & Roth (2010), as many students feel that science is only for a few select talented individuals. This is unfortunate because historically scientific discovery was done by laypersons with little or no scientific training. In the mid-20th century, however, science became much more technical and theoretically more difficult for non-scientists to assimilate into their everyday lives. This disconnect between science and the average citizen bled into the classroom, as modern science education became focused on transmission and retention of a collection of random scientific facts. This only exacerbated separation between laypersons and science. Soon the typical student was fearful of science and felt that it simply did not have a role in their lives (Bonney, 2008).

Citizen science seems to be uniquely situated to bridge the growing chasm between professional science and science education. Evidence suggests that individuals who participate in citizen science projects develop their research skills as well as their understandings of science (Trumbull, Bonney & Grudens-Schuck, 2005). For example, Trumbull et al. (2005) evaluated letters from over 700 individuals who volunteered to collect data for the Cornell Lab of

Ornithology's Seed Preference Test and found that 80% of the participants had engaged in scientific thinking during the project. Trumbull and her colleagues found that approximately 23% of the individuals offered possible hypotheses regarding their observations. Eight percent of the participants initially failed to attract birds to their study site, but instead of abandoning the project they tried alternative approaches. Trumbull, Bonney, and Grudens- Schuck's (2005) study seems to indicate that participants were not just absentmindedly writing down data points, but were thinking scientifically. This was demonstrated by the fact that participants evaluated their projects' success, developed a hypothesis on how to address issues and then took action by modifying their experimental designs. Similarly, individuals who participated in The Birdhouse Network project showed an increase in their understanding of the biology and ecology of the birds they were studying, although this did not correlate to a change in their understanding of the nature of science or in their views of the environment as had been hypothesized (Brossard, Lewenstein, and Bonney, 2005). This may not be as alarming as one would think initially because respondents indicated that they were concerned about the environment prior to beginning the citizen science project. In another example, participants in the Project Pigeon Watch (Cornell Lab of Ornithology, 2007) program indicated that they had modified their assumptions regarding scientists following their participation in the program (Lewenstein, 2001). Project Pigeon Watch is a Cornell Lab of Ornithology citizen science project that focuses on fostering urban youth participants. Prior to their involvement in this project, when participants were asked to draw a picture of a scientist they typically drew males, with messy hair and white lab coats. After participating in the Project Pigeon Watch, when students were again asked to draw a picture of a scientist many modified their pictures from the previously stereotypical scientists to depict someone that more resembled themselves (Lewenstein, 2001). It should be

noted, however, that other scholars have criticized these "draw a scientist" tests. She (1995) argues that these studies were based on a single drawing by a child and may fail to represent the wide range of views that children may possess. Furthermore, Farland and McComas (2006) were concerned that the analysis of the drawings was insufficient and may have failed to produce the richness of data that was actually present in the student illustrations. Other studies indicated that students who participated in citizen science projects strengthened their competence with taking measurements, conducting observations, analyzing data, engaging in scientific reasoning, and developing the ability to formulate hypotheses regarding the environment and ecosystems (Krasny and Bonney, 2005). These researchers argue that following participation in a citizen science program that students had begun to strengthen their science identities. In summary, substantial amounts of research seem to suggest that individuals who participate in citizen science projects increase their scientific knowledge and strengthen their science identity.

Rationale for the Study

As previously mentioned, citizen science has a long history within the scientific community. It has traditionally been viewed as a way to involve the public in ongoing community and environmental surveys to collect data for existing larger scale science studies (Trumbull, Bonney, Bascon, & Cabral, 2000), but this limited scope may change as citizen science gains traction as an educational context for teaching science in a formal classroom setting. If communities and teachers begin to utilize citizen science projects to connect science to students' lives and interests we may find that local citizens begin to initiate and organize projects that they deem important to them. However, before we can make that leap we need to understand how citizen science is currently used as an educational context. This study is especially

important as it focuses on the role of educators in this context while most studies that have been done regarding citizen science has focused on educational outcomes for participants.

First, let us consider why there needs to be continuing efforts to make science relevant to students and to develop their understandings of the nature of science. While the United States has for many years been considered the leader in research and development in science and engineering, it has long been dependent upon individuals who were born abroad and moved to the United States (NSB, 2002). These individuals were either trained abroad prior to immigrating to the United States or they were educated in US and then took jobs here. In fact, it has been estimated that 25% of individuals who hold PhDs in the United States were born abroad. These facts, among others, have created some concern that as other countries develop science and engineering at home that the United States will begin losing its research and development edge. This could negatively impact the US economy. For these reasons, many individuals in government feel that it is important to foster interest in the sciences in students throughout their education. To address these issues, there has been increased attention on student success in the sciences. High schools are increasing the number of science classes that are needed to graduate, but instead of students entering college better prepared; institutions of higher education are seeing increasing rates of students who have to take remedial courses (NSB, 2002). Also, according to NSB (2002) employers and professors feel that high school graduates are under-prepared for entering either the workforce or institutes of higher education. The NSB reported that the majority of professors feel that freshman and sophomore college students lack adequate math and writing skills. In fact, they rated these skills as "fair" or "poor." Fortunately, the science and engineering indicators are pointing towards improvement since the 2002 report (NSB, 2008). Obviously, these issues are of serious concern in the job sector; however, is producing the next

generation of professional scientists the only reason to address the issues surrounding science education? Is there not an inherent need for citizens to have a basic understanding of science?

Let us consider why there should be increased focus on scientific literacy for the general population. Miller (2007) found that only 28% of the adult population in the United States qualified as scientifically literate. While this is an increase from the 10% considered scientifically literate in the early 1990s, it still only represents approximately one quarter of the population. This seems to be a startling statistic, but it is important to consider what is meant by science literacy. Miller defines science literacy as being able to understand 21 of 30 scientific terms that would be typical of articles found in the New York Times or an episode of the PBS television show "NOVA." He goes on to state that having a population that is literate in terms of science is important so that citizens can make informed decisions regarding public policy and consumer purchases. He is not alone in his claims. The focus on science literacy began in the late 1950s. At that time it was proposed that science literacy should be achieved for all individuals who would not go on to higher education (Hurd, 1958). That was just the beginning of the focus on science literacy in the United States. Since that time, there have been numerous attempts to define what is meant by science literacy and how that may be achieved by science educators (Liu, 2009). The American Association for Advancement of Science (AAAS) defined science literacy to include understanding the interrelatedness of science, mathematics, technology, and the social studies sciences (AAAS, 1989). The National Research Council (1996) took a more narrow approach to developing their definition than the AAAS. They defined science literacy to include:

> "Understanding of unifying science concepts and processes,
>
> science as inquiry, physical science, life science, earth and space

> sciences, science and technology, science in personal and social perspectives, and history and nature of science. (Liu, 2009, p 303)."

Regardless of the exact definition, it appears that the science education community agrees that science literacy is a desirable outcome for secondary science education. While there are many reasons expressed as to why science literacy is important, there seems to be consensus that having a population that is scientifically literate promotes better policy decisions, reduces belief in superstition, is good for the economy, and creates a more ethical world (Laetsch, 1987). Others have echoed Laetsch's thoughts. Wightman (2011) argues that science literacy is definitely a worthwhile and noble endeavor, but he feels that we should avoid the argument that science literacy is important for economic reasons. He feels that by arguing that science literacy is important in order to produce technologically savvy workers conflates science and technology. In other words, this argument indirectly states that science is only important to produce technology. He is concerned that this places science in a position where it is only valued as long as it is profitable and once it no longer feeds the economic engine then it can be forgotten. This can create tension with many of the environmental strands of science. Those individuals who are involved in citizen science projects understand that citizen science is an outstanding tool for achieving these goals of developing science literacy. Bonney (2008) mentions that educators at Cornell Lab of Ornithology realized in the 1980s that public involvement in citizen science projects would be advantageous in fostering understanding of the nature of science. Bonny and his colleagues wanted to move citizen science beyond the large scale research projects where volunteers only collected data; they wanted to create research kits that would provide background information on the projects as well as help participants learn about birds and scientific investigations. In an after school program called “Service at Salado” middle school

students, undergraduate students, and professional researchers worked together to learn about a local stream. This program utilized both an in-class component as well as an outdoor lab time. This study found that students increased their use of scientific processes and technologies, as well as a better understanding of acting as an active citizen. In addition, participants noted an increased interest in pursuing careers in science (Bell et al, 2009). While the "Service at Salado" study was not deemed citizen science by the classic definition, it gives credence to the claim that participation in citizen science in science curriculum can increase science literacy, overall interest in science, community awareness and citizen engagement. While the Tremont study will focus on the interpretation of the role of citizen science by the educators, this will provide a critical perspective to understanding its position and possible value in their curriculm.

Need for the Study

Great Smokey Mountain Institute at Tremont (GSMIT) uses citizen science projects within their curriculum. As is evident by GSMIT's history of involving visitors in citizen science, it is clear that the staff considers it to be an important component of the educational experience. Furthermore, because the GSMIT staff has groups participate in citizen science projects, and has done so for many years, it seems safe to assume that they feel that this pedagogy is an important aspect of the centers' focus on "Connecting people and nature." Is that truly a safe assumption? Although GSMIT has been using citizen science as part of their educational curriculum for some time, there has been virtually no educational research on the subject. However, there has been an increasing number of papers published by science educators, environmentalists and scientists focused on the influence of citizen science for cultivating scientific thinking (or awareness of science) and content knowledge. However, few of these studies suggest that citizen science develops an ethical orientation towards lifelong learning or

environmental awareness, which seems to be at the heart of Tremont's guiding message of "Connecting people and nature." It is these later orientations within the citizen science-as-education-context that Tremont emphasizes in publications noting their guiding philosophy. As science educators and scholars continue to promote citizen science as a way to engage students in science within their local communities it is useful to look at how citizen science has already been utilized in an education context. Great Smoky Mountain Institute at Tremont has been participating in citizen science projects since 1999 and as such they have an abundance of experience with implementing citizen science within an educational context. However, there has not been any research conducted concerning how GSMIT is utilizing citizen science to address stated goals or citizen science's role in "Connecting people and nature."

Purpose and research questions

Purpose. The purpose of this study is to understand how and why citizen science is used as an educational context at Great Smoky Mountain Institute at Tremont. The research questions guiding this study are:

Research questions.

1. What assumptions frame the GSMIT staffs' definitions of "Connecting People and Nature?"
2. How has the GSMIT staffs' interpretation of "Connecting People and Nature" been expressed historically?
3. How is the GSMIT staffs' interpretation of Connecting People and Nature" expressed today?

4. How is citizen science used as an educational context at GSMIT to foster the goal of "Connecting People to Nature?"

    a. How has the use of citizen science at GSMIT evolved over time?

Theoretical and Methodological Perspectives

The theoretical perspectives that inform this study are Ecojustice philosophy and Place-based education. Ecojustice philosophy argues that the planet's cultures, as well as its natural systems, and the organisms that are contained within them should be treated in a just manner (Karrow and Fazio, 2010). To this end, place-based education asserts that by educating students within the context of the local, (i.e, their communities, ecosystems, schools) they will develop stronger connections to these places, understand them better, and possibly, as a by product, endeavor to protect them. In other words, education plays a pivotal role in developing ethics surrounding the preservation and conservation of ecosystems and cultural resources. These theoretical perspectives will be explored more fully in Chapter 3.

The methodological framework for this study is interpretive research as described by Erickson (1986). Interpretive research design is centered upon the researcher bringing a fresh perspective to situations in which participants are embedded and therefore find commonplace. According to Erickson, individuals construct meaning in their lives based upon their experiences and interactions with other people which, in turn, influence their behaviors. Chapter 3 will provide an in depth explanation of the methodological perspective and methods of the study.

Researcher Subjectivities and Assumptions

Every researcher brings his/her own set of assumptions and subjectivities to his/her study. I am no different. In this section my biases and assumptions will be discussed in order to ensure that my subjectivities are as explicit as possible.

Epistemology. According to Crotty (1998) epistemology is "how we know what we know (p 8). My epistemology for this study is centered within social constructionism. Social constructionism focuses on how our various cultures influence the way in which individuals view the world and how they construct their beliefs and knowledge (Patton, 2002). Burr (1995) reminds us that all understandings are simply artifacts of cultures. There is no right way of understanding. Instead knowledge is dependent upon the life experiences, culture, and locations in which a person has lived. Given that, there can be no one right way of understanding. There are just different ways. As such, it is assumed that individuals within a community are constructing their understanding of that culture as they live the experience (Crotty, 1998). Therefore, the Tremont staff is constructing their understandings of environmental relationships through their experiences with citizen-science in an educational context. It is to be expected that each person's interpretation and implementation of citizen science activities will be unique as they are modified during interactions with students, teachers and other staff members.

Who am I in relation to the study?

My scientific perspective. In any qualitative study it is important for the researchers to remain cognizant, and evaluate how their preconceptions, biases, and experiences influence their collection and analysis of data. As such, it is critical that I consider my biases in relation to this study. To begin with, it is important to note that my Bachelor's and Master's degree are both in biology and not in education. Prior to beginning my course work in the doctoral program I had

never taken a single education course, and while I am passionate about teaching I sometimes find it difficult to step outside of my training in science to focus on the educational opportunities during fieldwork. For example, during the course of this study I spent one morning at GSMIT observing a group of 10 - 12 year old children as they participated in the aquatic salamander citizen science project. During the course of this activity the students were to find the mesh polybags (mesh bags that are filled with leaf liter and act as salamander habitat), empty the polybags into a white plastic tray, and examine the contents for salamanders. If they found a salamander they were to weigh it, measure it, and identify it to species. They were then to refill the polybags with leaf liter and return it to the creek. As I observed the students, it was apparent that they were having a fabulous time. They were animated, smiling, and laughing. They would sing out in delight whenever they found a salamander, and were so excited that they were looking under rocks and logs in an effort to find additional organisms. As I was observing I caught myself feeling anxious anytime I felt that they weren't taking the data collection seriously enough. I wondered if their measurements were exact, and their identifications were correct. This was a reaction to how I was trained as a scientist. Data collection is serious work and one must always be sure to gather accurate data. At least that is what I was feeling. Then I realized how engaged in the activity the students were. They were asking questions and making sure that they got the identification of species correct. In fact, as we were walking back to campus, I overheard the students talking about the activity and wondering if they were going to be able to look for salamanders again later in the day. They were asking each other if they were going to come back to the camp the following summer. It then dawned on me that a lot of learning had occurred during the two hours that they had been out at the creek, and that they each had experiences that could not be quantified by data collection of salamanders. So, while my science brain may have

difficulty with the sense of disorder in the data collection, the teacher-naturalists at GSMIT would most likely view the morning as a huge success. The students were excited about the activity, were hoping to be able to do it again, had collected useful data, and seemed to have learned a great deal.

Teaching experiences. Another important aspect of my life that has been significant in forming my subjectivities is my professional experience. My professional career has been focused on teaching biology in higher education. I have taught freshman level biology at Dalton State College for more than ten years. During that time I have been continually bothered by the fact that many of the students who take my classes claim to hate science. If they do not "hate" science then they certainly seem to have lost all interest in the subject and express that it is something at which they cannot succeed. In other words, most of my students have lost all motivation to engage in science either in school or out. I would very much like to see this trend reversed so that students learn that science is not only interesting, but that the subject is also relevant to their individual lives. I hope that by introducing students to real-world science, preferably within their communities, educators can begin to create this change. Furthermore, I think that by engaging students of all ages in citizen science projects educators can prevent students from becoming disinterested in science in the first place. Currently, based on my personal experience, it appears that students see biology as something that happened in the past, or that takes place in elite research laboratories. They do not see science as occurring in the present, and it certainly is not happening in their own communities. It is my hope that by engaging these students early on in their academic careers they may understand that science is in fact connected to them as well as their communities. Even if these students decide to pursue

careers that are not related to science they may develop a life long interest in studying and learning science.

The lack of student interest in my college biology classes has been influential in the development of my thinking about science education, in general, and in citizen science specifically. It is because of my concerns regarding student motivation that I became interested in the citizen science work being done at GSMIT. As this is a subject that I have strong opinions about, I had to recognize how my biases may have influenced my analysis and interpretation of the data. Furthermore, I learned about the citizen science projects being utilized at GSMIT through my participation in one of their programs for teachers. I felt that their work was interesting and contained significant potential as an educational context for science classes in general. In other words, I believe in what they are doing and think that it should be very beneficial to students who participate in such experiences. Throughout this study I had to be aware of how my bias, in this regard, may influence the study and my interpretations of the participants' words and actions.

My perspective on the environment. My passion for the natural world is probably one of my most defining characteristics. For as long as I can remember I have been concerned about treating the non-human aspects of this planet with respect and consideration. I never have been able to accept that humans, because of our domination of the planet, should destroy entire ecosystems and cause the extinction of species just to make a profit. That is not to say, that I feel that there should be no development and no creature comforts, but instead we should be thoughtful in our actions. We should minimize the harm we do and we should, in my opinion, treat other organisms with a great amount of care and concern. In fact, it is this passion for the environment that led me to study biology and to become a teacher. It is my greatest hope that

through my efforts as a teacher that I can increase the understanding of the interactions amongst organisms (human and non-human) on the planet, and that once people understand they will begin to appreciate the natural world and maybe even want to protect it. Due to my intense feelings for preservation of the environment it was critical that during this study I was consciously aware of biases and assumptions during my analysis. Furthermore, I worked to ensure that I was as open minded as possible in my analysis throughout the study.

Salient Terms

This section includes a list of terms that will be used frequently during this study. This section will also include a synopsis of the definition of each of the terms as they will be used during this project.

Citizen science is the involvement of non-professional scientists in scientific research projects. Historically, this involvement has primarily consisted of data collection by individuals that are not part of the established scientific community, but in addition it is commonly viewed as a way to develop the interest of participants in local issues including environmental issues.

Ecojustice is a philosophy that argues that the diverse cultures, ecosystems, and organisms on the planet need to be treated in a just manner. Effectively, Ecojustice philosophy merges the ideas of social justice and environmentalism. Ecojustice attempts to move beyond the western anthropocentric views of the environment by considering the just treatment of the ecosystem and organisms that are found within. In addition, ecojustice maintains that the diverse cultures of the world should be preserved and that individuals of different cultures should be treated justly.

Place-based education refers to educational experiences that are grounded in the local communities of students. In the context of science this would mean that students would learn about local ecosystems, environmental issues, research projects, etc instead of concentrating on issues that may be on the other side of the continent or world.

Scientific literacy refers to a person's understanding of the underlying concepts and processes of science, including nature of science, and science as inquiry.

Summary of Chapter 1

This chapter provided an overall introduction to this study by providing the background, rational, purpose, and research questions. The stated purpose of this study was to understand how and why citizen science is used as an educational context at Great Smoky Mountain Institute at Tremont. This chapter also gave a brief synopsis of the theoretical and methodological frameworks. The Chapter two will include a discussion of the salient literature for this study. This will include an examination of informal education and citizen science.

CHAPTER 2

REVIEW OF THE SALIENT LITERATURE

Chapter two consists of a review of the pertinent literature related to informal education, and citizen science. The discussion of informal education/learning will begin with an examination of what is meant by the term informal education/learning and then will look more specifically at research regarding the role of informal education/learning within the various contexts of science education, including museums, environmental education centers, museums and national parks. The review of literature will then turn to citizen science with an analysis of relevant research studies. That discussion will begin by looking at the empirical research related to citizen science in an informal educational context and will conclude with the role of citizen science in both science and environmental education.

Informal Education/Learning

History of informal education in the United States. For much of the history of the human race, education and learning have occurred in an informal context. According to Falk and Dierking (2002), school was typically only attended for about six months over five to eight years until relatively recently in the United States. In this context people learned the skills required to thrive and survive through experience at home, work, and even play. Formal education, groups of students situated in a classroom within a school came much later, but once it arrived it quickly became the expected norm as well as the standard in education. All children were required to attend a certain number of years of formal education during which time they were expected to attain mastery of a minimum set of requirements. This is certainly still the norm today. However,

many educators have come to appreciate the role informal education can play in enhancing understanding of concepts traditionally presented within a formal classroom context (Falk and Dierking, 2002). This is evident by the fact that the field of informal science education, while it has always been present, has grown substantially since the 1970s when it first began to be formally recognized by the educational community (Ucko, 2010). In order to have an effective discussion concerning the role and implications of informal education, it is first necessary to fully understand its meaning.

Falk (2001) states that the term "formal education" has typically been used to designate learning that occurs within the context of a brick and mortar school building, while the terms informal and nonformal education have been used to identify educational settings other than schools; such as, museums, aquariums, and nature centers, amongst others. According to Falk (2005), "learning," has become defined as something that people thought only occurred in schools or to a lesser extent the workplace and religious groups. Any activities that occurred outside of these establishments were viewed as leisure activities, fun, and therefore lacking in educational value. However, increasingly, modern society is remembering that much of learning and education in fact occurs outside of the formal educational setting and is not limited to children (Falk, 2005). As Falk reminds us, adults go to national parks, zoos, aquariums, museums, etc for numerous reasons, but one of their motivations is to learn. Furthermore, parents take their children to such facilities because they see these experiences as enriching educational events and want their children to benefit from them. It is important to remember, however, that adults attend such venues with and without children. Therefore, the education of the younger generation must not be the only enticement for them to visit such places. They must be finding some benefit from these experiences for themselves and it is not far fetched to assume that

learning about new and interesting topics in a stimulating environment is one of them. Of course museums and nature centers are not the only informal educational contexts in which humans learn. People, both young and old, watch television programs and read books in order to learn about science, nature, history, home repair, landscaping, and the world around them (Falk, 2005). Again, there are many reasons to participate in such activities, but certainly one of the main reasons is to learn. If education, and thereby learning, were to only occur in a formal context then there would be no need for zoos, documentaries, nonfiction books, etc. For this reason it is necessary to understand how informal education/learning is delineated from formal education/learning beyond the obvious that one occurs in a brick and mortar school building whereas the other can happen virtually anywhere.

Informal education in museums and beyond. Much of informal science education research has been focused on learning in museum settings (Rennie, 2007). The use of the term "museum," however may give the reader the wrong impression. While historically museums were mostly collections of biological specimens, art, and even oddities, the term has morphed over time to include many facilities that the general public may not necessarily consider to be a museum. Facilities that are now included within the definition of museums are: zoos, aquariums, planetariums, and nature centers (Rennie, 2007). As GSMIT is an environmental education center with a similar mission to those entities just listed, it is this later, more inclusive, definition of museum that is the most applicable to this study. Therefore, throughout this literature review the term museum will be used to indicate nature centers, planetariums, etc. Whatever a museum's primary focus, education is one of the stated goals of all such facilities and is at the core of the institution's overall mission. Of course, not all museums embrace the educational mandate as fully as others. For some museums, particularly those that are collection focused, a tension

remains between the research interest and the educational agenda (Rennie, 2007). According to Scott (2003), many museums that had once been more focused upon research are being forced, through accountability concerns, to move toward becoming more of a community relevant educational resource. One of the perceived advantages to museums as an informal context for learning is that they are less prescriptive in their educational agendas and the learner can be more in control of the experience. Hidi and Renninger (2006) tell us that in informal learning environments students have more direct input and choices regarding what they learn and how involved they may be in the process. While formal and informal education experiences may both have a person that leads the group and acts as a facilitator for the lessons, in general, participants at museums are not solely passive recipients of transmitted information. For example, students may get to choose which exhibits they visit within the museum, choose activities to participate in or which informational placards they read even if they do have a tour guide for the experience (Hidi and Renninger, 2006). By contrast, in a formal school setting, all students that are in the same class are generally expected to work on the same, albeit differentiated, assignments at the same time, learn the same information, etc. In addition, informal learning experiences present a more relaxed and enjoyable learning environment in that they do not typically have high stakes tests and assessments that can so easily place excessive stress on students in formal environments. In an informal educational context a participant can relax, enjoy the experience, while pursuing the information that they are most interested in. This type of setting allows them to soak in as much knowledge as they can without feeling the pressures that accompany preparation for a big test or exam and concern about not earning a passing grade. Informal learning environments also tend to be more flexible and even less explicit in their learning objectives. If a particular group is interested in a topic then the facilitator can allow them to

explore and learn about that instead of demanding that they stay strictly on task. Facilitators for informal learning groups can just allow the experience itself be the teacher. They do not have to be insistent that all participants learn a particular set of outcomes. Instead, individuals can take away the lessons and information that are the most important and relevant to them. In other words, the focus of such experiences may be as simple as fostering enjoyment and interest in a subject such as science, which, according to Hidi and Renninger (2006), may be as important as specific scientific knowledge.

Making sense of the terminology. There does seem to be a certain amount of ambiguity regarding the terminology surrounding informal, formal and nonformal education/learning, and it is important to get a clear understanding of these terms in order to fully understand their role in science education. Hein (1998), states that the terms informal and formal are related to the presence or absence of an organized curriculum as well as the setting in which the learning occurs. Ainsworth and Eaton (2010) agree with this link between learning and organization as they define formal learning as "learning that is intentional, organized, and structured (p10)." Meanwhile, they maintain that informal learning is never explicitly organized. They emphasize that informal learning is frequently spontaneous and experiential. They go on to make the distinction regarding nonformal learning as being loosely organized in ways that may or may not be planned or prearranged. According to La Belle (1982), the term "nonformal education" was coined in the 1960s in response to a perceived need for creating educational activities beyond the typical school day. La Belle claims that while there had been some attention given to "out-of-school education" prior to the 1960s that the new term of nonformal education helped legitimize this trend. However, it is important to remember that, unlike in the United States, the majority of the world's population predominately experiences learning which occurs outside of the school

context (Falk, 2005). However, Falk argues that even in the United States that the majority of learning occurs outside of the traditional classroom. According to La Belle (1982), nonformal education in the 1970s became much more common in the undeveloped parts of the world where people felt the need to supplement their formal education or were being poorly served by the community schools. This was typical in countries that did not have the funds to invest in schools and personnel; as a result, nonformal education grew in popularity in these areas so that the rapidly growing population could be educated without investing in the infrastructure and teachers that would be required for formal education (La Belle, 1982). La Belle also claims that nonformal education demonstrated an ability for facilitating citizen responses to societal issues such as food production, health, etc, which was critically important in local communities. It is interesting to note, however, that nonformal education filled a similar niche within industrialized countries as well (La Belle, 1982). According to La Belle, nonformal education in industrialized countries has served to complement formal education. As formal education has faced increased criticism nonformal education has been increasingly embraced. Nonformal education serves to enhance education and learning in all countries regardless of economic status (La Belle, 1982). While it appears that there is consensus regarding the definitions of formal, informal, and nonformal education this is not always the case.

The confusion amongst the terms informal and nonformal education becomes apparent as one delves more deeply into the literature. Some individuals (Ainsworth & Eaton, 2010; La Belle, 1982) draw a clear distinction between the two terms while others seem to conflate them (Falk, Heimlick and Foutz 2009; Falk and Dierking 2000). Falk, Heimlich, and Foutz (2009) seem to merge the two terms in their writing by using "informal/nonformal;" they state explicitly that, "although definitions exist that distinguish these two terms, they are frequently used as

synonyms (p. 5)." For this literature review nonformal and informal education will be used synonymously.

Given the ambiguity within the literature one must ask whether it is even necessary to have so many terms related to the context of learning. Rennie (2007) suggests that, perhaps, a false dichotomy has been established between the ideas of formal and informal learning. As Rennie argues, maybe the concepts of formal and informal learning are not two separate and distinct paradigms, but instead are just different flavors of a single concept, learning. Regardless, Falk and Dierking have asserted that both terms are inadequate and have pushed to move the science education community to a different descriptor, free-choice learning. The scholarly educational research community has certainly given significant thought as to what the appropriate terminology should be regarding informal education/learning. For example, the National Association for Research in Science Teaching (NARST) established an Ad Hoc committee to delineate what was meant by the term informal science education and they argued that "informal" was insufficient to describe what was meant by learning that occurs outside of the formal classroom. The policy statement published by the NARST Ad Hoc Committee (Dierking, Falk, Rennie, Anderson, and Ellenbogen, 2003) states that:

> "Informal science learning is the most commonly applied term for the science learning that occurs outside the traditional, formal schooling realm (precollege, university, and advanced degrees). Although widely used, the term has significant limitations because it artificially delimits efforts to describe the type of real-world learning that humans engage in daily: learning that occurs across a broad spatial and temporal context, both inside and outside of schooling (p. 108)."

Clearly, while informal education is a commonly used term, the committee clearly feels that it is the wrong term and a word that more fully encompasses the full scope of how learning occurs in the world should be adopted. In fact, this position is expressly stated later in the policy statement when the committee members state,

> "There are many possibilities (e.g., out-of-school, free-choice or lifelong science learning, public understanding of science) but there was unanimous agreement among members of the Ad Hoc Committee that it should not be the current term: ''Informal Science Education (p. 109).''

Much of the committees' reasoning for recommending a new term is focused upon the complexity of learning. They maintain that if the science education community is going to increase its focus on real world science then it must accept that learning rarely occurs through a single event or experience (Dierking et al., 2003). Instead, learning occurs in a cumulative way through the collection of understandings developed over many exposures. These experiences, of course, include learning that occurs in a formal context, but also ones that involve knowledge that is developed outside of the classroom. Because of these realizations the committee felt that the term 'informal learning' was not broad enough in scope and continues the false dichotomy between learning that occurs both in and out of school.

In addition, it is important to remember that learning is not something that is limited to years that a human is enrolled in school. Learning begins long before students step into their first classroom and continues long after they have graduated (Rennie, 2007). As Dierking et al (2003) point out; learning is an ongoing, cumulative process that encompasses all of an individual's life experiences. This may include school, museum visits, reading, watching television, social interactions, plus many more. La Belle (1982) states that learning is happening continuously for

all people regardless of where they are and what activity they are involved in. It does not matter whether an event is planned, unplanned, required or incidental – learning still takes place. Through participation in all of these events individuals will build a base of knowledge that they will continue to add to over their lifetime. However, according to Rennie (2007), it is important to categorize these different types of learning to bring clarity to the issue of what type of learning is occurring when. Ainsworth and Eaton (2010) state that it is important to categorize learning as it helps educators and learners to understand the process of obtaining knowledge. Ainsworth and Eaton go on to say that while the educational literature has created the categories of formal, informal, and nonformal learning that, in reality, they are all part of a continuum of educational experiences that make up a person's life. And while these terms have enhanced our understanding, it is imperative to recognize that they are inexact and there will be examples that will span all of these descriptors as well as items that will fall in between them.

If it is true that learning is an ongoing process and the categories are somewhat contrived, then what are the significant differences between formal and informal education? Falk, Koran, and Dierking (1986) begin to bring clarity to this issue by reminding the educational community that the fundamental difference between these two types of educational paradigms is the context in which the learning occurs. Bitgood (1988) agrees with this assertion by claiming that it is the setting in which the learning occurs in that is different when considering formal and informal education. However, there is no fundamental difference in the learning that occurs within both contexts. This is a key point and it is critical that we remember that while researchers continue to make distinctions, learning is the same whether it occurs in a classroom or in a zoo, aquarium, or nature center (Walton, 2000). According to Ainsworth and Eaton (2010), learning, regardless of context, has merit, and is fundamentally a life long endeavor that will be pieced together over

time. Society may find it easy to discount someone's visit to a museum as being a lower quality learning experience than attending a college lecture, but as Rennie (2007) points out, learning is a very personal process and no two people will view the situation the same. What one person may experience as a wonderful and informative learning opportunity another may see as uninformative, boring, and a waste of time. One individual may feel that they have gained an abundance of knowledge while someone else may feel that they did not benefit from the experience at all.

According to Rennie (2007), learning is multifaceted. Learning, in the human context at any rate, is a highly social activity. No person learns isolated in a vacuum, and as Rennie states, even if a person is not actively interacting with others then he/she is generally using some sort of object that was manufactured by others (book, computer, language, etc). Learning in this social, personal way requires linking new information to previously existing knowledge, which ultimately causes individuals to think and act differently. Learning is much more than just the absorption of information, like water to a sponge. Instead, learning comes from the internalization and interpretation of individual experiences. This means that while two people may be participating in the exact same activity they may learn totally different things because their educational experience is filtered through the events, needs, wants, and motivations of their life. Informal learning builds upon the experiences of formal education just as formal learning enhances the lessons learned during informal educational activities. For these reasons Ainsworth and Eaton (2010) remind us that all learning experiences, whether formal or informal, should be multidisciplinary in nature. No subject exists completely independent of another. The sciences are related to history, language, and mathematics and the same is true for other disciplines as well.

Are Informal Educational Experiences Effective for Learning? What the Research Says.

While there is an abundance of theoretical discourse regarding the perceived benefits of informal educational experiences, do the empirical studies that investigate the role of informal education support these claims? Does this developing focus on merging informal and formal learning experiences and through this creating a community centered educational experience correlate to people learning from these experiences? The research literature indicates that, yes, it does (Rennie, 2007). However, as Falk and Dierking (2000) remind us, while it is easy to say that people learn effectively in museum settings, it is more difficult to prove. In fact, Falk and Needham (2011) point out that while science centers and other facilities of a similar nature repeatedly make the claim that they are critically important in developing the publics' understanding of science, data supporting this assertion is rather difficult to find. However, in an effort to more effectively quantify the learning that does occurs in informal settings Falk and Dierking proposed and developed the Conceptual Model of Learning. They are careful to note that this model only tells researchers how people learn in informal settings not what they learn. Fortunately, as the field of informal science education has grown, it has, of course, been accompanied by a growing body of research that has examined the effectiveness of such learning contexts on student comprehension (Ucko, 2010). In a large part this is due to the consistent and significant support of The National Science Foundation (NSF). The National Science Foundation funded numerous grants in the 1970s and 1980s, which were instrumental in building the scholarly works of the field. For instance, NSF provided funding for new Association of Science Technology Centers (ASTC). In 1971 there were only 16 of these facilities and the number has grown to well over 600 worldwide today (Ucko, 2010). According to the ASTC website (http://www.astc.org/about/index.htm),

> "The Association of Science-Technology Centers (ASTC) is a 501(c)3 nonprofit organization of science centers and museums dedicated to furthering public engagement with science among increasingly diverse audiences. ASTC encourages excellence and innovation in informal science learning by serving and linking its members worldwide and advancing their common goals. Through strategic alliances and global partnerships, ASTC also supports science centers and museums in proactively addressing critical societal issues, locally and globally, where understanding of and engagement with science are essential. Founded in 1973, ASTC now numbers nearly 600 members in over 40 countries. Members include not only science centers and museums, but also nature centers, aquariums, planetariums, zoos, botanical gardens, and natural history and children's museums, as well as companies, consultants, and other organizations that share an interest in informal science education."

In addition, NSF has provided significant funding for scholarly research on the effects of informal science education (Ucko, 2010). In 2009, the National Research Council's Committee on Learning Science in Informal Environments published a report entitled Learning Science in Informal Environments: People, Places and Pursuits (LSIE) (Kiesel and Anderson, 2010). The NSF provided funding for this report and the primary objective of the committee was to evaluate the potential of informal learning environments for their influences in student learning of science.

Of course, research into learning from museums occurred prior to the efforts of the National Science Foundation, but it has certainly benefited from the NFS' continued support. One of the earliest studies looking at informal education was an 1884 study conducted at the

Liverpool Museum (Hein, 1998). Studies were also conducted in the 1920s and 1930s that examined the movements and actions of visitors to museums and then formally tested their learning (as cited by Rennie, 2007). However, what studies revealed about museum learning in 1884 is not necessarily relevant in the 1990s or 2000s (Hein, 1998). Hein reminds us that conducting studies within the field of educational research can be especially challenging. Unlike the sciences, not only do the variables in educational research increase over time, but they also change (Hein, 1998). Hein expounds on this thought by comparing educational research to that in the field of chemistry. He claims that in chemistry there is more consistency with the research subject than in the field of educational research. For example, an atom of a particular element will respond the same way now and 100 years from, but the same is not true of people. The people that were studied in the 1884 Liverpool study were different from the people studied in the 1920s who are different from students today. Humans are the product of their environment. Cultures change and as a result the people that live within those cultures change. Hein states that it is likely that people of different times probably even learned in different ways. Hein's point is that it is extraordinarily challenging to compare studies from different times. In addition, as has previously been mentioned, museums and informal educational facilities have also changed significantly in the 20th and early part of the 21st century. For this reason, this literature review will focus on the studies conducted in the 1990s and the 2000s. Furthermore, as cultural and societal influences are such profound aspects of learning and education this literature review will focus primarily on studies conducted in the United States. Hein also cautions us that studies of museum learning, as well as other informal educational settings, are hampered by the sporadic nature of visits to these facilities. Even people who are "frequent" visitors to museums may only go to such a facility a few times a year. This increases the difficulty of extrapolating generalities

from this population (Hein, 1998). Nevertheless, significant numbers of studies have been conducted regarding the role and impact of informal education.

What the Research Says About Learning in Museum Settings

Table 1. Key findings of studies relating to learning in museum settings

Authors	Date	Key Findings
Bielick and Karns	1998	* Participant knowledge of animal thinking behavior improved * There were moderate increases in overall interest in science * Return visits to the exhibit increased retention of knowledge * Adults perceived that the Think Tank exhibit positively influenced children's retention of information
Falk and Amin	1998	* Visitors demonstrated a greater understanding of the commonality amongst living organisms * Significantly significant increases in comprehension of four of five objectives * Quality of participant responses improved between the pre and post-exhibit interviews
Falk, Moussouri, & Coulson	1998	* Participants demonstrated an increase in their ability to discuss gems and minerals * Participants showed a greater vocabulary in relation to the topic of gems * There was an increase in the conceptual understandings of gems and minerals * This study demonstrated that participants' motivations for visiting the exhibit were linked to learning outcomes
Falk and Needham	2010	* The community was found to have an overall positive opinion of the science center with approximately 60% having visited * 95% of participants expressed that the science center had improved their understanding and appreciation of science *94% of participants stated that they had learned something during their visit
Falk and Gillespie	2009	* Exhibit was found to increase visitors' enjoyment of the museum * Exhibit was found to positively influence participants' level of cognition * Participants were found to have greater retention of information than control group
Quigley, Pongsanon, and Akerson	2010	* Students improved in their understandings of aspects Nature of Science (NOS) * Confusion remained in making distinctions between inference

		and observation
Holmes	2011	* No significant difference was found in motivation or achievement levels between groups who visited the museum and those who did not

Several studies have evaluated the impact that museum exhibits have upon visitor content knowledge with respect to science. Bielick and Karns (1998) conducted a study in 1996 to determine the long-term educational impact of the Washington's National Zoo's exhibit Think Tank. Think Tank was developed to introduce visitors to the concept of animal thought. The exhibit introduced zoo visitors to concepts surrounding animal thought by leading them through demonstrations, observations of living animals, and exercises. Activities were designed to lead attendees through the learning process by asking questions related to animal behavior and evidence of animal thought. The exhibit focused on three aspects of animal life: use of tools, language, and social behavior. In an effort to discover the impact of the exhibit on visitor learning Bielick and Karns (1998) focused on three topics: "1. Did the exhibit increase the visitor's interest in science? 2. Did the exhibit add to the visitor's scientific knowledge? 3. Did the exhibit increase the visitor's respect for animals (p1.)?" Personal interviews were conducted with large groups both prior to entering the exhibit and upon leaving Think Tank. In addition, 150 people were interviewed in follow-up interviews approximately 13 months after their visit to Think Tank. Bielick and Karns (1998) found that the Think Tank exhibit did improve the participants' knowledge regarding animal thinking behavior. Visitors, upon leaving the exhibit, were better able to provide examples of animal thinking behavior, and thought that their experiences with the Think Tank exhibit had increased their understandings of animal behavior. However, only moderate increases in overall interest in science were noted. In the follow-up interviews 13 months later, participants expressed opinions similar to those of when they were

interviewed at the National Zoo. Many of the participants reported that they had made return visits to the zoo with roughly ten percent of them returning an additional two to three times. The researchers found that these return trips served to reinforce the lessons learned by the participants during their Think Tank experience. In the follow-up interviews a year later 82% of repeat visitors were able to describe a key animal behavior that a scientist might study while only 60% of one time visitors were able to do so. Another interesting finding was that adults who visited with children who were interested in Think Tank tended to be positively influenced by the exhibit in terms of retention of Think Tank information. Overall, the results of this study indicate that participation in such informal educational experiences can positively influence visitors' scientific knowledge as well as their interest in science in general.

In another study that looked at the impact of museum experiences on participant science content knowledge, Falk and Amin (1998), completed an evaluation of the California Science Center's exhibit 'World of Life and Creative World' exhibits. The purpose of this study was to determine how the center was conveying their overarching message that all living things have many traits in common. The study was conducted by shadowing, observing and interviewing visitors to the exhibits. Falk and Amin found that all visitors demonstrated a greater understanding of the five main points of the exhibits (living things take in nutrients and perform digestion; respond to stimuli; defend themselves; and reproduce and transmit DNA to offspring). The researchers also found a statistically significant increase in participant comprehension of four of the five areas of focus. It was noted that the quality of the responses improved between the participants' pre-exhibit interviews and their post-exhibit interviews. Overall, Falk and Amin (1998) found that these exhibits had successfully met their goal of increasing public awareness that all living things share numerous characteristics as well as a fundamental interrelatedness.

Similarly, Falk, Moussouri, & Coulson (1998), evaluated the impacts of visitor agendas on museum learning at the Smithsonian Institution's National Museum of Natural History, utilizing its Geology, Gems, and minerals exhibit. As in the above studies, interviews were conducted with a select group of museum visitors prior to and following their exhibit experience as well as six to eight weeks following their trip to the museum. Participants generally showed an increased ability to describe gems and minerals as indicated by an increase in their vocabulary in subsequent discussions. They also demonstrated a significant increase in their conceptual understanding of gems and minerals as well as the ability to discuss the topic with an enhanced mastery. This study also confirmed that an individual's reasons for visiting a museum were critically important to learning outcomes. The individual whose motivations for attendance included education and entertainment showed the highest correlations to what they learned, how they learned, and how much they learned. It is interesting to note that individuals who expressed that entertainment was a significant motivation for attending the museum demonstrated greater learning outcomes than those who did not feel that entertainment was a prime reason for their visit. A similar, and yet independent, trend was demonstrated for those with educational motivations.

Similar results were discussed in Falk and Needham's (2010) report. Their study investigated the impact of California Science Center attendance on public the understanding of science within the greater Los Angeles community. Falk and Needham conducted interviews with over 800 randomly selected individuals within the Los Angeles area. Through these interviews they discovered that within two years of the science center opening that approximately 23% of the participants reported that they had visited the facility. Within ten years of the museum opening almost 45% of the respondents had attended. Participants also

conveyed to the researchers that significant numbers of their children had also visited the science center. From the data collected, Falk and Needham found that over 60% of people, adults and children, living in the greater Los Angeles area had attended the California Science Center at some point since its opening. It was also discovered that the community had a positive impression of the role of the Science Center within the community. This interpretation was supported by the fact that the majority of participants felt that the Science Center experience increased their child's understanding of science and their interest in learning more about science. Participants also tended to respond positively in relation to their own visits to the Science Center with 95% of them stating that the experience had increased their understanding and appreciation of science and 94% claiming that they had learned something new. Overall, the data highlighted the positive impact of the California Science Center upon the great Los Angeles area. However, one question that arises from such a study is, "why are science centers and similar facilities effective at teaching science and increasing interest in science?"

Falk and Gillespie (2009) explored this question by looking at the role of emotion in the context of learning during museum visits. As in the above study, this research was centered around visitors to the California Science Center. This study was focused on one particular exhibit at the museum entitled, *Goose Bumps: The science of fear*. This exhibit was designed to arouse visitor emotions that are associated with commonly feared items such as electric shock, insects, spiders, falling, etc. Overall, the exhibit was found to have increased participants' enjoyment of their visit to the Science Center and seemed to positively influence their levels of cognition related to the experience. In fact, interviews that occurred four to sixteen months following participants' initial visits to the Science Center indicated that the *Goose bumps* exhibit resulted in greater visitor reflection and continued learning than the control group. Also, data

indicated greater retention of understandings that had developed in relation to this experience. The researchers asserted that this was because these understandings had been incorporated into long-term memory and had become part of the participants' working knowledge of science. This study seems to provide support to the long touted idea that museum experiences are fun and exciting for visitors, and as such should enhance the learning of science for these individuals.

Quigley, Pongsanon, and Akerson (2010) conducted a study that evaluated how explicit-reflective instruction would influence students' understandings of the Nature of Science (NOS) in a museum-based Saturday science program for students in grades K- 8. Explicit-reflective instruction of NOS means that the topic is an independent topic taught within a science course, or experience in which students are provided time to contemplate, test, receive feedback and modify their ideas about NOS (Akerson, Abd-El-Khalick, & Lederman, 2000). The researchers found that students increased their understanding of the particular aspects of NOS that were focused upon; however, the level of improvement varied. The aspects of NOS included within the lessons were observation and inference, empirical, tentative, creative, subjective, and social and cultural embedded NOS (Quigley et al 2010). The most significant improvement in student understanding was related to comprehension of the role of observation in science, although there was still confusion surrounding distinctions between observation and inference (Quigley et al 2010). The researchers felt that the informal setting benefited student learning as class sizes were small and instructors were able to work with students in blocks of 150 minutes. Quigley et al (2010) stated that they were uncertain as to how well these teaching methods would translate to a formal classroom setting.

The above studies certainly provide significant evidence as to the profound impact informal learning experiences can have upon participant knowledge development, but not all

studies have uncovered such strong positive correlations. Holmes (2011) examined changes in student motivation and achievement related to a visit to a children's science museum. Two hundred twenty eight sixth-grade students were involved in Holmes' study. Students were given a pretest and post-test in order to determine baseline levels of motivation and achievement. A pretest was given a month prior to the museum visit and a post-test was given one month after the field trip. Results were somewhat mixed, but seemed to show that there was no significant difference between treatment groups and a control group that did not participate in the museum visit. Specifically, results indicated that there was no significant difference in intrinsic motivation or achievement levels between the experimental groups and the control groups. Holmes offered several explanations for why there seemed to be discrepancies between her results and much of the informal science education literature. For instance, she mentioned that many of the pre- and post- test questions were related to school based aspects of doing science. She discussed how these items included questions about whether the student liked to do homework and engaging in challenging scientific problems. She also indicated that many of the participating students demonstrated a strong motivation towards learning science before the study began. This may have made it difficult to detect differences (Holmes, 2011). As will be discussed later in Chapter 2, this difficulty in determining impact when participants are already strongly motivated to learn science content is also reflected in studies related to citizen science.

Informal Learning and Environmental Education

One area that has been deeply involved with informal education is the field of environmental education. Most frequently in environmental education, the learning experience occurs within the context of the message. In other words, the lesson and the setting are intimately intertwined and the learner would have significant difficulty teasing the two apart

(Falk, Heimlich and Foutz, 2009). In fact, as Falk, Heimlich and Foutz so clearly state, environmental education facilities can fall back on the inherent 'hook' of the natural world: a flower in bloom, a bear crossing the path, the smell of a skunk. Anyone of those items can lead to excitement, and further questioning. For these reasons there seems to have historically been a natural link between informal education and conservation efforts. Educational outreach has long been a fundamental component of most organizations that focus upon conservation and environmental sustainability (Braus, 2009).

Organizations such as the National Audubon Society, the National Wildlife Federation, the U.S. Fish & Wildlife Service, as well as the Association of Zoos and Aquariums all contain statements regarding the importance of education within their organizational goals. For example, the National Audubon Society website (2012) has a page that is solely devoted to education. It includes information on the various Audubon centers as well as how teachers can involve their students in environmental education programs in their own schools. Similarly, the U.S. Fish & Wildlife Services' website has a page devoted to education. It has resources for kids, families, and educators. The National Wildlife Federation website (2012) states their mission as: "We protect wildlife and their habitat, work to restore and maintain healthy ecosystems, and strive to educate and inspire Americans to safeguard our natural heritage." These are but a select few of the numerous conservation centered organizations that embrace educational goals as a significant component of their primary focus. Because the vast majority of environmental education experiences occur in an informal learning context it is important to consider how these experiences affect student or participant learning outcomes (Heimlich, 1993). As conservation efforts and environmental education have been critically linked for so long it has been necessary

to investigate the impact of informal learning in an environmental education context, and as a result numerous research studies have been conducted to evaluate that link.

Impact of Informal Education in an Environmental Education Context

Table 2. Key findings from studies related to informal and environmental education

Authors	Date	Key findings
Milton, and Cleveland	1995	* Students post-test scores were significantly higher than pretest scores demonstrating gains in their understanding of ecological concepts * Students who participated in the forest ecology program out performed those in the control group * Increased sense of responsibility and ownership for the neighborhood park * Decreased behavioral issues * Increased motivation for academic success
Lieberman and Hoody	1998	* Students learn more effectively in an environmental based context than in a traditional setting * EIC framework resulted in improved performance on standardized assessments in multiple study areas * Fewer behavioral issues * Increased attendance * Greater student engagement and interest
Chandler and Swartzentruber	2011	* Students drew upon their experiences with nature to enhance their classroom lessons * Positive experiences in nature correlated to improved science scores
Walcizek, Zajicek, and Logan	2003	* Students were demonstrating a higher level of understanding of the subject by utilizing higher levels of thinking according to Bloom's taxonomy * Students were able to demonstrate understanding of the material by graphing, measuring and plotting data * Students seemed to be formulating positive attitudes about science and mathematics as a result of participation

Milton, & Cleveland (1995) conducted an investigation that demonstrated the positive outcomes of utilizing an environmental context to enhance learning. During this project 46 fifth

graders conducted field studies which focused upon urban forest ecology in a neighborhood park. Two graduate students who were interns for the project guided the students through the field studies. The graduate students also presented the curriculum to the students. The overarching goals for the project were to increase student awareness of human/nature interconnectedness, to develop a sense of ownership and responsibility for the park, and to develop ecological knowledge. The curriculum consisted of three units of study related to urban forest ecology. These three units consisted of eight 75 minute classes that utilized a combination of indoor and outdoor activities designed to enhance student understanding of the community in which they live. At the end of the project Milton et al found that the goals of the project had been met. Students who participated in the program scored significantly higher on post-tests than they did on pretests related to ecological concepts. These students were also found to perform substantially better in this regard than students in the control group. Students who participated in the program also demonstrated a greater sense of responsibility and ownership toward the park at the completion of the study. In addition, teachers reported that many of the participating students not only explicitly claimed the park as theirs, but encouraged younger students to express ownership as well. Results indicated that this sense of ownership extended well beyond the study. For example, several students helped plant bulbs in the park the year following the program and two years later many students were still returning to participate in the annual park cleanup day. Another interesting outcome of this project was that there was a reported decrease in student behavioral issues. Both teachers and principals commented on the positive change in behavior of even their most difficult children. This decrease in behavioral issues was accompanied by increases in student motivation. Parents and teachers commented on how many students demonstrated an increased desire to progress and succeed. This was expressed by

students noting that they were worried about their personal impact on the success or failure of the group. Groups were found to have coalesced into tight working units where individuals expressed that they were motivated to work hard by the fear of letting down classmates. Clearly, participation in this informal environmental educational experience, while meeting the researchers stated goals, had impacts that extended well beyond the objectives initially laid out by the study.

In another study completed during the late 1990s, the State Education and Environment Roundtable, a group of 12 state agencies from across the United States, conducted a study to identify the most effective environmental programs in the nation and to analyze their similarities and differences (Lieberman & Hoody, 1998). This study involved more than 40 different schools located across the United States and focused upon "using the environment as an integrating context for learning (EIC) (Lieberman & Hoody, 1998, p. 1)." According to the executive summary, EIC is multidisciplinary in nature and centered upon students developing their own meanings of environmental issues within the context of their home communities. One of the key findings from this study was that students learned more effectively in an environment-based context than they do in the traditional school setting. Evidence for this demonstrated that the EIC framework provided numerous benefits including: improved performance on standardized assessments in multiple areas including reading, math and science, fewer behavioral issues, increased attendance, and greater student interest and engagement.

Chandler and Swartzentruber (2011) conducted another study to examine the relationship between student learning and informal learning in an environmental education context. The researchers were interested in investigating the relationship between students' nature experiences and their grades in science. The participants in this study consisted of 56 forth graders from two

different schools. One of the schools was located in an urban area while the other was located in a suburban neighborhood. In order to evaluate whether student participation in nature experiences influenced their grades in science, researchers utilized three different types of nature experiences. The activities that were investigated through the course of the study consisted of: field studies utilizing a creek bed, field trips to a zoo, and nature films that were shown in the classroom. At the conclusion of the investigation Chandler and Swartzentruber found that students were able to draw upon their nature experiences to enhance their participation in classroom lessons. Chandler and Swartzentruber also found that positive experiences associated with nature were correlated to improvements in science scores. Similar results were found by Walcizek, Zajicek, and Logan (2003) when they examined the impact of student participation in an outdoor environmental program on learning and engagement in elementary school students. In this study one hundred seventy five students participated in the on-campus program 'Math and Science in the Outdoor Classroom.' This program allowed second thru sixth grade students to work in a hands-on, laboratory-based curriculum where they studied topics including water, insects, weather, and soil. What the researchers discovered was that not only were students acquiring information at the knowledge level of Bloom's taxonomy, but that they were also demonstrating higher order thinking such as synthesis and evaluation. Data also indicated that students were able to apply the information that they gained during this experience by graphing, measuring, plotting, etc. In general, the themes that emerged from this study were that students were learning both science and math during this informal learning experience and they seemed to formulate positive attitudes about the subjects in the process (Walcizek, Zajicek, and Logan, 2003). It is important to remember, however, that the preparedness, involvement, excitement,

and overall philosophy of the educators who teach in an informal setting are influential in the success or failure of the programs in which they work.

The Role of Parks in Informal Education

Table 3: Key findings and studies relating to informal education in park settings

Authors	Date	Key Findings
Knapp and Barrie	2001	* Student retention of ecological concepts increased following visits to Indiana Sand Dunes National Lakeshore * There was no significant change in student attitudes related to Indiana Sand Dunes National Lakeshore following their field trips
Knapp and Poff	2001	*Students retained information more effectively that was taught through active learning methods *Lessons taught via passive transmission models was not retained effectively *The field trip did not increase student inclination to take action to work on issues associated with the wilderness area
Brody and Tomkiewicz	2002	* Park visitors build upon prior knowledge to develop new understandings of biological and geological processes that occurred at the park * Socially constructed knowledge was more complex and indicated the development of deeper understandings *The physical place influenced understanding. By visiting Midway geyser every visitor left with a more profound understanding and appreciation for such geological structures
Farmer	2007	* Participants retained long-term ecological and environmental content knowledge * Participants demonstrated an increase in pro-environmental attitudes
Taylor and Caldarelli	2004	* Educators view themselves as participant centric who expressed themselves as comforters, assessors, and appreciating of individual differences amongst students * Educators valued hands-on activities as they felt people with all types of learning styles benefited from them * Educators felt that responding to student questions was a critical part of the experience even though it sometimes made them feel uneasy. *Educators described that they felt the need to be well versed on many topics and not an expert in any one particular field.

Informal education, as has been discussed, can occur in a broad range of educational contexts. This varies from museums, zoos and aquariums, to less contrived settings such as

local, state and national parks, as well as wilderness areas and wildlife refuges. This study was conducted within Great Smoky Mountain National Park, and as such, a review of the relevant literature related to informal education in park settings is critical. It is interesting to note, however, that while there has been a considerable amount of research conducted to investigate the impact of museums on visitor understanding, there have been relatively few studies completed that examine the influence of parks on visitor learning (Brody and Tomkiewicz, 2002). One study, conducted by Knapp and Barrie (2001), studied the impact of two field trips to the Indiana Sand Dunes National Lakeshore on elementary students opinions of the park. For this study approximately 500 fourth, fifth, and sixth graders from urban Northern Indiana were taken to visit the National Lakeshore on two separate occasions. The initial visit to the National Lakeshore occurred in the fall of 1997 with the second trip the following spring. The focus of the initial trip was centered upon introducing students to ecological concepts related to the National Lakeshore, while the second trip concentrated on environmental issues associated with the park. In order to evaluate learning, students were given a pretest one to two days prior to their trip and a post-test immediately upon their return. At the conclusion of the study researchers found that data indicated significant increases in the students' understanding of scientific concepts after both of their visits to the National Lakeshore. In addition, Knapp and Barrie found that there was an additive effect related to student retention of scientific knowledge. Student pretest scores were found to be higher before the second field trip than they had been at the beginning of the study. Furthermore, data indicated that student understandings of scientific content knowledge increased again following their second visit to the park. However, the study did not find any significant change in student attitude regarding the National Lakeshore (Knapp and Barrie, 2001).

In a similar study, Knapp and Poff (2001) utilized qualitative research methods to examine the impact of an environmental interpretive experience on developing environmental ethics. The participants of this study consisted of 24 fourth graders who visited the Charles Deam Wilderness near Bloomington, Indiana. Each participating student was given a pretest approximately one week prior to his or her field trip. The purpose of this pretest was to determine what experience students had with the wilderness area prior to the trip as well as whether the participants felt that this experience would alter their attitude toward the wilderness area in the future. In addition to these pretests, students participated in two follow-up interviews after their trip. The first follow-up interview was conducted one week after the experience and the second one occurred four months later. During the trip to the wilderness area students participated in numerous activities. These activities included: hikes, ranger led discussions, nature based games, and other exploratory type investigations. The results of this study indicated that students learned and retained information best when lessons were incorporated into active learning activities. For example, students seemed to retain information regarding predator prey relationships quite well; this topic was taught through student participation in nature games. In fact, most respondents had vivid recollections of these activities and topics. Conversely, those lessons that were taught in a more passive nature, i.e. lectures, seemed to quickly fade from the students' memories. During the course of the field trip there were times when rangers lectured to students in order to convey information. Unfortunately, the students seemed to only vaguely remember this information following their field trip and as more time went by the memories of these types of lessons became even more vague. Overall however, the students viewed the trip as a positive experience and stated that the Deam Wilderness area would be a place that they would like to visit again. Knapp and Poff (2001), however, also found that this trip to the wilderness

area did not influence the students' inclination toward action on issues related to the area. Students, in fact, were disinterested in taking personal action in relation to environmental issues associated with the Deam Wilderness. While Knapp and Poff are uncertain as to the cause of this disinterest, they postulate that it may be related to the lack of student retention of ecological and environmental concepts that were part of more passive lessons. They argue that because students failed to retain this information that they will feel less connected to the area and thus not feel as motivated to act on its behalf.

Brody and Tomkiewicz (2002) conducted the first study to examine visitor experiences and learning outcomes in Yellowstone National Park. More specifically, these researchers investigated if and how experiences at Midway Geyser Basin changed visitors' understandings, beliefs, and values regarding specific geological and biological events that occurred at that location. Participants in this study consisted of 191 individuals. Some were interviewed in groups, others individually. Participants were interviewed before and after they toured the Midway Geyser Basin. Pre-tour interviews primarily focused on what participants already knew about the area while post-tour interviews centered on what they learned during their visit to the geyser, how that compared with their prior knowledge of the area, and their overall experience at the site. Brody and Tomkiewicz (2002) concluded that park visitors build upon prior knowledge, particularly when provided additional information in the form of an interpretation brochure. For example, one park visitor stated that he/she knew that bacteria existed virtually everywhere on the planet, but that he/she had thought that most of them would make you sick. However, after they toured the geyser area he/she stated that he/she could envision bacteria extending into the earth and that perhaps it was the origin of life on earth. From this, as well as other statements by participants, Brody and Tomkiewicz (2002) concluded that visitors were building upon their

prior knowledge to construct new understandings. In addition, Brody and Tomkiewicz's study indicated that while visitors to the geyser were building upon prior knowledge in order to deepen their understandings of biological and geological concepts, they were also developing deeper and more meaningful constructs by interacting socially while at the site. The data indicated that by discussing topics associated with the geyser with groups of friends, individuals demonstrated that they were sharing knowledge and negotiating meaning in order to incorporate the new information into the information they held prior. Finally, the researchers asserted that none of these lessons would have been as successful in the integration of new information if the individuals had not been learning where they were actually experiencing a geyser. In other words, the participants benefited from this experience because of its informal educational context.

Framer (2007) conducted a study to evaluate whether participation in informal educational experiences in Great Smoky Mountain National Park (GSMNP) influenced students' pro-environmental attitudes a year after their trip. This study involved thirty 4th grade students from an urban Tennessee school who took an all day field trip to GSMNP. While at the park the students participated in numerous activities including hands-on learning activities, and discussions led by park rangers. The data collected in this study revealed that student participants in this study retained long-term ecological and environmental content knowledge as well as an increase in pro-environmental attitudes.

In informal learning environments the facilitators or teachers are just as critical to a successful educational outcome as they are in formal learning contexts. In order to evaluate how teachers influence the educational viability of such informal educational experiences, it is just as important to study their roles as it is to evaluate student achievement. To learn more about the

role of teacher beliefs in informal education, Taylor and Caldarelli (2004) examined how environmental educators who work in informal educational settings described their responsibilities. The participants in this study consisted of 13 state and local park educators who regularly led visitors on various educational activities such as interpretive hikes, bird and wildlife watching, wildflower hikes, etc. Taylor and Caldarelli (2004) identified six themes associated with how non-formal educators made meaning of their teaching practices in state and local parks. One theme that they identified was that of perceiving themselves as "participant centered educator." This belief was found to express itself in several ways. For instance, it was found that participant centered educators tended to express themselves as comforters, and assessors, who appreciated individual differences amongst students. Those who tended to identify themselves as comforters did so because they felt it was necessary to quickly develop a rapport with their students as well as make them comfortable in the outdoor setting. One participant clarified the role of comforter by stating that "People that aren't going to interact with nature aren't going to feel comfortable with it ... the main thing is being comfortable outside ... and the more they know, the more comfortable they feel. (p. 458.)" The role of comforter was viewed as being a critical aspect of changing peoples' views on being in the outdoors.

In terms of the role of assessor, the educators stated that they had to quickly assess the group they were working with in order to evaluate their level of knowledge, misconceptions, and facilitate a connection with the park visitors (Taylor and Caldarelli, 2004). The role of assessor was viewed as being an ongoing aspect of their role as facilitator. The assessment process would begin as the educational activity started and would continue throughout the event. The educators felt that assessment of the group was one of the key factors that allowed them to connect with participants to keep them involved and interested in the activity. The assessment of the group

was also viewed as being critically important as the educators felt that it enabled them to recognize and appreciate the differences amongst their participants. The teachers expressed that this was an important skill to them because people learn in different ways; accordingly, they would need to adapt their teaching style and lessons to match the needs of the students.

Taylor and Caldarelli (2004) also found that educators in parks valued hands-on activities. Researchers found that the educators understood and embraced the fact that park visitors would have differences in the their learning styles, but that virtually all benefited from hands-on activities. One of the study participants stated, "I think hands-on activity is one of the best ways that people learn, actually doing things. There are different learning styles and different ways that people learn, but being involved and doing hands-on activities seems to make a connection (p. 459)." Another individual claimed, "If they can become an active participant in something, I think their experience is much better and they will tend to learn a little more (p. 459)." And while the participants felt that active learning was critical to the development of a quality educational experience they also emphasized that participant questions were equally as important. The questions allowed visitors to formulate the learning experience as would benefit them the most even if it meant that the program did not evolve exactly as the educator had intended. However, educators did note that sometimes visitor questions caused the teachers discomfort as they worried that program participants would ask them questions that they would be unable to answer or were controversial in nature. Regardless of the discomfort that teachers felt, the naturalist stressed that the visitor questions were an important aspect of the development of the learning experience. In addition, many of the naturalists did convey that if they were asked something that they did not know the answer to that they would often make a concerted effort to look up the information at the end of the program. The researchers suggest that it is

possible that this continual need to become more fully informed was responsible for the fact that many of these park interpreters expressed the need to be well versed in many different topics, but did not consider themselves experts on any one subject. Taylor and Caldarelli referred to this last quality as being a "jack of all trades." These are not all of the teacher beliefs that were uncovered by this study, but it is a representative sample that serves to inform the reader of the importance of educator perceptions in informal education.

Citizen Science in Informal Education

Table 4: Key findings and studies related to the use of citizen science in an educational context

Authors	Date	Key Findings
Brossard, Lewenstein and Bonney	2005	* The study did not show indicate any change in participants' attitudes toward science. * The study did not show any significant change in regard to participant attitudes in relation to the environment. However, pretest indicated that participants where concerned about the environment prior to joining the project. * There was no significant increase in the participants' understandings of the scientific process.
Evans, Abrams, Reitsma, Roux, Salmonsen, & Marra	2005	* Data collected indicated that being involved with this project participants scientific knowledge. * Data demonstrated that participants utilized scientific thinking during the course of the project: concern regarding quality and quantity of the data etc. * Many of the participants stated that they did not know how the data they collected would be used by the researchers. * The study also indicated that participants had a greater sense of place than they did prior to their involvement in the program. * Participant reported a greater awareness of bird and interactions between avian species and their habitat. * Participants began thinking about their yard as habitat
Bonney, Ballard, Jordan, McCallie, Phillips, Shirk, and Wilderman*	2009	* All participants indicated that they enjoyed the project and felt that they had increased their knowledge about invasive species. * However, there was little to no measurable difference between pre and post experience results in relation to the nature of science. * The majority of participants were concerned about

		environmental issues when they began the project and there was no measurable increase at the conclusion of the experience. * Nine percent of respondents indicated that they had changed their planting habits as a result of participation in the project. * Eighty six percent or participants reported considering whether a plant was invasive in their purchasing decisions at the end of the project compared to 78% at the beginning of the study.
Bonney, Ballard, Jordan, McCallie, Phillips, Shirk, and Wilderman*	2009	* Volunteers were trained to analyze water pH and how to choose study sites. * Participants frequently expanded the scope of the project to attempt to explain water quality issues * Participants frequently disseminated information regarding the project to their local community. * The project was expanded in scope because so many participants were investigating water quality issues beyond that of acid deposition * Evidence suggested that participant knowledge of water quality issues increased during this project. * Participants' attitudes toward science remained unchanged
Mankowski, Slater, and Slater	2011	* Motivation was the primary focus of this investigation * Retention was found to be an important to the success of the project * The opportunity to interact with professional scientists as well as feeling that they were contributing to the body of scientific knowledge were important motivating factors for participants * Participants were motivated by an inherent sense of making a difference in science. * Participants joined this project as it allowed them to return to a passion of their youth

* These studies are discussed in the same report, but have been separated in the above table because they look at different projects

Citizen Science as an Educational Context: Focusing on Adult Participants. Involvement in citizen science projects may be one type of informal learning that can be especially useful in increasing public understanding of scientific concepts and the nature of science. Until recently, according to Brossard, Lewenstein, and Bonney (2005), the majority of research related to scientific literacy and informal learning was conducted primarily in relation to museums. These

researchers remind us that facilities such as museums, zoos, aquariums, etc only represent one aspect of the informal learning context. As previously mentioned, many conservation organizations have a significant educational component, but little research has been done to evaluate its effectiveness in relation to scientific literacy. And while a number of citizen science projects are currently flourishing there has been little research done to document their impact upon participants' scientific knowledge and attitudes about science (Brossard, D., Lewenstein, B., & Bonney, R., 2005). These authors claim that while, yes, there are numerous types of informal learning that can be beneficial to developing scientific knowledge, citizen science is unique because it serves the dual purpose of meeting educational and research goals. However, Brossard, Lewenstein, and Bonney (2005) assert that in order for the research in informal learning contexts to advance scholars are going to have to develop techniques that allow them to make generalizations across multiple projects. This is one issue that they worked to address in their 2005 study related to The Birdhouse Network (TBN). Brossard, Lewenstein, and Bonney (2005) state that their objectives for the study were to: "1. assess the influence of participation in the project on the "participants' knowledge of bird biology and of the scientific process, and on their attitudes toward science and the environment, and 2. compare those data to national norms so that instruments could be developed for evaluation across citizen science projects (p 1100)."

The Birdhouse Network project asks that participants place one or more nesting boxes in their yard and then make observations while following one of four possible methodologies. Participants are provided with extensive information regarding the protocol that they choose, and are actively encouraged to correspond with TBN staff either electronically or by phone. The data from the study provided mixed results. While Brossard, Lewenstein, and Bonney had been hoping that their sampling methods would allow them to make correlations between their results

and national averages, this was found to not be the case. They found that the national data was too general in nature to allow for comparisons to smaller data sets as collected during TBN. The data failed to indicate any change in participants' attitudes toward science. The researchers gave two plausible explanations as to why this may have been the case. First, they postulated that this was related to the persuasive nature of the educational materials that were mailed to the participants prior to the start of the study. It had been assumed that these educational materials would initiate a "thoughtful process" that would eventually allow for a change in participants' attitudes. Secondly, the researchers proposed that the participants' attitudes toward science were more complex than they initially thought. The researchers emphasized that both of these explanations need further study in order to gain a fuller understanding of participants' attitudes toward science. Data also failed to show any significant change in regard to participant attitudes in relation to the environment. However, pretest results indicated that respondents were already very concerned about the environment before the study began. They also found no increase in the participants' understandings of the scientific process. Brossard, Lewenstein, and Bonney argue that this result may be due to the fact that individuals became involved in TBN due to an interest in birds and not because they wanted to participate in the scientific process. As a result, the participants most likely focused on the birds and did not concentrate on the explicit process of engaging in science. And because nothing in the program stressed nature of science content it is understandable that there were not significant changes in the participants' understandings of investigative processes. The fact that respondents did significantly increase their bird biology knowledge seems to lend credence to the researchers 'explanation. The results from this study seem somewhat surprising, but when one considers that the participants self-selected due to a primary interest in birds and not science in general the data seems to make more sense. Brossard,

Lewenstein, and Bonney (2005) claimed that if citizen science projects are going to be used to increase comprehension of the nature of science that the topic needs to be clearly and explicitly expressed to the participants.

Another project, Neighborhood Nestwatch, was developed to improve connection to place as well as knowledge about avian ecology in an effort to increase local conservation initiatives (Evans, Abrams, Reitsma, Roux, Salmonsen, & Marra, 2005). The program had two overarching goals. First, the project was to provide data to researchers studying a few bird species along the urban-to-rural transition area of Washington D.C. Secondly, Neighborhood Nestwatch was to inform residents of urban/suburban areas about bird biology. Participants were provided with written materials prior to the start of the project that included background material, contact information, and a description of participant tasks. For this project, participants were to observe nesting behavior and nesting success of eight common birds found on their property. They were also to be on the lookout for any banded birds that returned to their yards in subsequent years so that researchers could gain information about adult survival rates. Annually, researchers from the Smithsonian Environmental Research Center would visit each of the participants' property to mist net and band birds, as well as record physiological data about the birds that they capture. Participants were also encouraged to contact the researchers via email or phone if they had any questions. Data collected from interviews and surveys with participants indicated that being involved with this project and interacting with the researchers increased their bird related scientific knowledge. Ninety percent of the participants, even those with significant knowledge about birds, reported learning during the course of this project. There were also examples of participants utilizing scientific thinking. For example, several of the participants expressed concerns about the quality and quantity of the data that were collected during the

project. Others expressed concern regarding other factors, such as the presence of bird feeders, that might skew the results, or issues related to the scientific method. It is interesting to note that most of this evidence that points to scientific thinking emerged from emails to the researchers. The interview transcripts failed to bring out such trends related to scientific thinking, but did demonstrate positive trends related to scientific knowledge. Evans et al (2005) stated that they felt that Neighborhood Nestwatch had not yet reached its full educational potential. They mentioned that while several educational outcomes could be documented, that many of the participants stated that they did not know how the SERC researchers would use the data they collected. Findings from the study also indicated that participants had a greater sense of place than they did prior to their involvement in the program. Virtually every participant reported a greater awareness of bird and interactions between avian species and their habitat. In addition, there was a change in the way participants thought about their yard. They began to recognize that it had value as habitat, and more than 50% of them changed some aspect of how they behaved in relationship to their yard, through such actions as planting shrubs that would act as shelter or food sources, putting up nesting boxes, and keeping their domesticated cats inside when birds would be fledging their young. Evans et al felt that the interaction between participants and researchers was one of the key aspects of engaging scientific thinking skills in those involved, and this is perhaps one of the key elements that was missing with other projects that did not elicit increases in scientific thought.

Bonney, Ballard, Jordan, McCallie, Phillips, Shirk, and Wilderman, (2009) evaluated the impact of participation in various citizen science projects. One of the projects evaluated was "Spotting the Weedy Invasives," a project operated by Rutgers University. The project began in 2006 and was designed to engage hikers in the process of identifying and mapping the locations

of invasive species along 160 km of trails in New York and New Jersey. The project had four overarching goals that were researcher generated.

> "1. Generate a long-term dataset about the distribution and abundance of key invasive plant species
>
> 2. Help participants learn about the ecology of invasive plants
>
> 3. Help participants understand how project data will be used to draw conclusions about the establishment and spread of weedy invasive plants
>
> 4. Encourage participants to take personal action toward reduction or eradication of invasive plants (p. 25-26)."

The protocol for this project required that the participants attend a training session where they learned to identify the targeted species and data collection techniques. They were then assigned a specific section of trail that they were to collect data on. In order to collect data regarding the impact of this experience on their scientific knowledge, interest in science, and environmental issue awareness, as well as other selected items, participants were asked to fill out several questionnaires. They were asked to fill out one questionnaire following their training session, one following a data collection debrief, and one six months after they conducted their survey for invasives. Unfortunately, only 35% of the participants returned their questionnaires at the end of the project. The results of this inquiry provided similar results as to the TBN project. All of the participants indicated that they enjoyed their involvement in the project and felt that they had increased their knowledge about invasive species. However, in general there seemed to be little to no measurable difference between pre and post experience results in relation to the nature of science. However, nine of the 33 post-experience respondents reported that they had a greater understanding of the process of science than they did prior to their participation. Similar trends

were found in relation to environmental literacy. The majority of participants were concerned about environmental issues when they began the project and their was no measurable increase in this at the conclusion of the experience. There was a slight increase in participants' awareness and consideration of invasive species when making plant purchases. The percentage of participants reporting that they considered such information increased from 78% at the beginning of the project to 86% at the completion of the data collection. Similarly, 9% of respondents indicated that they had changed their planting habits as a result of participation. In addition, many participants reported that after they worked with this project that they were taking notice of invasive species in the environment and talking about them to other people (Bonny et al, 2009). As was the case in other evaluations of learning outcomes related to participation in citizen science, measurable increases seem limited by the fact that participants are relatively knowledgeable about science and environmental issues when they volunteer.

Another citizen science project that was studied by Bonney et al (2009) was the Alliance for Aquatic Resources Monitoring (ALLARM) Acid Rain Project (www.dickinson.edu/allarm). ALLARM was conducted in the state of Pennsylvania for over 20 years in order to address concerns regarding the lack of public awareness related to acid deposition within the state. Volunteers were trained to analyze water for pH and alkalinity and how to choose study sites. Following training, the participants chose their sites and began monitoring them once a week. According to Bonney et al (2009) this project was designated as a contributory type of Public Participation in Scientific Research. Bonney et al describe contributory projects as ones that are “research driven data-collection projects,' which is the most typical model of citizen science project (Bonney 1996, Bonney 2007, Krasny and Bonney 2005). However, participants frequently expanded the scope of the project by independently gathering additional information

regarding their study site in an effort to explain water quality findings. Many also chose to disseminate their findings to their local community. One of the most interesting outcomes of this project was that participants were directly responsible for expanding the scope of the study. Because so many of the volunteers were inquiring about water quality issues beyond that of acid deposition ALLARM expanded their mission to include additional water quality issues. And while ALLARM volunteers did not seem to alter their attitudes toward science as a result of participation in this citizen science initiative they did present evidence that their knowledge related to water quality issues increased throughout the project.

Not all citizen science projects are of environmental or even biological relevance. One non-biology-oriented project is Galaxy Zoo. Galaxy Zoo, according to Mankowski, Slater, and Slater (2011), was developed so that astronomers could enlist the public's help in classifying galaxies whose images were captured by the Hubble telescope (www.galaxyzoo.org). This project was begun in July of 2007 and by March of 2010 the website had achieved 60 million classifications (Mankowski, Slater, and Slater, 2011). Mankowski, Slater, and Slater (2011) conducted a study to evaluate trends regarding participants' motivations and their relationship to the overall success of Galaxy Zoo as a citizen science project. Mankowski, Slater, and Slater examined the Galaxy Zoo forum post to gain insights into the motivations of project participants. Although motivation was the primary focus of this investigation they found retention to be an important component to the success of the project. Mankowski, Slater, and Slater (2011), found that the opportunity to interact with professional scientists as well as feeling that they were contributing to the body of scientific knowledge were important motivating factors for participants. Interacting with professional scientists was found to be multifaceted in that participants also expressed that the break down of barriers between amateurs and professionals

enhanced the sense of community and was an important aspect of this project. The inherent lack of elitism within the Galaxy Zoo forum between amateurs and professionals, allowed participants to feel comfortable enough to ask questions and freely interact with working astronomers, and increased retention of volunteers in the project. Mankowski, Slater, and Slater (2011), also found that participants were motivated by an inherent sense of making a difference in science. Instead of simply enjoying the hobby of astronomy by observing celestial bodies through his/her telescope at night, they had the opportunity to contribute to papers and the body of knowledge surrounding their passion. Still others embraced this project as it allowed them to return to a passion of their youth. Many volunteers expressed that they had been interested in pursuing a career in astronomy when they were young, but that the required mathematics turned them away. Some women stated that they had turned away from astronomy because girls were discouraged from being interested in science and math. Additionally, many women stated that even today they feel discouraged from participation in astronomy related functions such as star parties and astronomy clubs. Galaxy Zoo allows women to be involved in a way where gender is less important.

Implications for Citizen Science Involving Youth Participants

Table 5. Key studies and finding related to educational outcomes from citizen science experiences

Delaney, Sperling, Adams, & Leung	2008	* Third graders were found to be 80% accurate and seventh graders were 90% accurate when distinguishing native from non-native crabs. * Seventh-grader were only 80% effective at determining crab gender * Individuals who had two or more years of higher education were found to be 95% accurate at determining species and gender.

Kountoupes and Oberhause	2012	* Adult interviewees stated that involving youth in "real" science and providing them with the opportunity to make a contribution to science was the primary reason that they participated in the project. * Adults felt that the above goals were achieved. * Adults stated that they felt that the use of scientific equipment was an important aspect of the youth feeling that they were involved in authentic scientific research. * Forty four percent of adult participants reported that the youth felt like real scientists. * Adult participants were very careful to maintain the scientific validity of the research project even though they modified the protocols to be more appropriate for younger audiences. * Adults worked to ensure that the youth were engaging in all steps of the scientific process.
Trumbull, Bonney, and Grudens-Schuck	2005	* Findings failed to indicate that participation in Classroom Feeder Watch facilitated student learning of scientific inquiry * Researchers found little teacher interest in having students participate in inquiry based projects * There was a slight increase in student understanding of scientific inquiry following participation in the project
Moss, Abrams, and Kull	1998	* Students found data collection tedious * Students did not understand the roll of their data collection in the overall project. * Students were concerned about collecting accurate data and took steps to be sure they followed the protocols exactly. * Students were only part of the data collection process not the other aspects of experimental design.
Clendening	2004	* Students gained experience with molecular biology techniques as well as analyzing results and trouble-shooting issues related to experimentation. * Students in group one were unable to obtain reliable PCR results. * In group two the researcher provided significantly more oversight and training for participants. * Seventy five percent of the students involved in project two obtained usable PCR results * All of the participants in group two reported that they understood PCR reactions and its uses more fully. * Ninety seven percent of the students stated that discussions surrounding the research allowed them to understand related topics much more fully.

A study conducted by Delaney, Sperling, Adams, & Leung (2008) placed its primary focus on the reliability of the data collected by volunteers. According to Delaney et al, this study is of particular interest as data reliability in citizen science projects is one of significant concern amongst the scientific community. The participants in this study ranged in age from three to 78. As one might expect with such a variety of ages, there was also a broad range of education within the group of approximately 1000 volunteers. The educational experience of the volunteers varied from pre-kindergarten to PhD. The participants in this study were to identify species, sex, and carapace width of crab specimens that were collected. They then separated the crabs by species and placed each group in a different bucket so that the research team could verify the data. Unsurprisingly, a volunteer's level of education was a strong predictor of their accuracy in the data recorded. However, it was found that third-grade students were at least 80% accurate and seventh-grade students were more than 90% accurate in distinguishing between native and invasive crab species. Determination of crab sex proved to be more difficult with seventh graders only being 80% accurate. Delaney et al (2008) found that for participants to be more than 95% accurate in determining crab gender and species that they typically required at least two years of higher education. It is interesting to note that Delaney et al (2008) asserted that lack of patience amongst volunteers could limit their utilization in certain studies. For example, they stated that some of the participants failed to complete the carapace measurements because they found them to be too difficult. However, all groups recorded all species and sex information.

The Monarch Larva Monitoring Project (MLMP) is a citizen science project that utilizes volunteers in United States and Canada to study Monarch distribution and abundance (Kountoupes and Oberhauser, 2012). Monitoring involves weekly measurements of Monarch egg and larval abundance in the volunteer's selected observation site. The focus of Kountoupes and

Oberhauser's study was to determine the degree to which adults engaged youth in participation in MLMP, what the adults' motivations were in doing so, and what were the perceived results of youth participation. The majority of youth participants in the project were found to be family members, neighbors, students and friends of the adult volunteers. All adult interviewees stated that involving youth in "real" science and providing them with the opportunity to make a contribution to science was the primary reason that they participated in the project, and they felt that this goal was met. Sixty seven percent of the adults who participated felt that one of the perceived outcomes of their involvement was the opportunity for young people to understand real scientific research. Youth participants were involved in finding patterns associated with Monarchs using scientific equipment; adults viewed this as an important aspect of creating a feeling of being involved in real science. Forty four percent of adult participants reported that the young people felt like real scientists. The youth participants felt that proper use and care of the equipment used during this project was critical to them feeling that they were involved in authentic science as a scientist. The adults involved in the project did actively nurture this feeling of being a real scientist. It was reported that some groups posted signs to recognize the youth who participated in the project. Another group wore "Jr. Lepidopterists" nametags while participating, and other group leaders simply made sure that the youth participants went online to observe the data that they collected. Given the findings of the Brossard, Lewenstein, and Bonney (2005) study, one result of the MLMP project was somewhat surprising. Kountoupes and Oberhauser (2012) found that adult participants were very careful to maintain the scientific validity of the research project even though they modified the protocols to be more appropriate for younger audiences. The adults made sure that the procedures could be reproduced. Furthermore, it was apparent that the adults took the science quite seriously and took steps to

convey that seriousness to the youth that they were leading. Kountoupes and Oberhauser also found that the adults were working to ensure that the youth were engaging in all steps of the scientific process. This included having the youth ask their own questions, as well as analyzing and presenting their own data. While on the one hand it may seem alarming that the adult participants were modifying the set protocols, Kountoupes and Oberhauser remind us that this may actually be more like what happens in research labs. As they state, one of the main functions of research laboratories around the world is to train the next generation of scientists, and frequently protocols must be modified to match with available resources including expertise and equipment. This may just be another example of how working in citizen science projects allows for participants to be involved in authentic science experiences.

Trumbull, Bonney, and Grudens-Schuck (2005) reported on a study that they conducted to evaluate whether participation in the citizen science project known as Classroom Feeder Watch (CFW) would assist students with learning scientific inquiry. However, results indicated that this was not the case, at least not with the first iteration of CFW protocols. Subsequent revisions of the protocols have occurred based upon this and other evaluations. The researchers at Cornell Laboratory of Ornithology (CLO) had noticed that hundreds of teachers had signed up to participate in numerous other projects related to the study of birds. All of those projects had been developed for educational contexts outside of the formal classroom. The staff at CLO thought that if they developed a project that was designed for the schoolyard that even more teachers would get their students involved in bird studies. For this reason CFW was designed specifically for a middle school setting and was field-tested in that context. In order to field test the CFW project 200 teachers from 32 states volunteered. Each teacher received a teaching packet that contained 15 explorations that could be used as units. Of those 15 units nine of them

were relevant to inquiry. One of the areas of primary interest in the evaluation were student-learning outcomes, particularly as they relate to inquiry. What the study showed was that while the majority of teachers utilized one of the explorations that were thought to foster understanding of scientific inquiry, having students conduct studies was not one of the reasons teachers participated in CFW (Trumbull, Bonney, and Grudens-Schuck, 2005). This information was garnered via a listserv devoted to the project. On the listserv teachers were mostly concerned with how to put up the feeders, what to feed the birds, and where to locate more information regarding birds. There were no posts asking questions related to student investigations. In terms of student outcomes there was some positive change related to their understanding of inquiry, but it was just a slight improvement. This may read as though CFW was a failure at increasing students' understanding of inquiry, but it is important to remember that this was a field test of the program in its earliest stages. The CLO staff recognized that the CFW materials did not contain enough information about how teachers could lead students through the process of moving to a more inquiry based way of thinking. Also, the CLO staff overestimated the perceived benefits of online data submission. The CLO staff had thought that students would view this sharing of data with researchers as a partnership and understand that they were directly contributing to the scientific process. Unfortunately, the evidence suggested that students failed to make such a connection. The staff, again, felt that if their curriculum materials had contained more information that these connections would have been more readily apparent. For example, if the materials had contained examples of how citizens' data collection had directly contributed to long-term national bird studies then students may have understood that the data they were entering online was beneficial to ongoing research. These are but a few examples, but repeatedly the CLO staff came to the conclusion that most of the issues that they uncovered would have

been cleared up with more information provided to the teachers. For example, because of the CLO staff's content knowledge associated with birds, it never occurred to them that the participants would have difficulty attracting birds, but they did. At first glance, as Trumbull, Bonney, and Grudens-Schuck pointed out, it would seem that feeder placement would be out of the scope of inquiry. But they realized that hypothesizing about feeder placement would indeed fall under the purview of inquiry. Regardless, subsequent versions of CFW contained more information concerning such topics. These findings allowed Trumbull, Bonney, and Grudens-Schuck to make the following recommendations:

> "(a) integrate into materials content knowledge about birds and about inquiry to enable teachers and students to successfully plan and conduct bird studies (b)provide discipline specific models for conducting inquiry (i.e., ornithologists' decisions related to designing bird studies), and (c) assess outcomes mindful of broad rather than narrow definitions of inquiry to better reflect the *Standards* (p893)."

These findings should prove to be useful as more citizen science projects become linked to educational outcomes and standards.

Another study evaluated student perceptions of their involvement in scientific research projects (Moss, Abrams, and Kull, 1998). All of the participants in this study were high school students who were enrolled in a project-based Conservation Biology class. There were seven total participants in the study: four males and three females. During the course the students participated in three research based projects throughout the school year that were created to foster partnerships between students and researchers. These projects were: 1) local watershed monitoring 2) land use/land cover mapping 3) a statewide environmental monitoring program

called Forest Watch. Forest Watch and the local watershed monitoring project made up about three fourths of the year. Several themes emerged through the course of this study. First, as data collection took up a significant portion of the year it was viewed as being tedious. It was reported that while students collected significant amounts of data that they did so without understanding how it was related to the overall project. However, it was noted that several of the students mentioned the importance of accuracy when collecting data and were very careful to follow the protocol exactly. In addition, as data collection was the primary activity in which students were involved, very few of them were able to state the research questions for the projects. The researchers suggest that this disconnect with the guiding questions may have been because the students were not involved in their development. As such, they were not personally invested in the questions or even drawing conclusions. Some of the students did conduct some data analysis, but the majority of them were only involved in data collection. The researchers also suggest that the lack of direct student/researcher contact may have led the students to believe that the project was not an ongoing authentic study even though their teacher described it at length. In other words, they had no personal ownership of the project. They were simply there to collect data (Moss, Abrams, and Kull,1998).

The majority of citizen science projects are related to ecology, geology, astronomy and conservation efforts but it is unusual for them to be related cellular biology (Clendening, 2004). According to Clendening, the scientific content of molecular biology is often thought to be too complex for non-professional scientists. Furthermore, it was thought that researchers would receive little benefit from involving non-professional scientists, but numerous tasks related to molecular biology research have previously been thought too difficult to be accomplished by volunteers and students. Clendening (2004) reports that on two separate occasions she formed

partnerships with high school teachers to involve their students in molecular biology research. In the first partnership students isolated DNA from *Drosophila melanogaster*, designed primers and conducted PCR amplifications of DNA. The students conducted the experiments, analyzed data, and passed the results on to Clendening. Clendening, in turn, was available to offer assistance throughout the project. From an educational perspective the project was a success. The students gained experience with molecular biology techniques as well as analyzing results and trouble-shooting issues related to experimentation. Unfortunately, the program was canceled due to issues related to class time restraints. The partnership, according to Clendening, was less satisfying from a research perspective. The students were unable to obtain reliable PCR results. There were numerous possible reasons for this, but regardless the researcher felt that in order for this project to be successful that it would require significant more oversight by her. For the second project, Clendening states she invested significantly more time training the teacher and supervising the students. At the conclusion of the project 75% of the students obtained usable PCR results and all of the participants reported that they understood PCR reactions and its uses more fully. Ninety seven percent of the students stated that discussions surrounding the research allowed them to understand related topics much more completely. For instance, students claimed to have a better understanding of DNA synthesis and the biochemical nature of DNA than they did prior to the experience. Fifty percent of the students reported that participation in this project provided them with a deeper understanding of scientific research. The researcher was somewhat discouraged by the limited results given the time demands placed upon her; however, she did feel that such projects could produce greater results with less time demands in the future.

Summary of Chapter 2

Chapter 2 included a discussion of the salient literature related to informal education and citizen science in the United States. The chapter began with a discussion of the history of informal education including its roll in museums and environmental education. The chapter concludes with a discussion of citizen science as an educational context for both youth and adult programs. Chapter 3 will provide an overview of the research design for this study as well as a discussion of the theoretical and methodological frameworks.

CHAPTER 3

METHODOLOGY, THEORY, AND METHODS

Chapter three provides the reader with the methodological and theoretical frameworks that were used throughout the study. This chapter begins with a discussion of the overall context for the study. Next will be a discussion of how the theoretical and methodological frameworks were utilized to frame the study. The chapter will conclude with a thorough explanation of the methods that were utilized to conduct the study, a description of the data analysis process and an introduction to each of the participants.

Context for the Study

This qualitative study was situated at Great Smoky Mountain Institute at Tremont (GSMIT). Great Smoky Mountain Institute at Tremont is a residential environmental education center that is housed within Great Smoky Mountain National Park. The clientele of GSMIT is fairly diverse. According to GSMIT's website (n.d) they have participants from virtually all levels of education. This means that individuals visiting GSMIT range from elementary school to college age. In addition, GSMIT offers programing for teacher development, and elder hostel (Road Scholars), as well as summer camps for individuals ranging in age from nine to seventeen. Two of these camps (Field Ecology Adventure, and Girls in Science) are science focused and the participants spend their entire time at GSMIT studying science topics in depth. Great Smoky Mountain Institute at Tremont also has several citizen science interns on campus during the summer months that work with the citizen science coordinator to collect data and assist with summer science camps. And while GSMIT's primary objective is centered on bringing paying

customers into their programming they also have numerous volunteers who are instrumental in data collection for their in-house citizen science projects. Regardless of their age group or when they attend GSMIT, many of these individuals will participate in citizen science during their visit. Any of these groups may visit GSMIT at anytime of the year, but the primary clientele during the academic year predominantly consists of fifth and sixth graders from schools in the southeastern United States. The typical school group comes to GSMIT for a three to five day visit with most groups being in residence at the park for three days. While at the park the students participate in various activities including forest ecology, daylong hikes, and stream ecology. While citizen science is just one of the many experiences in which students participate during their stay at the park, it is viewed as an important aspect of the teacher-naturalist's work to "connect people and nature." The students are asked to help with data collection for authentic citizen science projects and this is a time when they will really get their hands dirty, muck in a stream, hold a salamander, measure it, weigh it, and hopefully begin to realize that science is more than just sitting in a classroom and listening to a lecture.

Theoretical Framework

The theoretical framework for this study draws upon the works of ecojustice scholars and the assumptions of place based science education. Ecojustice is a philosophy that merges the ideas of social justice with concerns for ecological sustainability (Mueller, 2009), while place-based education, according to van Eijck (2010), is focused upon teaching and learning that is situated in the students' place. In other words, place-based education is centered upon what is local to the students, and includes many aspects of their lives such as their school, neighborhood, town, or community. These two theoretical frames embody much of the lived curriculum at GSMIT.

Ecojustice.

What is meant by ecojustice. Mueller (2009) identifies the central focus of ecojustice philosophy as "developing an understanding of the tensions between cultures (i.e., intergenerational knowledges and skills, beliefs and values, expectations and narratives) and the needs of the Earth's ecosystems (p. 1033)." Therefore, ecojustice philosophy endeavors to analyze what is fair in terms of preserving and protecting diverse cultures while simultaneously conserving ecological systems (Karrow and Fazio, 2010). In this process ecojustice is a philosophical perspective which enables individuals to assess how cultural assumptions frame and construct the world around them as well as how those assumptions influence how they treat others, including both humans and nonhuman beings. Ecojustice philosophy includes attempts to balance the tensions between cultural systems and environmental systems by analyzing what resources should be conserved and how the use of these resources can be less taxing on ecological and cultural systems. Juker (2004) states that ecojustice calls for the equitable sharing of resources between all individuals on the planet, not just humans. This means that when decisions for "progress," "development," and "growth" are considered within a community that society will have to look beyond just the needs of *Homo sapiens* and consider the requirements of the other species and ecosystems that will be impacted by such actions. Ecojustice philosophy argues that the inequitable distribution of power that ranks humans over nonhuman species or even some humans over others (related to class, culture, etc) is unjust, but yet is passed on through our cultural norms such as language (Lowenstein, Martusewicz, and Voelker, 2004). Bowers (1995) claims that most citizens of western culture fail to recognize that the consumer oriented lifestyles that are explicitly and implicitly encouraged by society are directly related to the decline of environmental and/or ecosystem health. Furthermore, according to Bowers, the

majority of the population also fails to recognize that the formal education system is a powerful force in maintaining the cultural status quo of consumerism and globalization. Ironically, it is also one of the most promising forces for developing a deeper understanding of how these cultural norms are negatively impacting the environment. Bowers (2006) emphasizes that it is uncertain whether these institutions can be reformed from their current focus on maintaining and expanding the worldwide presence of western industrialized culture to embracing a broader view of sustaining other cultures and the earth's natural systems. To work toward this objective ecojustice philosophy maintains that communities should work to protect and revitalize their cultural and environmental commons (Martusewicz , Lupinacci & Schnakenberg, 2010).

The role of the "commons" in Ecojustice. The concept of "commons" is multifaceted. According to Bowers (2006), the commons, historically, were the environmental aspects of the community required for subsistence; pastures, forests, lakes, streams, etc. In other words, the commons were the aspects of the environment that citizens depended upon to provide for their families. More recently, the definition of the commons has expanded to include more intangible items: air, language, narratives, craft knowledge and technology, to name a few (Bowers, 2006). These are aspects of the community and culture that are common to the majority of individuals of an area even though they are not "owned" by anyone person. They belong to everyone within the community and they do not require money to be accessed. For these reasons, it seems rational that the national parks of the United States could be considered a "commons." While some parks can only be accessed with an entrance fee, Great Smoky Mountains National Park does not require one. Furthermore Great Smoky Mountains Nations Park is not gated, and people can access it easily. Citizens can come to the park for a day of relaxation or a longer vacation, but

while they are there it can also act as a classroom. This is one role fulfilled by GSMIT as well as other entities in the park. By visiting GSMIT individuals can learn about the local flora and fauna as well as history of the park. For example, while Monarch tagging in Cades Cove participants learn about the life history of Monarchs as well as other butterflies and moths that are caught. They may also learn about plants in the area and the ecology of Cades Cove. This is just one of the many possibilities of using the park as a classroom.

Great Smoky Mountain Institute at Tremont strives to make connections between the participants in their programs and the environment, specifically the ecosystems of Great Smoky Mountain National Park. Certainly, the natural environment should still be considered part of the commons, particularly that of the US National park system. While it could be argued that the National Park System is "owned" by the US government and therefore should not be considered a "commons" it seems logical to assume that most US citizens view these parks as commons that everyone has a right to access and utilize. It also follows that students who are participating in the programs at GSMIT will develop some affinity for Great Smoky Mountain National Park and this may help to revitalize these areas. Furthermore, ecojustice philosophy asserts that in order for individuals to make just decisions regarding ecosystems and society they must be engaged within their local community. While the work at GSMIT is not "local" to the majority of the students who attend their programs, it could be argued that since these students are primarily coming to GSMIT from schools in the southeast region that it is local in the sense that what applies at GSMIT will likely apply in their local communities as well. There will be aspects of the students' communities reflected within the context of GSMIT and the ecosystems there.

Education's Role in Ecojustice. According to Bowers (2004), an ecojustice framework argues that educating individuals is a critical aspect of ensuring that resources are available for

future generations and the revitalization of the commons. Juker (2004) maintains that education is a critical aspect of developing a more just society in terms of culture and environment. He states that teachers play an important role in this process. Juker maintains that if teachers are to expect students to embrace change and alter their lives then they must model such behavior. He builds upon this claim by stating that if educators are only preaching to their students about the just use of resources while they themselves are refusing to recycle or they treat nonhuman species in an unjust manner then it is going to be difficult for their students to believe that an ecojustice consciousness is truly necessary. This is a monumental undertaking, as it requires educators to alter their behaviors as they are asking their students to modify theirs. Furthermore, teachers need to become educated themselves about matters of ecojustice and sustainability in order to teach about them. Juker goes on to state that in addition to modeling the change that they desire in the world that educators need to embed their lessons in the local community to truly be effective. Juker maintains that if students only hear about global issues that are far removed from their immediate lives they will feel more disconnected and resist embracing new behaviors. In addition, educators must work to develop critical thinking skills with their students. Juker states that students need to understand the nature of knowledge so that they will have confidence in their own decisions and actions. For these reasons ecojustice is an important lens through which to view citizen science at GSMIT, particularly in relation to the message of "Connecting people and Nature." The just use of resources and reverence for culture is woven into almost every lesson that students participate in at GSMIT. In fact, ecojustice, while not explicitly referred to, appears to be the underlying framework of much of the lessons and activities at GSMIT. At first glance, ecojustice seems to be at the heart of "Connecting People and Nature," but it is necessary

to gain a greater understanding of what that means to the GSMIT staff before this can be assessed.

Place-based Education.

An overview. To understand how place based education influences the theoretical framework of this study, it is first necessary to consider what the term implies. Sobel (2004) describes place-based education as:

> "The process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science, and other subjects across the curriculum. Emphasizing hands-on, real-world learning experiences this approach to education increases academic achievement, helps students develop stronger ties to the community, enhances students' appreciation for the natural world, and creates a heightened commitment to serving as active, contributing citizens. Community vitality and environment quality are improved through the active engagement of local citizens, community organizations, and environmental resources in the life of school (p. 7)."

Smith and Sobel (2010), condense this definition by describing place-based education as "an approach to teaching and learning that connects learning to the local. (p.viii)." They argue that place-based education is a critical response to what they term the "community deprived" nature of American classrooms and experiences. They maintain that this diminished sense of community is because American culture has become more electronically focused, resulting in youth who are losing touch with both the natural world and the people that make up our society.

The electronic based disconnect. Americans are spending significantly more time interacting with electronic media than they did in the past, furthering the disconnect between citizens and the natural environment (Louv, 2005). Louv asserts that this shift towards

electronics is one of the primary reasons that American national parks are experiencing a decline in the number of visitors annually. According to Louv, national park attendance declined by almost 25 percent between 1897 and 2003. Louv states that this is because the time Americans spend interacting with electronics has increased considerably and has resulted in less interest in park visitation. He goes on to state this is just one of several reasons that park visitation has declined. Louv states that other reasons that people are not going to national parks include a shortage of family time, a widely held belief that people only visit parks to view scenery, shorter vacations, and increased entrance fees. Regardless of the exact cause, visits to the national parks are declining. Fewer visitors means that parks are generating less revenue, which makes it difficult to maintain them adequately. Louv views this as just one more example of Americans becoming more disconnected from nature.

Gruenwald and Smith (2008) agree that people are more disconnected from the natural world than they have been in past generations. In fact, they view the American education system as being complicit in this disconnect rather than working to alter the trend. The reasons for this are multifaceted. According to Gruenwald and Smith, schools encourage individuals to reject their local communities and to seek out the life elsewhere. This life would mimic the ones that they see advertised on all of the electronic media with which they so readily engage instead of one where they are engaged in their local communities interacting with the environment and other members of the population. In addition, as Gruenwald and Smith state, many people find it necessary to move away from the communities where they were raised or have long-term bonds in order to earn the wages they need. In fact, they may find themselves moving many times and only spend a short period of time in an area before they need to relocate again. For many individuals this means that they do not form meaningful connections to other people, the

community or the environment in which they live. In other words, they remain unattached to the place where they live (Gruenewald and Smith, 2008). Gruenewald and Smith maintain that place-based education is one aspect of what they calls the "new local." The new local is grounded in "place" and works to fight against the forces of globalization by providing students with the skills they will need to maintain their connections to their community.

Place-based education and community. Community is the focus of place-based education. In addition, place-based education is multi-disciplinary in nature (Smith and Sobel, 2010). Smith and Sobel claim that there are two critical aspects of place-based education with the need to be interdisciplinary being the first. According to Smith and Sobel, place can be utilized to teach any subject whether it be math, social studies, science, or language. The second key component of place-based education requires that members of the community be involved in student learning. In other words, education and the responsibility for teaching the students of the neighborhood, city, county, etc. falls on all of the community members and extends far beyond the walls of the school buildings. Any place of business or community meeting spot holds the possibility of being the locus of education for the community. Many place-based scholars agree (Bowers, 2001; Gruenewald and Smith, 2008; & Sobel 2004) that the current model of education in the United States has served to separate youth from their communities. According to Gruenewald and Smith (2008), public education in the United States has become intent upon training children to become part of the global market place, either as consumers or as workers. Historically, education in the US has focused upon preparing youth so that they can obtain jobs that will benefit the US economy and the US competitive edge globally. According to Inkeles and Smith (1974), the massive expansion of the education system following World War II was accompanied by an equally large increase in economic activity. There was significant "progress"

in weapon development, science, and technology. This led to the establishment of a lasting link between perceived technological dominance and a sense of military security. As a result, the United States federal government began to invest in educational programs that had previously been the sole focus of the local governments. Smith and Sobel (2010) claim that in the 1980s, when government officials began to worry that the US was losing its economic edge to Germany and Japan, *A Nation at Risk* (National Commission on Excellence in Education, 1983) stepped in and equated the educational failures of the United States to a similar lapse in military defense. The United States' global economic position was being threatened and this was perceived as being analogous to a direct military threat. This is when the US educational focus, according to Smith and Sobel (2010), began to shift towards its focus on accountability and standards and cemented the move away from the focus on a local centered education for students. This conflation of education with the United States' economic prowess continues today. Smith and Sobel go on to express that schools are one of the few mechanisms available that may be able to counter this trend.

Methodological Framework

This study utilizes an interpretive research design centered on the use of citizen science as an educational context at GSMIT. According to Erickson (1986), interpretive research focuses on how individuals within a particular setting construct understandings. It concentrates on the meaning of actions in face-to-face interactions and how those behaviors influence society. The way in which people derive meaning from their interactions is a critical aspect of interpretive research as it focuses upon taking something familiar and making it strange. For example, most individuals are very comfortable at work. They anticipate their days and personal interactions to proceed in predictable ways and, as such, they are unlikely to see the nuances that are present in

those experiences. Interpretive research works to upset that sense of comfort and strives to bring a fresh set of eyes and perceptions to the familiar making it new and unfamiliar. Interpretive research brings the unseen to the center of focus and the researcher then records it so that he/she can scrutinize the assumptions present in the smallest of actions. Eisenhart (1998) builds on these ideas by stating that one appealing aspect of interpretive research is its potential to reveal something new and potentially surprising. A person can have ideas that seem to be coming from opposing view points merge and coalesce into something new, interesting and refreshing. Meacham (1998), in response to Eisenhart's essay, explicitly mentions how he was surprised by the merging of the ideas of urban and environment to create something new and exciting. Typically, when one thinks of urban, they envision buildings, vehicles, noise, and lots of people. By contrast, when they envision the environment they picture mountains, streams, wildlife, quiet, and solitude. In other words, frequently these ideas are at odds with one another, but through interpretive research Meacham recognized the possibilities of merging concepts and creating exciting possibilities. To illustrate this point Meacham refers back to Eisenhart's merger of the concepts of "urban" and "environment" and that when he sees something titled "Urban Environmental Education" he no longer views two dissonant topics, instead he anticipates a program that would help urban youth to identify and act upon environmental issues that are impacting their communities.

Klein and Myer (1999) build on work of these scholars by stating that research is interpretive if it assumes that individual knowledge is built through social interactions. For instance, individuals construct ideas from shared language, experiences and documents. Through these interactions their understandings and knowledge are constructed so that there are shared connections within the community. Erickson (1986) points to this as one of the reasons why the

local meanings of interactions must be considered by researchers through extensive field studies. On the surface, related activities at different schools or communities may appear to hold similar meanings, but once the researcher delves more deeply into the interactions amongst participants he/she may realize that the local actions hold very different meanings in each of these locations. For instance, as Erickson describes, the direct question of a student may be perfectly acceptable in some situations, but may be viewed as punitive in others. For this reason, it is important that the researcher considers different perspectives and move out of his/her own biases as he/she conducts a study.

In addition, interpretive research does not seek to predefine independent and dependent variables, as would occur in quantitative research, but instead, seeks to develop understanding of phenomenon through the meanings that individuals assign to events. The researcher develops understanding of these phenomena as the situation emerges, which is why substantial time is required for contemplation and analysis of the data. Tobin (2000) states that interpretive research is useful in studies that ask broad questions seeking to gain understanding of communities in terms of the actions of the participants. According to Tobin, it is important to remain open to the emergent qualities of interpretive research, including the selection of the participants. While the researcher must identify the primary participants of the study he/she must also remain ready to include additional participants as they present themselves as being important to the study. Tobin stresses this point by including an example where their research group had to be responsive to just such a situation. They had selected the participants for a particular study, being sure to include individuals throughout the spectrum of learners. During the course of the project groups were shuffled in the classroom and due to personal dynamics in the class it became important to bring additional people into the study. If the researchers had remained rigid in their original

research design then they may have missed valuable information that could be obtained from these additions. Or worse, the project may have ultimately collapsed as the class structure was altered. This flexibility, in terms of participants, is just one important facet of interpretive research, according to Tobin. In addition, the researcher needs to leave ample time for ongoing analysis and interpretation of the data as it is collected so that he/she can modify the design of the study as themes emerge. He goes on to offer a word of caution, however, by reminding the researcher to be mindful of the fact that while it is important to recognize that the emergent design nature of interpretive research allows him/her to be responsive to the events surrounding the data collection it is also subject to personal biases of the values and experiences. In other words, no two researchers will view unfolding events in the exact same light. Eisenhart concurs with Tobin's sentiments, but couches the notion in terms of one of the most attractive aspects of interpretive research. She reminds readers that individuals interpret and respond to the world through their own experiences and that before researchers can truly understand the events of their study they must understand the different views that participants hold. As an example she notes how she personally views graffiti differently than someone who participates in the act of graffiti. She points out that most of her understandings and perspectives on graffiti were formulated by the media and written accounts of others from similar backgrounds as she. Eisenhart suggests that someone who participates in graffiti will have a completely different view because his/her ideas and opinions are based on first hand experiences. So, if a researcher were to try to understand the ins and outs of graffiti writing without seeking out different viewpoints then he/she would be left with an incomplete picture. Denzin (1989) reminds us that we can never view the experiences of participants without interjecting our own biases into the interpretation. In addition, as human beings, research participants are continually evaluating what to share and

how they choose to reveal their thoughts and experiences. As a result, there is no completely objective reality for a researcher to uncover. All interpretive research is impacted by the participants' and researchers' actions and experiences. An interpretive research design was especially useful for this study, as it requires the researcher to obtain rich and thick descriptions of the settings that she was studying, while at the same time including in depth interpretations of the participants' accounts. The development of these thick descriptions allowed for the cultivation of an in depth understanding of how and why citizen science is used as an educational context at GSMIT. The emergent nature of interpretive research was especially informative in this context.

Participants

The participants of this study were selected because it was thought that they would give the most informative overall description of the use of citizen science at GSMIT. The primary participants in this study consisted of two members of the GSMIT administrative staff, two current interpretive staff members, the current citizen science coordinator, and two former citizen science coordinators of GSMIT. One of the participants has worked at GSMIT since 1984. That individual was included so that the study would benefit from the institutional memory he could provide. Others were included based upon their roles at GMSIT or because they were recommended by other participants. The individuals from the interpretive staff were selected by snowball sampling (Patton, 2002). The administrative staff members were interviewed first and were asked who among the current and former interpretive staff should be interviewed and shadowed for this project. The first two interpretive staff to be interviewed were asked to identify two additional participants for the study. Pseudonyms were used to protect the true identities of the participants

Introduction of the participants. Jeff: Jeff has been with GSMIT since 1984 and is a member of the administrative staff. He has a Bachelor's degree in Parks and Recreation and a Master's degree in experiential education. Before he began working at GSMIT he taught environmental education programs in Ohio, North Carolina, Minnesota, Pennsylvania, and Tennessee. In addition to working at GSMIT, Jeff and his family also live on the Tremont campus.

Stiles: Stiles is also a current member of the administrative staff at GMSIT. He has a Bachelor's degree in English literature, which he claims is a bit of anomaly at GSMIT and a Master's degree in Natural Resources and Environmental Education. Prior to his arrival at GSMIT, about five years ago, he worked in Yosemite National Park. He also has worked in environmental education in New England, Georgia, and abroad as a member of the Peace Corp.

Matt: Matt served as the very first Director of Citizen Science as GMSIT (the title has since morphed into Citizen Science Coordinator). Matt grew up in Michigan and from a young age found himself intrigued by nature. Ornithology has been a passion of his since he received his first pair of binoculars at the age of twelve. He went on to earn a Bachelor's degree in science from Cornell University and a Masters degree in Conservation Ecology from University of California at Davis. Throughout his career he has worked to merge science and education and this lead to a natural interest in citizen science. Matt now works for the park service in Great Smoky Mountain National Park where he is still involved in citizen science.

Sarah: Sarah is the current Citizen Science Coordinator at GSMIT. At the time of data collection she was in her first year at GSMIT. As part of her duties as the Citizen Science Coordinator she oversees the existing programs at GSMIT. This includes coordinating volunteers, teacher-naturalists, and school groups to be sure that the data is collected at the appropriate times. She also works with the citizen science interns during the summer to collect data, in addition to working the summer camps. Beyond these duties she also teaches as a "teacher-naturalist." Sarah grew up in Virginia where her educational background was predominantly science oriented. She obtained a bachelor's degree in Wildlife Science from Virginia Polytechnic Institute and State University and a master's degree in Wildlife Science from University of Tennessee at Knoxville. She, too, is passionate about merging science and educational opportunities at GSMIT.

Tricia: Tricia is a teacher-naturalist at GSMIT, and has been working there for two years. She has been involved in environmental education for a decade and is very passionate about citizen science. She holds a bachelor's degree in biology and a master's degree in environmental education. She works with all age groups and loves helping people to learn about Great Smoky Mountains National Park.

Hannah: Hannah is also a teach-naturalist at GSMIT. She worked with GSMIT for five years, but shortly after the data collection phase of this study Hannah resigned to pursue other endeavors outside of education. She stated that she was drawn to GSMIT because she loved the Smokies and was passionate about education. Prior to coming to GSMIT full time she volunteered as an intern for a couple of summers. Hannah also had experience as a day camp

counselor in Kingsport, Tennessee before she came to work at GSMIT. However, she effectively came to GSMIT immediately after graduating from college.

Simon: Simon was a former citizen science coordinator at GSMIT and was there from April 2006 until September 2008. He still returns to the facility to assist with training periodically. It is clear that he is passionate about citizen science. In fact, he is currently working to have the data from the ongoing aquatic salamander project published. He holds a bachelor's degree in Forest Resources from the University of Georgia and a master's degree in Wildlife and Fisheries Resources from West Virginia University.

Methods of the Study

This interpretive study utilized several methods including; case study, oral history, observation, and interview In addition, researcher journal entries informed this study.

Case study. According to Stake (1995),

"A case study is expected to catch the complexity of a single case. A single leaf, even a single toothpick, has unique complexities - but rarely will we care enough to submit it to case study. We study a case when it itself is of very special interest. We look for the interaction with its contexts. Case study is the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances (p.xi)."

Case study as a research method has been used frequently in many diverse academic fields including psychology, sociology, political science, and numerous others (Yin, 2009). Each of these fields of study are focused upon developing an in depth understanding of complex social phenomena, and case study method allows the researcher to do this. Case study methods allow

researchers to capture the key elements of social behavior and interaction of real life experiences while developing an understanding of how these relate to the research questions. These interactions may include small group behavior, organization processes, school performance, and numerous other aspects of every day life that are key to understanding critical aspects of human behavior. Stake (1995), reminds us that one critical aspect of case study method is determining exactly what the case will be or how the case is bound. For instance, in an educational study the case could be a single student, a teacher, a group of students from one class, or a unique educational program, but the reason behind implementing that program or the relationship between different schools or classes are not generally considered as cases. According to Stake, these items that are not to be considered cases are generalities while a case is specific. He goes on to state that a program works well as a case, while events and processes less so. Case study methods are an appropriate method for this study as it is focused on a particular aspect of the curriculum at GSMIT, citizen science. It is the use of citizen science at GSMIT that is the case, and the data generated through this research was utilized to develop a case study of citizen science as it is viewed and enacted by staff at GSMIT. In order to develop a rich and meaningful case study of citizen science at GSMIT it was necessary to use multiple data collection methods (Yin, 2009). This case study was developed through the use of oral history methods, interviews, observations, and archival data. It was formed by the individual stories of the participants and bounded within the context of citizen science (Patton, 2002). Each of the participants' stories could be considered an individual case, but this study focused, instead, on developing a larger case that considers the use of citizen science at GSMIT. The data that was collected was analyzed to coalesce a deeper understanding of the role of citizen science at GSMIT. As Stake (1995) describes, the purpose of case study is to learn about a particular program in great detail.

It is not about making generalizations regarding citizen science in all educational contexts. Instead, the purpose of this study is to deeply understand citizen science at GSMIT.

Oral histories. Oral histories are used to develop one's individual story of events or to gather a snapshot of events from many individuals (Suchan and Brewer, 2000). Reinharz and Davidman (1992) state that while oral histories are similar to interviews, but they are broader in nature. Oral histories will cover a wide range of topics, as the participants are encouraged to tell their own stories of their lived experiences by remembering pivotal events. Janesick (2007) states that oral history has a history of its own and has evolved over time. Originally, oral histories focused on the famous and privileged members of society. For example, people who were initially interviewed for oral histories were famous politicians, actors, scientists, etc., but the method has evolved over time to include the histories of average citizens sharing their stories. Janesick goes on to assert that oral histories are more than just a collection of audiotapes and transcripts. They move beyond that due to the analysis and interpretation that is conducted by the researcher, and as Janesick would argue, the participants as well. Oral history method allows for participants to tell their own stories in their own words. So, the participants begin the interpretive process by deciding how to tell their own individual story. Thompson (1988) makes the case that oral history is more than just a nice way to present information; it is a critical technique for obtaining information that may be missing from the public record. He illustrates this point, by sharing how the official documentation regarding mining operations in Britain during the late nineteenth century was lacking, fragmented, and misleading. One researcher turned to interviewing individuals who participated in the various aspects of mining during that time. What was found was that these interviews provided a much more descriptive and rich understanding of events of

that era. Furthermore, these interviews were found to correct significant errors that were originally found in the public records. Thompson repeatedly indicates that oral histories are a critical tool in social research for two reasons. First, oral histories can provide a look at experiences from all perspectives. In terms of the mining industry it would mean telling the stories of those who worked in the mines, as well as those individuals who ran the mines. Secondly, oral histories can tell more of the whole story than documents alone. Oral history was especially useful within the GSMIT context as each person's understandings and relationships with citizen-science at GSMIT were different and evolved over time. For these reasons, an understanding of the role of citizen science at GSMIT through oral history methods was critical to the development of this study, as it provided a critical longitudinal and personal perspective to the research topic. The oral histories of the executive director, and a former director of citizen science at GSMIT provided an exciting and novel perspective into the role of citizen science at GSMIT over time. The construction of the oral histories of these individuals allowed for the formation of a mosaic of citizen science that integrated each of their different perspectives.

Interviews. Interviews are a critical component of data collection for the development of a case study (Yin, 2009). Yin claims that interviews are more important than survey data as they are a conversation, which unlike that of surveys, is more fluid and allows for the researcher to venture off script and pursue lines of interest as they develop. Stake (1995) reminds us, however, that it is important to have a structured plan for the interview to keep the conversation focused on topics relevant to the research questions. He goes on to suggest that getting a good interview is not an easy task. Yin (2009) builds on this assertion and points out that during the interview process the researcher must be sure to stay focused on his/her subject, as Stake mentioned, and

ask the interview questions in an unbiased manner. Furthermore, the interviewer must maintain a friendly, nonthreatening demeanor while simultaneously adhering to the research agenda. In this study, two semi-structured interviews were conducted with two members of the administrative staff, two current interpretive staff, the current citizen science coordinator and two former citizen science coordinators. These interviews were separate from the oral history interviews that were previously mentioned. Each interview lasted approximately an hour. The interviews of current employees took place summer and early fall 2011 at GSMIT near Townsend, Tennessee. One of the former citizen science coordinators was at GSMIT for the initial interview and at his current place of employment for the second. The other former citizen science coordinator was interviewed in person at his place of employment for the initial interview, but the followup interview was conducted by phone as he was working out of state for several months. Both of these interviews focused on the role and context of citizen science at GSMIT. The initial interview with participants allowed for their descriptions and experiences with working at GSMIT and the role of citizen science at the facility. The second round of interviews centered upon the participant's interpretations of the meaning of GSMIT's motto of "Connecting People and Nature," the nature of citizen science and its relationship to their educational objectives, and follow-up questions regarding the initial interview and observations that were conducted.

Observations. In addition to oral histories and interviews, two of the current interpretive staff at GSMIT, as well as the current citizen science coordinator (who is also a teacher-naturalist) were observed while working with students to collect data for citizen science projects. The projects that the GSMIT visitors were engaged in while these observations were conducted were: aquatic salamanders, bird banding, and monarch tagging. The aquatic salamander project is a survey

study that was started by Matt approximately fifteen years ago. Participants go to local streams within GSMNP to collect data regarding species, length, and weight of salamanders found in polybags that are set in the creek. Polybags are small mesh bags that are filled with leaf liter and provide habitat for salamanders. These bags are approximately 5 x5 inches and are made from a mesh with squares that are one centimeter square. The individuals who were participating in the aquatic salamanders project for this observation consisted of a group of ten to twelve year old children who were staying at GSMIT for summer camp. The group hiked from GSMIT campus to one of the nearby creeks to collect data for the aquatic salamander project. The participants of bird banding were a highly varied group of visitors consisting of people from the local area and GSMIT campers. Bird banding is done by setting up long "mist nets" that are made from very fine mesh. The nets cannot be seen by the birds. The birds fly into the nets and become entangled. The birds are removed by trained volunteers and then data is collected regarding species, age, sex, and whether parasites are present or not. The bird banding was conducted on GSMIT campus. The third observation was of students participating in Monarch tagging. Monarch tagging took place in Cades Cove and the participants were a group of home school students and a group of 6th graders. These observations were conducted by shadowing the staff members as they worked with students on these citizen science projects, and varied in length from one to four hours. Detailed field notes were written during each of these observation periods to create a complete record of the events and researcher impressions as the lessons proceeded.

Researcher Journal. A researcher journal was kept during the course of this project. This journal consisted of daily reflections by the researcher concerning the data and data collection

process. The writing of this journal allowed the researcher to organize her thoughts regarding the data as well as additional reflect on patterns as they emerged from the data, and consider theoretical and methodological issues. In addition, the journal facilitated the development of follow-up questions. Follow-up questions were sent to the participants via email as they arose during reflection and analysis of the data.

Data Analysis

Data analysis consisted of thematic analysis using analytic induction (Patton, 2002). According to Gilgun (1995), analytic induction is based upon emergence of themes during the course of data collection and analysis, but the researcher is not expected to begin the process as a blank slate. Instead, analytic induction requires that the researcher formulate general assertions prior to beginning the study. Then, as data collection and analysis are in progress, assertions are modified to fit emerging trends. It is for these reasons that analytic induction was chosen as the primary method of data analysis for this study. The researcher for this study came into the project with preconceived ideas, and it would have been impossible to start this project as a blank slate. In addition, the expectation of modifying assumptions throughout the process of analysis fit with the researchers overall methodological framework of interpretive research.

In keeping with the norms of analytic induction, data analysis for this project was conducted throughout the entire study. This allowed for the identification of trends as they emerged and the modification of the research design as those trends required. Initial analysis occurred as the data was collected. In other words, analysis was ongoing as the recorded interviews were transcribed, the oral histories were collected, the observations were conducted, and the expanded field notes were written. However, this was only the initial iteration of

evaluating the data. Analysis continued throughout the process of data collection. Once all data was acquired comprehensive analysis began. This occurred during winter 2012. Coding was done during this process to locate emerging themes within the data. This allowed for the researcher's complete familiarization with the data to ensure that it was thoroughly analyzed (Maxwell, 2005).

Coding, according to Charmaz (2006), is a critical step in the analysis process of any qualitative study as it serves to take the researcher from a general description of the context to a deeper understanding of what the data indicates. A code, in qualitative analysis, is simply a short-hand notation (word or short phrase) that identifies a topic within the data (Saldana, 2009). However, coding is not a one step process, but must be done repetitively in cycles using different coding methods so that themes can emerge (Saldana, 2009). To start this process, a descriptive coding method was utilized (Wolcott, 1994). When using descriptive coding the researcher summarizes a section of data (e.g. a sentence or two from an interview transcript) into a single word or short phrase. According to Wolcott (1994), descriptive coding is an especially beneficial tool to use at the beginning of the process as it provides an overall inventory of what general topics are present within the data. Next, the data was coded using in-vivo coding. In-vivo coding, according to Charmaz (2006) uses a word or short phrase contained, specifically, in the data record as the code. This was beneficial as in-vivo coding preserves the actual words used by the participants during the coding process. Finally, the last type of coding that was utilized for the analysis of this project was focused coding (Charmaz, 2006). Focused coding sorts through the codes that have been developed earlier in the process to in order to develop meaningful categories from the data. It is important to note that these categories are themselves emerging as the coding process is completed (Glaser, 1978).

Following the completion of the coding process and the creation of categories, individual narratives (one per participant) were constructed. Historically in qualitative analysis, there has been a significant amount of discussion regarding the exact definition of a narrative. Several scholars argue that a narrative is a story that contains a distinct beginning, middle, and end (Mishler, 1995; Scholes 1981; Tilley, 1995). Other scholars maintain that a narrative is defined as a story that follows a chronological sequence through time (Bruner, 1990; Labov and Waletzky, 1967; Polkinghorne, 1988; Reissmann, 1993). For the purposes of this study Denzin's (1989) definition was utilized. According to Denzin,

> "A 'narrative' is a story that tells a sequence of events that are significant for the narrator and his or her audience. A narrative as a story has a plot, a beginning, a middle and an end. It has an internal logic that makes sense to the narrator. A narrative relates events in a temporal, causal sequence. Every narrative describes a sequence of events that have happened (p.37)".

Following completion of the individual narratives a cross-case pattern analysis of the narratives was conducted (Patton, 2002). According to Patton (2002) cross-case pattern analysis involves studying the individual cases to find patterns that are present in them all. Of course, as Patton mentions, this requires the researcher to completely understand each of the individual cases so that themes that emerge from the cross-case analysis will be firmly grounded in specific contexts. Once these individual cases were completed they were used to develop themes reflecting the overall case study of the use of citizen science as an educational context at GSMIT.

Summary of Chapter 3

Chapter three provided a description of the overall research design for this study. It included a discussion of the theoretical and methodological frameworks that formed the foundation of this study as well as a discussion of the research methods that were utilized for data collection. Chapter 3 also included an introduction to the primary participants in this study as well as a discussion of how the data analysis for the project was conducted. Chapter four consists of the oral histories and individual cases of this study.

CHAPTER 4

ORAL HISTORIES AND WITHIN CASE ANALYSIS

Chapter four consists of two oral histories and a within case analysis of the other five participants. For each of those participants, a case was developed. Each case presents the emergent themes and includes the supporting evidence for them. Each case concludes with a discussion and interpretation of the themes as they relate to the theoretical evidence.

Jeff's Oral History: The history of Tremont and its relationship with citizen science

Looking at Tremont from the very beginning.

Becoming a Naturalist. My path to where I am now as the director of Tremont began when I was a kid. I grew up in the suburbs of Dayton, Ohio, and Mom told me not to come home till after the streetlights were on. We were outside all of the time. And we played. This was an important time, but I didn't know it. It was like when Robert Michael Pyle in Extinction of Experience wrote about how we need rough places. Not manicured wilderness even, but just those rough edged places around. There were a lot of those at that time around Dayton, Ohio. There was a park, a city park nearby, a lot of big trees in our neighborhood, a wooded lot behind the park that we had and a big wooded area that was kind of like no man's land where the bum's hung out by the railroad tracks. And, you know, some sketchy kind of places, but those were places that we, my friends and I, went to. And we rode our bikes far and wide. I mean we rode really far. We'd leave the city and go out in the country and places, and we'd just beat around. Unfortunately, a lot of those places are gone now, I think. Big box stores and stuff have moved

in and kind of taken up all those little places of green. My love for the outdoors was also strengthened through family camping and scouts. And it led me to the great opportunity of working at the Dayton Museum of Natural History, which today you'd call a nature center, while I was in high school. That was a huge experience. I benefited from being around people that called themselves naturalists, and working in different areas of the museum. For me, the big draw there was working with the live animals, because they had a big collection of mostly native Ohio animals. We had a place in the museum called the animal room. It was kind of an all-encompassing natural history museum where you walked in the front and there were the prehistoric indigenous people kind of stuff, and then the solar system, and all these cool displays of natural history stuff. But the animal room was the big thing. There were displays on basically all natural history topics. We taught classes there with kids in the summers, and they had a junior naturalist program where you could volunteer and so I volunteered and worked with the animals. We had coyotes, raccoons, groundhogs, birds of prey, a pond full of turtles, and a whole wall full of different snakes. Just a little bit of everything. I was in charge of the reptile collection. We had a bobcat. He had grown to be a pretty big bobcat. We would get the occasional boa constrictor, or something that people couldn't find a place for and we'd end up with it. But we cared for those animals and took them out to schools on animal talks and stuff like that. So, that's what I did all through high school. I worked there pretty much full time my senior year.

When I went to college I was debating whether to major in religion or biology, since they're both kind of my interests, but finally it ended up that I decided that I really wanted to work with people in the outdoors. Of course, that meant I was a biology major. Eventually, I had taken all the field courses, which is what I loved, and was down to needing things like, anatomy and microbiology, and that wasn't what I really wanted to do. So, I looked around and found out

about this program at West Virginia University in nature interpretation. And I thought, ah, nature interpretation. That sounds, yeah, that sounds closer to what I want to do. So, I went through that program and took a lot more field courses. You know, field science, field ecology, botany, ornithology (the ologies) and that was what I wanted. During that time I also used to run camps around the country. There was a camp over in Hendersonville, North Carolina called Piney Lake. And it's kind of similar to some of our program here at Tremont. Piney Lake was a small field campus that the University of North Carolina owned and they worked with Greensboro City Schools. They had kids come from Kindergarten through sixth grade, and it seemed that there were kind of two types of kids that tended to come to these camps. There were the kids who just like read field guides and had them memorized. I remember I met a kid from California who knew more about Eastern birds just from reading the field guide than I did. He hadn't been in the east. You know just geeky kids like that. And then we had kids of parents who thought they should have that kind of experience. The staff were people from all over the country. They had a really great staff, and the director there was a real mentor to me. He had grown up with NOLS (National Outdoor Leadership School) and really had done some pioneering stuff with environmental and outdoor education. He also worked at University of North Carolina, Greensboro where he was on the faculty in outdoor education. So he ran that camp and the campers would take two major classes. That meant that every day you taught these classes. I taught lake study and I think I taught reptiles and amphibians. The kids would go real in depth with those major classes over two weeks. Every day we would have like a couple hour class and we'd go out and we'd just explore. And it was kind of cool 'cause he paired staff, like people that knew something about the subject and people that didn't know much about the subject and we worked together and learned from each other. Anyhow, that was really cool, but that was my first

experience with working at camps. I mean, I'd been to camps and stuff, but through this experience I saw the value of that residential experience, that long-term impact with kids. You know it's kind of like I just fell into these jobs one after another. Because it's definitely a field where you've got to move around to where the positions are, 'cause there are only so many residential places around. The one thing my wife and I realized, with both of us trying to work in this field it was not going to be real easy.

Well what happened next…while working at the field campus at the University of North Carolina at Greensboro, I was promoted to program director, and I thought, "I'm not ready for this." But I was learning so much about administration and about running these program and, I'm going to learn more in this program than I would in any graduate degree program. So, uh, you know, how can I capitalize on that, so um, actually, several friends and I got into a program at Mankato State (Minnesota) in experiential education. A that time it was kind of the early stages of that program and they really allowed you to design the program a lot yourself. But it was based on field experience, so I was able to take what I was learning at University of North Carolina, Greensboro, and through working with people at the University wrote an Administrative manual. Their idea at Mankato State was that it's not just through experience that you learn. You learn from drilling down into it and doing some research and application that you can build on it. So, I got my Masters from Mankato State. My wife went back and got a teaching degree in education. And after that we moved to a residential center in Pennsylvania and worked with inner city kids in Philadelphia. While we were in Philadelphia I first heard about Tremont. One of the guys had worked at Tremont in the summer, or during the fall, and was telling me about it. So I had heard of Tremont and its reputation. I had also kind of fell in love with the southern mountains. We were at this great program up in Philadelphia, but when I heard about

Tremont, being in a National Park, and in the southern mountains…With going to school in West Virginia that's kind of where I'd learned my natural history. I was like, wow, this is a dream job. So my wife, who was pregnant, and I moved from Philadelphia with a big U-Haul trailer. When we arrived I met one of the board members in Maryville, TN. They gave me the keys to the Tremont gate and the facility, made a suggestion of a place I might move into and told me to go on up. I was like oh, is there anybody that could help me move a little bit? So Elsie Burle, who was at that time in her 80s and the Chief of Interpretation met us, and helped us move into the place. We were going to move into one doublewide but then realized all the pipes had been busted, and it was just full of junk. So we moved into another one that was one across the river. There was no electricity. My job was to start getting Tremont up and running.

Great Smoky Mountain Institute at Tremont: The beginnings. Tremont, and the other environmental education centers that are associated with National Parks, all started in similar ways. If you look back at the late 60s and the first Earth day, it's amazing how many nature centers and environmental learning centers and non-profits started up right around that time. And a lot of their evolution is very similar. They started out with a few passionate people who had a vision, but really weren't sure how to pursue it, and just did it. They operated on a shoestring with just people working crazy hours, but doing it because they loved it. They moved into a place that was designed and built for something else. I mean, this, this is kind of the story of most nature centers and most environmental learning centers across the country, and they kind of evolved from there. So here, at Tremont, there was a program called the NEED program, National Environmental Education Development program, or something like that, that the park service was running. It was basically like today's Parks as Classroom program. It was getting

schools to come into parks. They established certain areas, which called were environmental study areas. So, the park service personnel would come in designated places like Cade's Cove which would serve as an environmental study area. Tremont still has some of that old materials from the NEED program. So the NEED Program had been going on here, but additionally this place was a Job Corp Center that was built in 1964 and was closed down in 1969. The people who had been involved in the NEED program, including Elsie Burrell, who was one of the founders of Tremont. Prior to that she had been a school supervisor. She had been working with kids, taking them outside, planting trees, teaching classes and had been conducting some of the environmental studies. I don't know exactly who talked to whom first, but they talked to people in the biology department at Maryville College. Maryville College approached the National Park and said, "what about making this an environmental education center?" And the park bit, and said, "Cool." The Park service gave one of their rangers a year off to help establish the program. Elsie Burrell and the folks at Maryville College worked really hard to build Tremont as an environmental education center. So that's how it got started. You know it was a little different how they did it initially, but they were getting lots of kids out here and moving them through programs and doing a lot of the same things we do today. So, that's how Tremont initially got its start.

When my wife and I arrived here from Philadelphia the executive director of the Great Smoky Mountains Association had managed to send a letter out to schools and had booked some schools starting in early September. So, that was my deadline. That is when I had to have the whole facility up and running. Now remember, there was no electricity hooked up when we got here, but there was a rain gauge that belonged to the Tennessee Valley Authority (TVA). I found it in the back of what is now the main office building at Tremont. It was in a little box. The first

day we were here I heard a phone ringing from the vicinity of that rain gauge, and I'm like whoa, what's that? There was a phone that was connected so that people could call in and get the data off of that rain gauge. So I found that phone. You know this was before cell phones were invented. And that phone became my lifeline. I was able to get the power on, and it kind of became my business phone. I'd stand back in this little furnace room in the dark with that line, trying to get stuff hooked up. Then like the second or third day I was here, all of a sudden all of these park service vehicles come driving up, and people started walking through this building. So, I walked out and introduced myself to everybody. They were already going through things. They started down here in one of the rooms and I said "Hi, everybody, I'm Jeff." And they said, "Who are you?" I think they thought I was the maintenance guy or something. I was cleaning stuff up. I said, "Oh, I'm the new director." All of a sudden you could tell it was a little awkward. But what I realized later was they were kind of figuring out how to divide up the space here. They were like, "well what do you need in terms of space here?" Remember, this was my second or third day. I'm still trying to get things hooked up. I didn't know but I said, "Well, we need all of it." I was learning real quickly and writing down all these names and trying to keep records of everything. And I still had to hire staff. The second morning, before we got electricity, we were in this little doublewide, and someone knocked on the trailer door and said, "hello?" "Hi, I'm Lou Thompson, I've been working up in the kitchen here for years and me and Venus here sure would like to come back and have a job." I'm like, "you're hired." These people have worked here, they know how to run the kitchen, it's like, yeah. So, I hired or cobbled together a really great staff actually. We had probably spotty groups off and on for that first season, but the staff and I sat down and we wrote the whole curriculum.

We came on at a really interesting time in the history of GSMIT. Like I said, Tremont had been run by Maryville College for the first ten years, and they pulled out. That was during the Reagan era and anything environmental was not friendly. Even within the park service, you didn't use the word environmental or environmental education. So, for various reasons Maryville College pulled out of Tremont and the park asked the Great Smoky Mountains Association to take it over. At that time the buildings were falling apart and they needed to do some rebuilding. They took all the old dorms out and rebuilt what are now the current dorms. Another structure was built that so it could be used for housing. So, there was an off and on operation with Tremont for those couple of years. And then as soon as they got all of that done, the highway commission came in and condemned the bridges coming up to the campus. So, they closed the road for a year. I was hired right after that time. It was a really cool opportunity because the place had been shut down; no staff, no one at the facility, the electricity had been off at this place for a year. This place looked like the rapture had occurred one day. It looked like somebody had just come in and said "okay everybody, we're shutting down, go home." Things were still lying around and the place was a mess. So, it was not only an opportunity to work at a cool place like this, but also an opportunity to kind of rebuild the program. It wasn't completely starting over, 'cause they'd had a reputation, and they had a clientele. But, of course they'd lost some of that during the closed down period.

Some people ask, "Well, did you work your way up?" I was hired as director and remained the director, but that job changed a lot over the years, you know. I mean, the first couple years I was teaching and I've done pretty much every job here, at one level or another, so I know the guts of this place. I had hired the staff for the place in Philadelphia. You know, that was my job, too, to hire the summer staff. I had hired a couple of really good people, and so I

asked them if they wanted to come down for a job. Let's see, I got 3 people who were kind of…well a woman who was my assistant director who was really key early on. And then I hired a guy who was a naturalist, and uh, and I guess it was just the two of them. And then I think I started advertising and getting word out that summer and was able to hire good people. You know, we built programs, turned them over to folks, and let them do stuff. It was a lot of work, but it was great. I loved doing those kinds of things. You know when things get routine here, well then, it'll be time to move on.

The residential piece. But really, through all of those camps and teaching experiences it was the residential aspect that I was doing where I really saw the most value. It's what I loved and what I had really learned to value and had learned the ropes of. Just the ability to really have people for longer periods of time and be able to see the transformations. It's like these kids who have been here at Tremont this week. These kids have been here for five days. And it kind of seems that on Wednesday they're just getting into it. They're just getting comfortable with the routine and getting comfortable with all the transitions they've had to make from the real world, to living in a community for a few days, to being in this new facility. They're just kind of getting into it and then like Thursday and Friday it's like exponential growth for them. They were out on the trail yesterday, and they were comfortable. And last night I saw a bunch of the kids were down playing in the river when they had a little free time in the evening. It's like they'd become comfortable and at home here. And to me that's what the residential experience does. At a residential camp we're able to get more in depth for a period of time. You know, I may have mentioned this before, but one of our struggles is with funders and everybody wants to know how many kids, people, do you serve a year? It's like, 5000. And they are like, whoa, you know,

the zoo serves 50,000 or 100,000. But the zoo is like window-shopping, a real quick experience that you can't compare to a residential camp. And so how do you compare depth with numbers? To the funders, the numbers always win out.

I'd rather affect a few individuals really deeply than the masses on only a surface level. I mean the very last thing I'd want is for kids to come here, especially, and feel like what they got out of it is "Wow we saw nature. We saw the natural systems, and now I've just gotta go back to my urban or suburban or life where none of that exists." But instead, what I hope is that through seeing this place that's been preserved and left untouched as much as we can leave it untouched that maybe they can see the systems at work a little bit more and maybe the awe's a little bit more on the surface so that they can go back and see those kind of things in their backyard, on the sidewalk or in the street even, and be able to apply that back home. So, on the one hand I think our big goals are to create people that are champions for this park that go back feeling like this isn't just a park they're visiting, but that this is their park. That they feel that they want this place, Great Smoky Mountains National Park, to remain as it is because they've seen how valuable it is to have a resource that's semi untouched. But then, if they just do that and don't go back home and express the same kind of stewardship attitude in their home communities then that's not what we're working toward. We want them to understand that there are things that need to be protected in their home communities too, and there are ways in which they live that affects things in a deeper way so their actions can positively or negatively influence things. So they decide that they're gonna start making decisions to try to make a difference. Those are big, big heady goals. Does it happen with every kid that comes through here? I've often said, look, if you think I'm naive enough or big headed enough to think that this ONE experience is going to change, going to make people develop an environmental ethic and stewardship attitude that we

need of our population, no way. If we're alone in that we're in trouble. Hopefully, we can provide threshold experiences. You know, one of those experiences that make a person go, “Whoa!” I know experiences at Tremont can kind of help people with that. So, providing experiences that move people a little further along the spectrum of an environmental ethic or good stewardship, so, that's all I'm really hoping to do. We’re trying to help visitors have a threshold experience that can make them take another leap forward. You know, there is a continuum and some people are way over here at one extreme in terms of where they need to be and some people are way over here at the other end. So, can we move people a little further along? And again, if the impact is just is totally up to us at Tremont to have that impact and nobody else is involved then we might as well give up. It's kind of like gardening. We're planting seeds. In some cases we're just trying to give that seed some good soil to feel good in. Sometimes we're seeing fruit, but we're doing a lot of watering or a lot of weeding and it just depends where people are in that spectrum. You see people grow and you see people change. You see those little impacts, those moments of wonder that you say, “Wow...something significant happened there.” When that happens you wonder how much that is going to affect that person's behavior back home. Will it influence their practices, their voting habits, or their decisions down the road when they're faced with something that could be of major importance? Those people could become leaders, and you'd love to think that a lot of our politicians have had an experience like people have at Tremont that can keep them rooted in a place. That way when they're making some big decisions maybe it comes up that “Wow, I spent some time in a national park once. I saw systems at work. I understand where my food comes from.” You'd love to think that those things are considered. So I think that’s the residential piece. I do think, I look at what we do and think the bigger impact we have on the school programs is good, but it is still, it’s just a three or five day experience

once in a kid's career. I think it's enough for some kids to be a life changing or a threshold experience. But the real impact, I think, is with the kids who come to summer camp year after year after year. And the adults who come back to programs again and again and the relationships we've built with teachers and schools who have been bringing their students over many years. The school here this weekend has been bringing their students and teachers since Tremont started in '69. You know that's a huge, huge impact over a long period of time to where there's now an impact in that community. When I meet people out in the community they say, "Oh yeah, our kids went to Tremont." Or like when we were out in Utah on vacation, and met an older couple and the guy had a University of Tennessee hat on so I said, "Oh, where are you from?" And he said, "Oh, I'm from Norris." And Norris Middle School was up here this week. So, I said, "Oh yeah well, you know, we work in the Great Smoky Mountains National Park," and kind of told him what, where we were while we were on a boat ride together. Afterward they kind of made the connection and they came up and said, "Do you work at Tremont?" And I said, "Yeah." They said, "Our kid went to Tremont, from Norris Middle School, and it was a great experience for him." And then there are the teachers who keep coming back and to workshops, it's a home away from home for them to be here. That's something I don't know that you can replicate at a traditional community nature center. That's the value of a residential experience.

Tremont as part of a larger community. One of the weaknesses of Tremont in its early years, I think, was that it was this little community that was very segregated from everything. It was almost a commune utopia kind of place. So, building partnerships and relationships with other aspects of the surrounding community, the park service, people in Townsend and Gatlinburg, etc., well, it's been a learning experience. I think one of the reasons Maryville

College pulled out of Tremont was ‘cause they never made a good connection between the education and biology departments and what was going on here. It was just this thing that was going on at Tremont and not connected back to the college. Eventually the administrator looked at the fact that they were sinking a lot of money into Tremont, but then they were also looking at why are we doing this? And it’s because it’s a good thing to do. I know Maryville College today regrets that decision.

In connection with the park service, I think the park service's attitude when Tremont was run by Maryville College was that the people here were kind of a bunch of hippies and tree huggers running this environmental education center, and as long as they don’t bother us, that’s fine. So it wasn’t really something that the park did much with – it’s an anomaly. But as long as it’s not a problem, fine. And I think that was kind of the feeling when I first got here; although, I should say that the Chief of Interpretation was very interested in what we did. He wanted to guide what we wanted to do, and so, we worked with him. And then Karen began working for the park service. She’s over all of the Park Service’s education programs. There weren’t any Park Service education programs until Parks as Classroom came along. Up until that point there were just interpretive programs. You know, just the walks and talks, and traditional stuff, but working with schools and that kind of stuff, there wasn’t much going on. Tremont was it. Karen was hired about 20 years ago, and was our liaison to the park service. She was actually hired to be the link between resource management and interpretation. The idea being that resource management in the park is doing all this stuff and that’s where science happens. The Park Service operates in a lot of silos, but they were like, we need an interpreter to tell these people, the public, what’s going on with science and to be able to integrate that into the interpretation. So that was Karen’s role initially and she ended up being our liaison for some reason too. And we

were very interested in that same thing. You know, understanding what science is going on in the park. All of this good science was going on and we wanted to figure out how to link what we were doing at Tremont with that. And at first it was more interpreter as translator. In other words, I would translate what the scientists are doing. I'd learn their language, and translate their work to the public so that the scientists could continue doing their work and keep their faces in their test tubes while we were over telling the public what was going on. And over time that evolved to where we realized that we needed to get the park scientists involved with education. And as funding got tight, some of those people started realizing, we needed to have people who were good educators too. And so that's where we begin talking about how to accomplish that. And that is how citizen science initially started here. It really just began with discussions about how do we get more involved with the science that was going on in the park.

And so the relationship with the park service has evolved over time. Back when I started here they didn't have partnerships and they didn't know how to do them. And they still are learning. And some places they do it great and there are really great examples, but there are really bad examples too. Probably the most frustrating thing with the park service has just been change in personnel. They either love us and get it and figure out how we fit in or, or we're like gum on their shoe. You know, they don't know what to do with us. They don't, again, as long as we don't bother them, we're okay. It's mostly been good. But there's been some of that, especially with maybe some of the other divisions that have made it harder. And then there are the winds of politics that takes the direction of the park from one way to another. You know from 'oh we don't say environment' to 'we want to be doing environmental education' to 'Parks as Classrooms' are great. Probably 15 years or maybe 20 years ago, the park service started this program, Parks as Classrooms, which was just basically let's find ways to get kids into the parks

and involved with rangers doing educational programs. And there was some grant money available and I really thought this is cool. This is a grant; this is an opportunity for us to do day programming and be involved above and beyond the residential programming. I thought we could get groups to come out for the day and then that could build into our residential program. So I wrote a grant. And I went to the Chief of Interpretation, and this guy kind of liked what we did, but there's also been this kind of thing that well, the park service knows how to do things best. He was supportive in words and, tried to help us, but he was mainly interested in what his staff did. So when I gave him this proposal, he said, oh yeah, it looks good, but I don't think we're gonna go that way. And it had to go through them to happen. While he liked what we did he didn't understand how to partner a whole lot. So, he basically saw this opportunity and he started the Parks as Classroom program and didn't involve us at all. Which kind of ticked me off, 'cause I felt like first of all, he kind of took our idea, and started working with a local school to do it. Now that program is like getting all sorts of awards and kudos and we've been really not linked with that. Which to me has been a mistake. Over the years we've kind of tried to do more with that, but it's kind of like, there's two silos, you know there's the Parks as Classrooms program and then us. The Parks as Classroom program is K through, originally it was I think K through 6. And now I think they go to 8th and even have added a high school component. There are different modules and kids can come to the park, a class can come to the park for a day. They could come and do a model on air quality or kindergarteners can have a cultural history lesson with a cool little talking chimney or with a talking barn, where a ranger gets behind the thing and they've got a big mouth they put on the chimney - it's really kind of cool. And, and it's free. I mean it's not free, it's grant funded. And they've worked with an elementary school in Gatlinburg and that's the big star because they've created this K-8 program so all the kids there

come to the park over their school career. They come to the park a bunch of times. And one of the thoughts was, well we can be part of that sequence. They could come here for a residential experience. The big kind of disconnect there is that, the National Park Service programs are free and ours are not. And so, you know, K through 4, you go through a free park program, and all you have to do is pay for the bus and what you need with teachers, get them up there. And then in 5th grade, come up to Tremont and you've got to pay $160 bucks per kid to come for 3 days…that's a big jump. And they didn't provide any funding to do that. So, that model of those experiences being combined is only working with that one school from Gatlinburg, and not with other schools. You know there's that program and it is a good program. It is a day program. Again, it's one of those things; I think the value of it is when they get schools to come back for multiple times. And we do have schools that come here for the residential experience but they also do the Parks as Classroom program. But it's not integrated like I think it could be. And part of it is related to our relationship to the Park Service. We've had a really good relationship with Karen all these years. We've had a couple chiefs that have been really awesome and really have tried to involve us. As a matter of fact, Chris Stein was one of the chiefs that probably involved us the most. And he and I got to know each other pretty well, so we started meeting more regularly and he would invite me to their regular management meetings. But I definitely have felt from the park either kind of well we're the park and you're Tremont and you're a partner and we like you and it's good and, and that kind of thing. There have been some in park management who have said, "Tremont employees are no different than any of our other staff, this is just another way that we get things done." You know, that we're a part of the family. And Chris was like that. He acted as though Tremont was part of the Park Service's outreach for education.

The reason I'm telling you all this is 'cause Chris and I, we began to meet with their Interpreter of Management team, and the Association and the Friends of the Park that gives money to the park each year to do special programs. Parks as Classrooms was funded almost entirely out of soft money. It's funded out of Parks as Classroom grants. I think they might have some baseline funding now, but the big thing that happened was they got the City of Gatlinburg to hire a person, a teacher who would work at the school. All that person does is coordinate the Parks as Classroom field trips. And that job is funded half by liquor taxes in Gatlinburg. So, when you're drinking in Gatlinburg you're helping children experience the national park. And the other half is funded by Association funds, Great Smoky Mountains Association funds. So, every year there's a pot of money that the friends and the Association makes available to the park. And the park creates what they call the Needs list every year. And so that Needs list is all the things that they would like to use that soft money, Association and friends money for. So they pretty much tell the Association and friends what they want and then the Association and friends determine how much money they receive. When it was a small pot of money the majority of it was used to fund education interpretation. That pot has grown larger since the Friends have gotten involved, especially as the Association's grown. So, we were meeting with the whole group to talk about what we were doing, what we wanted to do as a division, and what we wanted to submit as requests for that money. Tremont had never had access to that money because we were not part of the park. Chris was saying, we're in this together. You know, we as a division need to decide what our priorities are and that means whether it goes to Tremont or whatever. And so we did a prioritization session and had a discussion about our needs. We had been doing citizen science, and they really liked what we were doing with that. In regard to citizen science at that time, we didn't have a director or a person to run it. It was kind of done by

staff as they could. We had one person who was doing a lot but when things got real busy she had to do her real job. And so, I had identified the need for a director for this position and a budget to actually make this work. Chris bought it and the division folks bought it. It ended up being our number one priority of our list of things that were going to be submitted to the park for funding. This was kind of unheard of. First of all, it's like wait a minute, the interpretive division is requesting the money, but we're going to give it to Tremont? And it made some people go hhhhmmm. But I had recognized a long time ago that the only way to access that money was to get them to ask for it for us. The first year of funding was used for hiring Matt, our first citizen science director.

When I think about that next stage in my career, being somewhere else, I realize that the one thing that I can't take with me is the relationships with people that I have in this park and in this community connected to Tremont. I feel like there are some good relationships here. I don't think that my strength is in developing those relationships, especially when it comes to fund-raising and stuff like that. But it's been a skill I've had to develop. So it's been interesting to watch the park service as it has moved to engage with partners more. I think the forward thinking management and the top management within the park service is very much about partnerships and community relationships now. The park service traditionally has been a pretty isolationist organization with a military kind of structure. People from somewhere else move in and think they know more about how to run this place than the people who have a connection and a history with it. The park service has moved more towards their people not living in the park and living in the communities, so that they don't become just this isolated thing. I think because Tremont's been here for so long we've been able to have both aspects of that. But I've also seen real value with our folks who're living in town and the connections they've been able to make quicker.

Citizen Science at Great Smoky Mountain Institute at Tremont.

Just getting started. The pull toward citizen science was just part of a natural progression for us. I think it was just, again, an interest in doing our job right. We wanted to teach people about natural history, and we wanted to teach them about this park. It was part of us considering that there's a lot of issues facing this park, so how do we best interpret those? We never got into citizen science because we thought we ought to be doing research. We got into citizen science because we thought that engaging people in research, collecting data, especially if it is real data, and they feel that they are contributing to a product of some kind would be really engaging. It's pretty in depth stuff. It's wonderful for teaching the scientific method. It's wonderful for teaching observation and inquiry based learning and all those kind of things. So, it accomplished a lot of what we wanted to do. That's why we got into it. Because whenever we worked with scientists it was really valuable. Another thing that happened that was key, and maybe a bit of a catalyst, was that the park bear research program used to be based here. There was a double wide up on the hillside where the bear researchers lived in the summer. As a result of those researchers being so close we developed a really good relationship with them. Our staff started going out in the field with the bear researchers, going on trap lines, catching bears, taking blood samples and pulling a teeth, and stuff like that to learn about bears. In fact, the woman that I first hired as an assistant director married the head bear researcher. So, there were those kind of relationships. And I think that kind of opened our eyes to what was possible. It was like, "this research is so cool. How do we get our participants involved in this?" We were learning all sorts of stuff about the park, about bears, and about how things worked. That might have been a catalyst for us to say, "We need to do this in other areas. We need to find out what the hog people are doing, what the veg people are doing and, other science in the park." And so that was, as I think back about it, one of

those key things that probably made us value the relationships with researchers. It made us recognize what can happen through that experience. But, even when we were working with those guys, we knew we could take staff out, but we couldn't take kids out. We couldn't take teachers out. And that's when we started to explore the ideas of whether that was really true? Were there ways we could take people out and have it not just be show and tell? Because as we were going out with them, we were helping them do stuff. But when we first started it we didn't call it citizen science 'cause we didn't even know that term. We called it our Science Education Initiative. So, it was really us wanting to take the park science and find ways to blend that with what we were doing at Tremont.

Our path to including citizen science in our program was kind of a slow progression that began with meeting scientists in the park and developing relationships with them. And then it began to move toward a more formal thing. Early on the folks in the park service who were working with science in the park began talking with us about how do we involve the Tremont staff and participants with the researchers. The park service was kind of saying, it was not worth it to them because the scientists, well they've got to do their research. Even though the park service recognized the value of linking with Tremont. We met with the resource managers and talked with the National Park Service about that idea. We talked about how to make those linkages and a lot of times it came down to finding the right match between the kind of research and a researcher who cared about the education piece. Typically, what we'd get from the researchers was, "we've got to do our research. That's what we are being paid for. You guys can come along." They just didn't always understand that we really could help them with their work. And I think the value of a place like Tremont to a research scientist is that we're here year round, 24/7 for years on years. Most studies get funding for a year or two. Scientists then come out here

and visit us for a little while and do their piece and then go back and work on the data. Well, we're here collecting data as long as you want. In whatever format you want it done. And so that's valuable to the researchers. So, moths, if you're going to study, inventory moths. You're going to come here during some target times of the year when the most moths are out. Well, you're going to miss February when there's moths coming out. You're going to miss different times of year.

Then the All Taxa Biodiversity Inventory (ATBI) for the park started, so here's this HUGE influx of scientists coming in to inventory things. We thought...inventorying...that's that's pretty simple. Well, it's a little more simple than, you know, catching a bear and stuff like that. So, we started thinking, are there ways to link our educational objectives to the ATBI? One individual who worked with the park service, who was working with All Taxa Biodiversity inventory, is an amazing biologist and an amazing guy, started to talk with us and said, "”You know, it's not worth me”...he was being real straight...”for me to pay my staff to come over and basically talk to your groups because my guys have got to do their research. It's really not beneficial for you to send a group to them because my staff won't be able to get their research done when you’re tagging along. BUT I think it probably is worth it for me to send like one of my people over to train your staff in some of these things.” And then, I think, the light went on for him. And he started beginning to think about, “oh, okay, maybe there are some things that we can get information on that are those kind of things that aren't my front burner things that I am not going to get funding and I've got to get my researchers working on, but that's kind of...wouldn't it be cool if we knew about stuff.” He began to get the idea that, “okay, there's got to be either something that Tremont participants could do where we could give Tremont the right protocols for doing something then they could be be part of this data collection even if they're

not doing A to Z." So, he was really trying to figure out how to make that happen. And he finally said, "you know what I will give some time for is for our staff to train your staff. And they could set up a couple of projects, and set up the protocols." Tremont could do this stuff.

He wanted to keep our work simple and so it started with the moth project. And he said, "This'd be great. We don't know much about moths in the park. We'll set you up with a light. We'll help you. But you guys put this light out every night. We can teach you how to mount 'em and how to collect 'em, and how to do all that. And we'll begin to identify moths, and inventory them." So, effectively it started because of the ATBI. Our education director/school program director at that time was into that. I think she had already done work with Monarchs and had been interested in that. So, we put the moth light out and then tried to find a way to involve that with the kids. Now, we didn't do ALL of that. What we were able to do was collect the moths and then group them somewhat. We got a few kids, interns, and other people, that could work at labeling, pinning and some really specific science stuff that was a little more in depth, and even some identification. Well, then all of sudden the scientists are like, "Whoa...we want to come look at what Tremont's found since the last time we've been up here." So, we got people from the Smithsonian coming in and saying, "Oh cool. Look at all this stuff." They'd look through our stuff, send us back stuff, and help sort our stuff. Well, these kids were doing a pretty good job with pinning and labeling, and so we began to develop some respect with those people. So, with us putting a moth light out every week and then seeing what we got from there we were able to assist with the discovery of a 129 species of moths that were new to the park. And that's since we started the project in 1999. That's pretty cool...pretty significant.

When we started out doing citizen science we were kind of doing it as we could. And so, really what that meant was during the busy season not much [citizen science] got done because

staff were teaching and it was really hard to get it done. We didn't have it integrated directly into any of our lessons because we were just figuring it out. Citizen science took a lot of staff time and we weren't able to involve too many kids with it, except maybe helping a little bit and carrying things around. We had like two or three projects going on. And when we had a slow time of the year we were able to do a lot with it. But, when school programs got going, citizen science dropped out. And it meant that the education director was really spending extra hours trying to make that stuff work. We hadn't figured out how to really integrate it with what we were doing day to day. Even when Matt started out, he got a bunch of projects going. He started some of our summer camp programs and the intern program and stuff, but he was being more of a researcher than an educator because he was primarily telling people about what we were learning about in the different projects. It wasn't really until, I think, Michelle got here that we really started to really say look, okay we've got all these great things going on, how do we integrate it into what we're doing day to day. And that's still a challenge but we're doing it more and more.

Well, obviously, I didn't just want to do projects that were just keeping one person busy with research. Another program that we started was kind of based on the job I had in high school. Its focus was to bring in high school interns. So, we had 3 to 4 people a summer that were high school interns, specifically citizen science interns. And so, they would work during the summer, the big research season, and they were helping to do some education, but they were doing a lot of the grunt work, the grunt science work too. Okay, so that does the research, but then its just kind of research, it's not really doing the full education thing. So, on that end we've got the interns doing research. On the other end we have what I started calling window-shopping opportunities. Those experiences are more like the...the masses that come through here...5000 kids that come

through here looking in on and seeing what the guys are doing with moths, and having the interns and citizen science folks talking about what they did with moths. Maybe do a show in tell kind of thing. They'd be seeing how science works. They'd be seeing how these people do science, but they were not really able to do much of the science piece, in my view. But, window-shopping has value to the scientific community because, hopefully, it is starting to find people that are potentially excited about going into science and moves them along in that direction, as it did to me when I was a kid. Or it will influence people who are not going into science at least have a better appreciation of what this science is. There's a lot of people who think of science as a bunch of facts that people in white coats pronounce rather than science being a process, and a series of understandings that are developed through the process of your scientific discipline. What I'd really love to get at is the things in here [indicates more in the middle of the spectrum] that hit...or maybe more towards this end [indicates more toward the science end] that involve these people with scientific research and its hard to do. What kind of happened initially was we had a lot of great research projects going on. We had a few numbers of people doing the research and a bunch of people looking in, but not much in between. And part of that was because our program people and our citizen science people kind of evolved separately and didn't really know what each other was doing and it's kind of hard. It takes a while with our curriculum and our program to integrate something brand new into it...it takes a little while. It's not just that we're a cumbersome system. Part of it is that we've got teachers who have been coming here for years and years and they've already decided what they wanna to do and what they wanna to teach. And so, we say, "oh well...we've got this new thing on salamander monitoring...yeah...well, we wanna do the wildlife lesson..." And so, we've had to kind of convince them that this is something important. So, once we got all of these research projects going and then we started working on

the integration. So, we've started that, but we really aren't there yet. Two of our former Citizen Science Coordinators really focused a lot more on how we integrate it. And one of the best things that happened which was a formula that I don't know that you can replicate. Simon was married to...our citizen science director was married to our school program director, so when that happened there was a marriage of those programs. There was a synergy there that really helped. It really helped with some of the integration and began to be a place where we started to see what could be moved into the mainstream. For instance, that the stream ecology lesson that we are already doing and have been doing for years could have a salamander monitoring piece to it. Now the reality is that depending on how much time we spent with staff training and how much time we really worked on it...the data collected for that may not be as usable as at other times. But with a little tweaking we can get it there.

Making citizen science work at GSMIT. I think citizen science here is still evolving. Are we where we need to be? Are we where we'd like to be? In some areas maybe. I think over the past four or five years we've come a long way with that. We've really done a lot to make that integration happen. We've started to look at more and more ways to make sure the staff is trained, to know how we're doing different things. You know, the best projects we've done have been the ones that the park has been in on and the park has felt like "yeah that's something we want to know about." So, doing phenology studies was something that the Park Service wanted to expand more. We'd been collecting phenology data at Tremont...signs of spring and stuff kind of for fun since the 80s. And beginning probably a few years ago we started tightening that up a little bit and making it more intentional and keeping the data a little bit more regularly. So, we already had a good track of doing that, but the thought was how do we do some phenology plots around the park. That's a new project that we've begun to integrate. Our last Citizen Science

Coordinator was a naturalist here initially. He had worked as a naturalist for a bunch of years with us and he had a science bent. He spent a lot time thinking about the phenology project. The great thing was that he had been in the shoes of the people who are out there every day teaching and so was really thinking about how we could make this really work. Because the naturalists are not gonna spend 15 minutes filling out a data sheet and are not gonna get kids to intense levels of measurement. The key is developing, finding those pieces and developing the protocols that really can work and that are realistic. For the pheonology project it was the citizen science coordinator talking with the park about their mutual goals. At other times, we've shopped for those scientists that can help us. I mean we've always looked at that just in terms of scientific experts that can talk to people. And so, we try to find those who can communicate to work with people. We go to the ATBI conferences and listen to everybody doing their programs you know...this guys working on moles and this guys working tardigrades and this guy is working on rotifers, this person working with snails. And we looked at those people and then we talk to them about what we can do. Sometimes you strike out right away because they don't get it. You're not worth their time, but then you get people, like this guy who works with tardigrades. He knows more about tardigrades than just about anybody: he is a charming communicative guy that everybody likes right away, who gets it and wants to make it fun and does and says this'd be GREAT. So, he's come up here and conducted workshops with teachers showing them how to look for tardigrades in their downspouts and gutters at their schools and on the school grounds. And he's worked with kids we had up here to get stuff and says, "Yeah!! You guys are contributing." We had another person, a women, who was collecting information about water mites and she said, "Here's how you do it." She did a training to show us how to go out and collect water mites and develop a study, and then wanted to see what we found. Most of what

we've found though has been that those researchers have been great at giving us some protocols to work with a small group of people, but not great at helping us develop an integrated program. We get a few people who can go out and collect the water mites or tardigrades and we send the researchers good data and that kind of thing. To get to this point over here where we've got scientists who will help us develop a program where we can tap into the thousands of kids that come here and get that information, that's been harder. Simon developed this salamander monitoring project and has actually written a couple of papers and developed some real solid science, but it has been the educator/scientist that's helped us develop that project to reach the masses. So, you know, we're still looking. Its a matter of doing a little bit of everything you know and every once in awhile we'll find that person that can maybe move us a little further down the line.

In addition to converting the masses to science, we're transforming scientists to be educators. And it's interesting to watch that process as well. Is it the rare scientist that wants to be involved in education? I think there are plenty of people out there. Part of it boils down to why did they get into science. There are a lot of people who get into science 'cause they want to dig further into their little hole. Be further away from people and to only do it my way. And then there are people who are just amazed with that kind of stuff but who also love people. It's not that one's necessarily better than the other, but we've all seen, or sat under professors who were people ought to just go do research and not teach. But we've also seen people who ought to maybe teach and not do much research. So, I think it's a search. I think as citizen science has grown, as more and more people are doing it, there's more and more methodologies out there, there's more and more scientists saying maybe it is something we should be involved in. I think that is especially true when they see other researchers having success with it. And as researchers

see us being successful with citizen science, that increases their confidence in the process and they may want to give it a try. What a lot of the scientists haven't realized is the power of citizen science, instead of just being a project that you get a two year grant for and you are able to zoom in on deeply for a only short period of time, we're here for the long-term and it is an ongoing process.

And citizen science here at GSMIT is multifaceted. For instance, we also have these volunteer teams that are going out and doing salamander monitoring on streams. So, volunteer involvement, that's another component of citizen science here. And if I rate the impact we have on the community, you know it might be that the school programs, even though they affect a lot of kids they do not really involve repeat visits, so, we may have a bigger impact on volunteers. Those volunteers that come back again and again are developing a kind of a long-term relationship with us. That's a higher-level impact in some ways. That's what we want them to get out of it. It's the experience we're able to give people. Maybe we need to be thinking a little bit more about that. We just did a newspaper article about recruiting people to help with bird banding. Bird banding, it's pretty sexy, so it's a little easier to attract people for that. Although salamanders sound pretty sexy at first too. Over the years, several groups of volunteers have come in and done well with that project for a while and then it piddled out. And so, we've got to kind of nurture and build those relationships. Unfortunately, we were without a citizen science coordinator for about a year. We had some budget cuts and that set us back a little bit. One of the reasons it set us back was it slowed us down the volunteer recruitment. But from the very beginning in doing citizen science, I have to tell you, you know from being the guy that also has to make sure that this place operates, I initially was like how do we make citizen science pay for itself. We've talked about what can we charge for this program, but...well it's hard to charge for

programs when people are volunteering their time. Sometimes I feel like they're giving us a service but in reality I'm lookin' at it like they're more of a drain. We're providing more for them and our goal is to provide more in terms of education for them than they're really providing us. Our goal for volunteers, unlike the scientists' point of view but from the education perspective, is not to collect the data, or to do the work, but for them to be educated. It's for them to be connected, so from that aspect we ought to charge them to do that. But most people when they're volunteering to do a project don't think of it as something they're willing to pay for. That's okay, but how do we make citizen science pay for itself? And the answer has probably become that citizen science is fairly fund-able. I mean there are grants for scientific projects and the idea of combining science and education has been something interesting and with all the stuff on the STEM kind of standards and stuff like that industry and others are interested in increasing peoples' awareness of science and work with kids. I've also changed my thinking in terms of citizen science totally paying for itself. I've recognized that citizen science has really bumped the quality of our overall educational programs so that I think of it, in a sense, as a marketing tool. We have had a lot of people that are coming here because of the real science that we do and because we're grounded in science. And that has bumped the quality of our programming up to where I feel like well, if I fall short on what we're raising I can justify it from the marketing prospective. It's still a continuous struggle. I mean, just the fact that budget cuts cause us to look at where we can cut. I have to think about whose bringing in money all the time. If the citizen science person is creating work, getting volunteers and running all these different projects but that's sucking time away from our primary educational objectives. I have to remember that none of those things are really bringing any funding in then. In that case, it's on the chopping block.

Connecting people and nature: Why it is needed. One of the things I have always said about natural history and science in general, is that there are questions we haven't even asked yet, let alone answered. And in this information laden world where we think you can Google anything and find the answer it's important to remember that there is still so much out there to discover. To me it's almost back to the spiritual part of all of these things. The world's amazing. It's important to remember our natural history. I think natural history has been neglected. I think one of the places it has really been neglected is in higher education. Colleges and universities use to train people as taxonomists, and be places where the study of natural history was something that, well even in elementary schools, was something that was taught on a regular basis. It was science. It was looking at how things work, and it was looking at organisms, but it was more than that. It had a little bit of wonder to it too. It seems that a lot of higher education science, especially biological science, has moved away from the "ologies" and towards cell biology, molecular biology, and stuff like that. I've been critical before of environmental studies programs because I think what happened was instead of having the "ologies" and instead of having more environmental education which when really done best is not a subject but it is a methodology that crosses a bunch of different disciplines. That doesn't work well in higher education because they compartmentalize things. So what happened is they created environmental studies departments and environmental studies majors that kind of lumped together a bunch of that stuff that really needed to be interdisciplinary and spread across disciplines into one place. The "ologies" were split into specific "ologies," but natural history was something that wasn't connected to them. It was kind of, this is natural history here, this is natural history here, this is natural history here. It's an overlying thing that wasn't even taught but its going on in all those disciplines. So, the young people that we have coming to Tremont as naturalists haven't had

training in botany, ornithology, entomology or anything like that. I was fortunate enough to have some of that training and its something that we've always focused on here. I think that was what drew us toward citizen science was our natural history base and our tendency of really looking at organisms. Not so much just identifying things. I also believe that when you name something the learnin' stops. I've always been a proponent of the idea that you use expertise very carefully. Instead of just tellin' everything you know, you need to develop that wonder, that awe, that interest. And out of that comes desire to know what it is. It is more than just a name. Sometimes when you name it, it's like, oh okay well we'll move on to the next thing. That's to me what good natural history teaching is. It's exploring and asking the questions and THAT's what citizen science does too. It asks the questions of you know, not necessarily what is this but its the same kind of method of I want to know more about this. To know more about it I've got to know specifics. How many flower parts does it have? What does the ovary look like? You know, all of these things that lead you to knowing about it. Well, once you know that then its almost like in the old times when a name really meant something. Back then the name represented the essence of everything it was. It's about learning the essence before you put the name to it. I mean those connections, and I think that can happen both through that wonder, that awe, that oooo isn't that cool, but its also when you drill down into the science part of it. It helps you to do that too by just saying wow, look at how different this thing is from that thing or that this is what makes this species unique from that species. And when you start looking at behaviors and stuff that's even more complex and more exciting.

I've never considered myself a scientist. I've never done any real research which I guess is kind of what I think we think of as scientists. You know, scientists do research and they do research projects that do that drilling down and answers specific questions. But I have studied

natural history in a real, a very scientific way. But you don't have to be an expert naturalist to be in love with a place either, but developing those kinda skills helps to make those connections. I teach a class on just developing naturalist skills and that's both in terms of how to be a good teaching naturalist, but also how to within yourself develop skills of observation and, and inspiration and expertise and communication. Those are the kind of strands that I always look at that go together for me if you want to develop yourself as a naturalist.

We learn that by going out and experiencing natural systems and watching them work. We learn that by visiting Tremont understanding the ecology of the Smokies and how things live together and the amazing web of life that is out there. The park is a place where we can look at those natural systems that are preserved here a little bit more. They are more in their natural state here. What ever that is. And so we can see those systems at work a little bit more. I'm hoping then next they'll see those natural systems also work in their home communities and everywhere. But first maybe they can see 'em in operation here and recognize that. In many people's lives today with technology they don't see those connections day to day. They don't recognize that this eats that and that destroys this and this waste product is a result of this process but it cycles through. Those things aren't obvious if your watching a screen all day and driving around through traffic and towns, but it's going on here at GSMIT. And participating in citizen science connects people with those natural systems not only in an involving way, but in a contributing way. We're not just talking about it, or experiencing it. We're examining it and we're collecting data that is being amassed to hopefully learn something further about these systems. So we came at it from, 'wow, there's some cool science going on in the park. There's some people doing some cool research. How do we get our people engaged with that?' And why would we do that? Not because we want to do scientific research. To the scientists that's the product. It's a byproduct for

us. The learning that comes from being able to have that direct connection is the product. I think there is also that deeper level of knowledge that you get with science and working with scientists. Understanding that this person has studied this organism to the nth degree. Citizen science gives you a little view of that and looking at the microcosm of that really helps people to recognize, wow...the detail of stuff is going on with this, this one little thing here. It just helps you to recognize how massive all the interactions are. It helps you appreciate all of the other amazing systems, and the natural history going on within them. In short, it helps to give that connection. And I think that citizen science alone doesn't do that. Citizen science is one vehicle and its been a powerful vehicle for us to engage people on a deeper level. Just like people out bird banding. Having that bird in your hand and we're getting some data but sometimes the data is an excuse for having a bird in your hand because you don't really need to have a bird in your hand unless your doing something like that.

You know the importance and the reverence for place and for created order and the awe at the workings of it all. The walking lightly on the land. Recognizing that we need to model and do that. Personally, I mentioned trying to decide whether to major in religion or biology, which a lot of people laugh at. And yet I feel like they are vitally connected. I have my reasons for doing what I do. To me, I feel like this is what God called me to do. This is my mission. I sometimes feel like I walk this fence line between groups of people who consider themselves opposite one another, being fundamentalist Christians and liberal environmentalists. And there's almost like a membership card for each of those that groups. To belong you have certain things that you believe in. And I feel like I'm on the fence on a lot of those issues. And in some ways I feel like that's part of my... what I see in science, in a park, in the amazing things in nature. I see an amazing Creator. And I see my role in the world from my Christian worldview as one where we

are supposed to be stewards of this Earth. We are Earth keepers, and that's our role. I wrote a paper called "What Good is a Salamander?" And it's about a Biblical view of the Earth's worth. And it's kind of like it's good because God created it. God created it and so it was good. And so that's enough. The sacredness for me is not that God's in that. I don't worship the creation. Although I worship, or I can be tremendously moved by being in a redwood forest, being in a cove hardwood forest, walking out on a fall day, or seeing the unbelievable scientific details of how things work. So, I believe in a redemption for myself that is tied to a redemption for all of creation. And it's not just people. It's not just me. I believe what people can do on Earth is limited. It's an imperfect world. It's a fallen world and some people don't like that view, but it's kind of obvious around us. Because things don't tend to be getting better. So, we're limited with what we can do, but there is a, as I see it, again my Christian and biblical worldview is one that a redemption of mankind goes to all of creation. So, how do I put that at work in a secular place? For a while I thought what I'd really like to do is to run a Christian environmental education center because that's where I feel I could really talk about this. But the more I've thought about it, it's like, no, I don't want to just talk to Christians about this! I want to talk to everybody about this! I don't have opportunity and don't feel I should take the opportunity in my role to preach that, if you will, to people. Although in interactions and opportunities that I have talking with people, if you want to go into that depth, we can get into that conversation. And I think it's fun to hear different people's perspectives on that and develop that. You know, we've had different staff, it's different being in the south, in the Bible belt, running an environmental learning center. And I think one thing that's helped me to be successful is I don't have that liberal environmental card carrying, anybody over here to the right must be a moron kind of view. And so it's allowed me to work with a lot of different groups. We have a lot of Christian schools come here, and I

think it's allowed me to work with that. But we've also had Christian schools who've come here and decided to move on because they felt like what was being taught was too far over to the left. And, I feel like there's opportunities for conversations about some of that, but I also believe in the three strands that we have woven throughout everything: stewardship, diversity, and sense of place. Those three things are kind of at the core of a lot of things I value. The stewardship is that responsibility for acting responsibly and having a real, almost mandate to take care of this planet. We have an amazing ability to cause dramatic change and we need to wield that very carefully. But humans are a part of the natural system, we're not this different animal that is not part of things. We need to think about how it all works together. Diversity, just the awe at the diversity of life. But also awe at the diversity of people. And to me the idea of diversity applies to the 24/7 experience of working and living here. So, you know, you're living in community and you've gotta work together. You've gotta understand different perspectives and you are made stronger by exposure to them. Then the sense of place is one that we've lost in some ways; that people are reaching out to regain. People know, maybe it's that Bio-phillia thing, that E.O. Wilson talked about. That whole connection to place. And I would view that as connection to the Creator, but I think it's, you know people experience it through that awe with the natural world. Our ancestors had this sense of place that was a little more natural. They lived with it every day and they ate from it. It affected them daily and they saw the cycles. That's less in our face anymore. So we need to regain it. One thing I've come to think about was that you know our ancestors had a sense of place with a very specific locale and ecosystem and stuff like that. I think it's important for us to do that too. Kind of like your home turf. You know, where is your home turf? But I think in today's global and mobile society that home turf can be different places. There are national parks and other wild places where you can develop your sense of place by your

experiences with those places. And there are people who come back here all the time. They come back here because it is like coming home. They may live in Atlanta or Cincinnati, and I think they need to have some roots there, too. They can see their roots there too, but they can also have roots, a sense of place for these wild places that have really resonated with them as, wow, this is where I just really feel alive and at home. That bio-phillia is really there.

Matt's Oral History: A Life of Merging Science and Education

The emergence of a budding informal science educator.

Science and Education: A family legacy. I have to blame my lifelong interests in science and education on my parents as much as anything. My father was an academic so, I grew up in a university town, Ann Arbor, Michigan, surrounded by books. He was an English professor, but, you know, studying, getting to know things was very important to his worldview. And my mother, well...it was not considered a vacation if we could not see the ocean. And her idea of being at the ocean, by the ocean was to explore the tide pools and the beach rack and find out what was found and what had washed up, and to learn about that. She was certainly an amateur naturalist. So, that was my upbringing. I was actively encouraged to be interested in the world around me and also be interested in the planet from a naturalist perspective, from an amateur perspective.

Eventually, I developed an interest in birds. This was probably related to several events. First, when I was 12 years old, I think, my uncle bought me a pair of Kmart special binoculars. They weren't particularly good. They weren't particularly powerful. They were kind of big and clunky, but they were mine. And because my father and mother were both very interested in encouraging anything that they found value in and that I might have interest in we took a trip to do some bird watching. They had heard that there was this incredible place in Ontario called Point Pelee National Park where in the spring birds fly over Lake Erie. In their flight across the lake they get tired, and Point Pelee is the first point of land they see. They all settle down within the park to rest, and they're fairly easy to see because they are so exhausted. Point Pelee National Park was only a couple of hours away from our home in Michigan, so the three of us went there in early May of... I guess it would have been 70...1977. And we hit it just right. We found that a

big wave of birds had landed in the park and it was the sort of situation where I could look at one bush in one binocular view and I could see a Scarlet Tanager, bright red: a Baltimore Oriole, bright orange: a Yellow Warbler, bright yellow, and an Indigo Bunting, bright blue. And even my mother who was, well...this was not salt water, she was impressed. So, that I think kind of got me well on the road to being a passionate bird watcher.

Secondly, I had a sixth grade teacher who then moved down to teach third and fourth grade, who was interested in birds too, and he wanted to do a bird unit with his students. He roped me into helping him out with field trips. I think that when I was in high school I worked with his classes and took kids out to go birding. I'd get permission from the principle to come in late a few mornings each spring so that I could do the bird work first. I enjoyed that a lot!! Taking the 3rd and 4th graders out in small groups to look for birds was my first real experience with the education side of things. Then, in the spring of my sophomore year in high school my father sat me down and asked me what I planned to do that summer. I don't think I gave him the right answer! So, he said that he was going to arrange an interview with this a professor, Bob Storer, and that he might have something useful for me to do that summer. So, I went. Apparently, presented myself well enough. And Bob knew that one of his colleagues, Bob Pain, was in kind of a desperate situation for field assistants, so he recommended me to Bob Pain. Bob Pain agreed to take me on for five days a week as a volunteer during the summer. I thought it was great. A high school student doing something in the big world and seeing all kinds of incredible things with birds and feeling like I'm being useful and collecting useful data. He thought I was useful enough that the next year he got a big grant and brought me back and even paid me a couple of thousand for the summer. Which is still not too bad money. So that was a wonderful experience and opportunity for me, and you know, I've never forgotten that. So, I've

had several opportunities to hire high school students and mentor them and give them similar opportunities at Tremont and then in my current position at the Smokies. And it has been a delight for me to pay forward, I guess the term is. That's basically how I got started with birds. I often kid that birds pay the bills. There just kept being opportunities to get summer employment or temporary employment through my bird data collection skills. It ended up being that I was working on a bird project for my masters degree while at the University of California Davis. It is interesting that everything just kept building on my fascination with birds, but I have an interest in all natural history and maintained that throughout my career. In fact, when I got to Tremont relatively little of what I was doing involved birds. A lot more of my work was with reptiles, amphibians, invertebrates. Thankfully, I had maintained an ability to work with those too.

The confluence of science and education and the emergence of an interest in citizen science. After high school I went to Cornell University. My undergraduate degree was very strictly science. You know Cornell's Lab of Ornithology is known as one of the founders of the whole citizen science concept, but citizen science is not really something that the academic program took to heart. It was a very strong science program though. But then I would leave Cornell during the summer break and work at nature camps or in field programs...more education type experiences. It just worked out that I was widely exposed to both the science and the education part of things. I guess that makes sense though as I come from a long line of educators through both sides of my family. But, regardless, I kept bouncing back and forth between opportunities in science and education. I had a lot of influence from my peers as I hung out with a lot of people who were interested both the science and the education as well. So, the more I reflected on what I wanted to do personally, and the more I worked at trying to figure out...do I want to go more strongly into science or do I want to go more strongly into education I realized I

wouldn't be happy without the science side of things, but a good day doing science and a good day doing teaching were both incredibly powerful, enriching fulfilling days. However, a bad day teaching always seemed to give me something back. A bad day in the field or in a lab doing science was just a really, really lousy day. But, as time went on and the more I was involved with different research and education programs the more it become obvious to me that it didn't need to be either or. I could have a mix of science and education. So I think my realization was that for me to be happy in whatever career I pursued, it had to have some science with actual involvement, hands on with science, but the focus was going to be on the education side of things. I could have a mix of science and education. I did continue on to get a Masters in Science in conservation ecology at the University of California at Davis but after that I went back to the education side of things.

From that point forward, to pay the bills, I started looking for opportunities that would allow me to accommodate both education and science. The whole idea of doing educational programs that collected data was still not really something I was thinking of as possible. But eventually I got a job up at Acadia National Park. While there we had a situation where Peregrine Falcons were nesting on a cliff face that had an extremely popular trail going straight up the cliff face with paired rungs and ladders. So, to protect the falcons, we had to close the trail. This wasn't a popular decision with the park visitors, but it did prove to be a wonderful opportunity for people to see and watch peregrine falcons. In order to decrease tension with the visitors, I was given the job of trying to figure out a way to mitigate the trail being closed. So I did that by developing an education program around the falcons for the general public. And this resulted in visitors becoming regulars who continued coming back to watch the birds even when I wasn't there. I was usually only there at the viewing area in the morning when the light was at

its best. But because visitors were so interested in the falcons they were coming back at other times of day. So, to help keep the birds safe we basically developed a citizen protection brigade. This informal group would call in to the rangers when somebody tried to go up the trail and acted as our eyes and ears for things that were happening in regard to the trail and the falcons. This is effectively one of the first citizen science projects that I was involved in. You know, the difference between using citizens as our eyes and ears for protection purposes and using the general public to collect data of certain types is relatively minor. So, we started looking at opportunities and the more we looked at it the more we wanted to get people involved and recording data. Interestingly, it was around this same time that Cornell started to build up some of its citizen science programs with birds.

While I was up at Acadia National Park, I met a woman and married her. We had permanent jobs up in Maine, but her's was only for half a year and she was looking around for other employment opportunities. She applied for a job within the park service and ended up down in the Smokies in Cades Cove. I followed her down there and began looking for a job myself.

Citizen Science at Tremont.

Starting a citizen science program at GSMIT. The timing was fortuitous in that Jeff had been interested in getting more science into The Great Smokey Mountains Institute. My understanding is that Jeff was interested in having a Citizen Science Director position at Tremont because he felt that the programs at GSMIT were better if there were researchers around the staff. By having scientists around for the teacher-naturalists to rub shoulders with, especially in the field would provide them with richer experiences that they could transfer to the to the participants at Tremont. Back when Jeff hired me...way back when that he had noticed that there

was this beneficial exchange of ideas when the University of Tennessee, their researchers were stationed and worked out of Tremont. They had some time to interact with Tremont educational staff and Jeff wanted to build on that rapport and keep that sort of thing happening. Keith Langdon, the Branch Chief was very interested in involving citizens in the efforts to train citizen parataxonomists down in Costa Rica for their All Taxa Diversity Inventory. From that experience he realized that there were a lot of the great ideas and great needs for the Great Smoky Mountain National Park and insufficient resources to accommodate them all. So this was thought of as a way to expand what we could get in the way of information and then Karen Valentine would be the other visionary who viewed citizen science as a way to increase the connection and the hands on aspects of science. She also viewed citizen science as this wonderful opportunity, if you do it right, of getting support from a lot of different sides. You get support from the education side, and you get support from the research and the monitoring side. And there are times when one side or another has more resources, more support or more energy and you can use that to keep the program going while the other side's having resource issues or whatever. So, you know, that's another reason to maintain this sort of a program. Fortunately, other people there in the park were also interested in involving program participants at Tremont in collecting science data. The park actually requested Tremont…or the Great Smokey Mountain Association at the time, which was running Tremont to put money that would normally be going to the park into a new position at Tremont. That position would become what is now the Citizen Science Coordinator. It is a position that I had trained myself for at the junction of education and science. I mean, as we've discussed, I had been basically training myself to be a citizen science leader before such a thing even existed. What the administrators at Tremont and the park service

all had in mind for that position was exactly what I wanted to be doing. I was very glad that they gave me the chance and it helped shape the job that I'm in now.

My wife had worked at Tremont in the past and, as a result, she knew Jeff. I knew Jeff through her and through other people. So, Jeff knew of my existence. Somehow, I was told about this position. I applied for it and convinced Jeff to hire me. So, basically my job was to try and figure out what projects would lend themselves to collecting useful data, be of benefit to the park and that we could involve participants in. Eventually, funds were made available for high school interns…summer interns to participate in a lot of these programs. We had a number of volunteer high school and middle school students. Some of them were home-schoolers. Some of the local high school and middle school students would come and collect data at the salamander plots or work with the moth inventory. We tried a lot of things, a lot of different projects. Some of the projects did work. Some of them didn't work. And then some of the projects, yielded useful data but the participants were really not impressed by the experience. They didn't feel like they were getting anything out of it, so it was basically kind of like they were slave labor or unpaid field assistants. Of course, that really was not what we were looking for. On the other hand, we had some other projects that people really enjoyed but they didn't provide good data. So we kept trying to find that right mix where the participants were receiving something from an educational perspective, an experiential perspective, but the data was valid and good too. In other words, the projects needed to be something that we could maintain from both the science and the educational perspective. And I think that's the mission that has been continued and expanded upon by the other citizen science coordinators that followed. It's something we are all striving to achieve in the rest of Great Smokey Mountains National Park.

In terms of specific projects, two park service scientists developed a moth trap. It's a refrigerator that keeps the moths chilled so that they don't all die when we catch them. That way we can identify them and have a way of monitoring moths without having to stay up all night or having to kill them all. This is a nice alternative for an educational setting in a National Park. We had a big mercury vapor light up on the outside wall of the River House down near the ford. And...a big sheet under it and so after the night walk we went over there, ruined our night vision, and looked at what it attracted. Everybody had little plastic bottles and everybody grabbed a moth, and we tried to identify them So that worked well in several different settings.

Of course the aquatic salamander study has been a huge success, even though we are still working on getting that data published. The protocol for that project was adjusted for Tremont by a graduate student at North Carolina State University. She was present at the initial brainstorming session just after I was hired at Tremont. And she suggested that nobody knew much about stream salamanders anywhere, but particularly not in the Smokies. And she said, here's one way you could do it: take these mesh bags that salamanders could go in and out of, but that could hold leaf litter. And then every so often you grab the bags and empty out the salamanders and see what's in there. You'd have a way you could repeat over and over again the same protocol with relatively little disturbance to the habitat because you are creating the habitat. So we tried a number of different of types of mesh, and noticed how quickly leaf litter disintegrates in our streams. There are a whole lot of insects that specialize in breaking it down real quickly. So we created something that we could maintain that was relatively easy for high school and middle school students to collect the data on. Those mesh bags…they're called Poly bags. There's a professor up at…I think it was Marshall. It may have been the University of West Virginia, some place in West Virginia. He had created this type of bag and we had our own

version of it since we had never seen an original poly bag. But that was the start of it and they're still being used. It's probably one of the longest term datasets on stream salamanders uh ever anywhere, so, we're still working on how best to publish the information, but that's something that another former Citizen Science Coordinator has taken on.

But you know almost all that information, almost all that data is collected by volunteer citizen scientists. They're trained in the process, trained in the identification of the salamanders, and how to measure them so that we are all consistent. There would be a group from the local high school or home-schooled students, or middle schoolers. As they were getting older, about to graduate they would recruit some younger students to take over their streams so that there would be that consistency. There'd always be a Team Pigpen or a Team Dorsey or um...you know...all the...as many of the streams would be maintained by these volunteers as possible.

Another project that we started while I was at Tremont was studying land snails. Land snails are extremely diverse in the Smokies. We have, I don't remember the number exactly, but somewhere around 150 species that we've documented. And one thing with young students at Tremont is that we don't want to spend a lot of time focusing on killing things because that's not what a national park is about. So, we want to study something that we can study alive or at least study without having killed it. Other citizen science coordinators had Monarch programs, tagging Monarchs, releasing them. That was great. The moth project, the refrigerator kept about half of them alive, so it was certainly clear that we were concerned about killing them. The nice thing about land snails is that for most of them you can identify the species based on the empty shell. So, when a snail dies, it rots out of the shell, but we still have the record that that organism was there. We didn't have very good keys at that time so we were basically coming up with morphospecies that you know can compare. And you think okay this is this type and that is that

type. We needed to identify all of the types, which was difficult but I think we did pretty well. There were some very good snail ecologists that helped us a lot with identifying the snails, so that we would have a three-dimensional key to identify them. So, we could go out all over the park and take a coordinate and search through the leaf litter and find a bunch of snails and figure out most of what they were and enter into the database so that we had, you know, a better map of where snails were in the park.

I tried marked capture studies with crayfish that, that didn't work as well. We tried working on some GLOBE projects. It's a uh, web based international citizen science project. There are a lot of the GLOBE protocols that didn't really fit within the Tremont schedule. They needed the weather to be recorded in the mid day. It worked better for Tremont to do it in the beginning of the day, so that kind of fell by the wayside. I tried to do some things with having the Tremont backpacking groups collecting data. We were thinking it's a great idea, we've got the backpacking groups that go out on these long hikes, now they can do something when they're camped in places where no one else is getting to, except, there's not the time for that. You know, it takes them a long time to hike, then they're getting things together and they need downtime. I think they found that basically they couldn't do much more than the backpacking and getting the camp set up. Or possibly, we just haven't had the backpacking leaders who have committed to make that a part of their planning for their backpacking hikes. If some of the teacher-naturalists really got enthused about the project they would make the time. Those are some of the sorts of things that I have tried. You have to figure out what works well with regular school programs, summer camp, and the adult programs. Eventually I started a bird banding station at GSMIT. It was a MAPS (Monitoring Avian Productivity and Survivorship) station. The protocols with that again became too rigorous for our needs. We weren't able to set the nets up when the education

groups were most needing them. So, you're always trying to figure out what's going to fit in, how will it fit in, and what's relevant for the science program in the park. We're also doing that park wide with our Parks as Classrooms programs through the Park Service too. We're trying to find projects that fit in with the curriculum based programs for a particular grade that can be made age appropriate and can build in to a database that contributes to the science program at the park. An example would be the ozone bio monitoring gardens. These were created by a couple of researchers, one at Appalachian State and one at Auburn. Using plants that are known to be sensitive to ozone and the plants, over time, will have an increase in the percentage of visible ozone damage on the surfaces of the leaves. So, the students learn how to estimate the damage and then record progressive damage each time it's visited. This program fit very well into our 7th grade curriculum for field trips in the fall. We've been doing that for over a decade now up at Purchase Knob and to some extent at other locations throughout the park with our participating high school and middle school groups.

Now, through my present job, I oversee Tremont's Citizen Science Coordinator's bird banding permit. The coordinator is looking at trying to find a project that would allow her to be collecting data with more flexibility so she can collect with the groups that would be most appreciative of it. So, it's a constant evolution of trying to figure out how to fit the citizen science into an education program that's already established at Tremont. They have the camp which I keep calling Teen Science Camp, 'cause that's what it was when I created it. It's gone through several different names and involves taking the citizen science projects and fitting them with the programming. We ended up having the camp fit around the projects. This is a, a teenager's camp, and it is one of the older camps that we offer at Tremont. I believe its ten days. It involves a lot of participation in different sorts of research projects. So, back when I was doing

it there was a very active bear research project at the University of Tennessee. So one day the campers might go out with bear researchers and go along the trap lines to see if there were bears caught that they could then help process. Then they would maybe go out a day with the archeologists, park archeologists, to do some digging at some site. Then they would do the moth project, and/or salamander project, and they would also, and this is something still true today, they would develop their own scientific questions. They would investigate the question around Tremont, collect data, and usually spend a night or two at some other location. It's usually been up at the Purchase Knob. Then they can compare their data in terms of elevation and habitat. And consider how it is different in those two places. In terms of questions there has been a range of inquiries from reptiles or salamanders to plants around developed areas, all kinds of things. We also took on high school interns, volunteers at first. Eventually, we got a little bit of money from some grants to actually hire students. Often these were students who had gone through some of the programs at Tremont. These interns would be helping out with collecting data for our salamander monitoring program. They would go every month to their assigned stream and would later often find their replacements and help train the replacement volunteers to take over that creek.

Basically, while at Tremont I was given a pretty long leash and told to be as creative as I could be. So, that's a pretty good job. I remember a fairly early team meeting with lots of the administrators, a couple of the biologists in the park, and some graduate students where we were just brainstorming different potential projects. This was at the very beginning of my working there and they said "If you've got questions come and see us, but go ahead and see what you can do." I was not authorized really to be just doing research. Any of the citizen science programs that we were involved with at Tremont had to be something that was benefiting the education

program there. That was the only definitive guidance provided to me. Well, it also had to be something that was permitted within the park. We weren't going out shooting a bunch of birds and looking at stomach content.

And at the same time that I was hired the All Taxa Biodiversity Inventory (ATBI) was starting up. This was an attempt to document locations, and relationships of every species found in the park; plants, animals, fungi, and as much as possible archae, viruses, algae and bacteria. That provided a lot of opportunities and a lot of scientists I could reach out to. I could suggest that they help me come up with a project that we could do together at Tremont. It quickly became obvious that most researchers could only be in the field for a limited time. They could only really justify being in the field in the locations and at times that would be of peak benefit to get the most for their time as far as their group of organisms. So, the moth people would be there in June, July and August and maybe September, but they would never come there in March because they couldn't be sure they would hit the warm, few warm days that we were going to have in March. But after getting them comfortable with the idea of what a volunteer could learn and what we could do, everyone benefited. Tremont had education groups in March, and we'd put out the moth trap, go through it and we'd find species that were not known for the park. It wasn't particularly unusual habitat at Tremont, but it was a time that no one had bothered to look. So, we were able to accomplish things for the ATBI in terms of time of year, in terms of repetitiveness of sampling, in terms of some locations that we could get to that they weren't able to get to. That turned out to be worthwhile and we proved, I think we proved, our worth with a number of organisms like moths, like snails, and various other groups. We added species to the list that the experts were not going to get. It expands what you can say about your system.

No longer at GSMIT but still a leader in citizen science in Great Smokey Mountain National Park. Ultimately, professionally and career wise I was trying to get back to the park service. We were planning a family, so I wanted to have a secure job that I knew could support the family. So, when the opportunity arose for my current position at the Appalachian Mountain Highland Science at Purchase Knob, I applied for it. I had basically tried out a lot of techniques that the park envisioned using for the job and with our research learning center, so I basically had been training for two years plus to do this job, and so managed to out compete everybody else that applied. Jeff realized why I was moving on, and I think he would have been happy to have me back; at least that's what he said.

Quite honestly, I think that the program at Tremont benefited greatly from having people from different backgrounds moving through it. I think that what others brought to the program as far as improving data, improving moving some of the information towards publication, and getting it in databases were incredibly valuable. Some of my early attempts with that were not working as well. They tried different directions based on different skills and training that led to more success. There were a lot of things that they brought to it that brought the program to a higher level. It's very gratifying to me that the whole project did not crash and burn with my being gone, but I think improved. And it may have also benefited from my being around so that they could get some training as to the way we use to do things, and then I was far enough away that I didn't keep telling them "well, that's the way we USE to do things." So, that they could be innovative too. So, it may have been the best of all worlds.

Currently, I am the Science and Research Coordinator for the Appalachian Highlands Science Learning Center, which is a park service entity program designed to bring more science to the parks and to help us manage our resources based on science. It is also to get that

information out to as wide an audience as possible. Here in the Smokies, we consider citizen science to be an important part of that. That part of getting the information out is not just getting the results of a study out, but getting people more familiar with how science is conducted, with how we came up with these results, and more science literate through experiences such as citizen science or similar sorts of things. Citizen science is kind of a range between the highly trained parataxonomists at the one end to sort of the window-shopping at the other. The group that's coming out and practicing collecting data; that is not data of the quality that you would retain. But they are still learning by doing science. Technically citizen science is the collection of data in a scientifically rigorous way by individuals who are not trained as full scientists. They often don't even have a bachelor's degree in science; they may not have a master's or a PhD. They certainly don't have degrees in the field they're working in. They're part of the general citizenry and they are usually working on a project that is overseen by someone who is formerly trained in science; such as, somebody who's written all the protocols and they are just following them. I just had an intern up here and I provided her with a basic overview of a bee inventory project and basically what she did was she set out the bowl traps once a day, collects them the next day, and eventually brings the specimens back to me. It's not high level, but we've actually added some components to it to make it more useful to her. But, it can also range to someone who is very interested in synchronis fireflies. We have a researcher in the park who has no training formerly, but has trained herself and has worked with some, faculty members at a couple of different universities and has gotten to the point where she is publishing her observations on synchronis fireflies flash period related to ground temperature, and similar sorts of questions. Her data could be quite useful to us in predicting when the fireflies are going to be active. So, that's a very high level, very capable and high intensity citizen scientist.

My job here at Purchase Knob has changed over the years. It use to be more focused on citizen science development in the park. I worked with The Friends of the Smokies to secure a grant. They gave us money to hire an assistant and to hire a number of high school science interns to basically assist us with citizen science projects, or essentially be field techs for scientist researchers working in the park, while getting experience along the way, and to see themselves doing science. So, that was a lot of work. Working with them, coordinating them, even with an assistant, but it was a lot of fun, a lot of gratification. We had somebody that was actually still overseeing the research permits side of things a few years back, maybe it was about five years now, we had a new chief of resource management and she made the decision that my time was...that money put into my time was best used by focusing on the research permitting system, overseeing that and searching for grants to attract researchers to work that they are particularly interested in. So my job changed. I was doing some of that before. Some aspects of seeking funds for researchers and helping researchers with logistics and coordinating a number of things like that became my primary duty. I'm doing relatively little citizen science now compared to what I use to at least. But it does give me an opportunity to know the research community in and around the Smokies. So that I can say, hey, you know, this project you are trying to do, you are only collecting data in July, gee wouldn't it be great if uh we could continue some of that into September or December or...you know keep it, you know we can do it with uh with high school interns, with college groups, with other, with volunteer citizen scientists. And help the researchers to improve their data collection and their research protocols and also continue with bringing new people into science and getting them involved and understanding the process of science. So, I'm still doing a little of that.

Why citizen science? It is better to have people involved in finding the answer, and learning about things than it is just telling them about it. That quickly became obvious to me because I really don't believe in couch potatoes. Think about all the things that you've learned in all of your course work back as an undergraduate or even a course high school. How much of that information do you still remember? There are a few key moments...some ah ha moments or just a fun day or a teacher that really grabbed you somehow. But I remember and integrated into myself much more some of the field trips that I took or some of the things that I actually did. I also took into myself the National Geographic specials, NOVA, and Wild Kingdom. Different things that I saw on TV sort of primed me but what I really internalized were the things that I did. People learn in a lot of different ways, but it is a personal passion to me that we protect natural areas and wildlife and natural processes, the ecology, the way things fit together. If we are part of that then people should understand themselves as part of the world that we are in...the natural world...and that we do benefit by preservation, by involving ourselves in it. And with that as a core belief, I want to get people involved. I want to get people out there, seeing and understanding, appreciating, feeling, and experiencing what is really important to me. And, you know, I don't have enough hubris to believe that it is the only important thing in the world at the expense of all else, but I see it as an important thing for me to be bringing to them because it is so important to me. I'm in this unique position to try to bring to other people around me. And, if I can do it I should be doing it. Plus, I enjoy doing it. So I get paid for something I enjoy doing and that lifts my spirits. What better job in the world? But, yeah, I think that people should find their passion and what they are good at being advocates for. And if their passion is something that they really believe is important it is incumbent on them to do something about it either as a hobby, a volunteer, an intern, or to find a job that will allow them to do that. And I don't expect

everybody who goes through an educational program that I'm involved with, or is one of my interns, or does citizen science work with me to become scientists or rabid conservationists or whatever else. I do think that they could be brainwashed into...you know the people who are in our grocery stores, that are managing our portfolios, that are fixing our cars, that are driving down the highway for whatever reason could notice the world around them a little bit. And understand why when someone says, "our best information is that we should be preserving this ecosystem in such a way. That we should be concerned about Global Climate Change, or about mercury deposition, or that sort of thing." That they understand that there is science behind it and that science is not just a bunch of information in a textbook up on a shelf, or a bunch of people in white coats in an ivory tower or ivory lab making these incredible bits of information...discoveries that you would never ever have a chance to be a part of. But that science is also Jack from Missouri noticing a moth that we never noticed in the park before and calling it Jack's Umber moth, and it ends up on our park list in the database. And now we know another species that we are protecting in Great Smoky Mountain National Park and thank you Jack! So, it becomes something that everybody can have a little bit of a buy in to. It is not "Oh those scientists are always try to do something that's totally inappropriate and no bearing on reality."

We had at Tremont a visitor from Russia and he worked in a National Park near Vical out in the eastern part of Russia. And his national park you had to get a permit to enter the park. It wasn't something that you paid at the entrance station. You had to apply for it, justify it and get approval. At the time, I think it was, well...Russia is still somewhat tied into a Soviet system. You know, the people agreed that the government said, "you don't go there." And we don't go there. I don't think that is the way people in this country accept things. The government, unless

maybe it's military, it is not something that we would support our tax dollars going to a place that we couldn't go. So, we have to in the park service, we think it's an important part of our mission is to make it possible for people to enjoy the park. But we have to keep justifying ourselves and we have to keep ensuring that our advocates and the taxpayer world are not getting older and dying. We are constantly bringing in the next generation and sharing with them what we know and getting them excited and having them teach us how to get them excited. We're learning new social media ways of having them interact with the parks and some of these are going to turn out to be kind of weird virtual connections to the parks. Well, do you need a virtual connection to an existing park? Or maybe it is just as good to have a virtual connection to a park that no longer exists. Well, you start worrying about that and you want to get them back in the park. Get them REALLY here. Get their hands on. Get them involved in science, involved in history and hiking and just being interactive with the resource. These are important things that parks have understood for a long time.

Regardless, I certainly get outside every chance I get. I have my own two children. One's in 4th grade and one's in kindergarten. So we do a lot with them. It alters the way I experience what's out there, but one thing that I do that I think you would call citizen science. I run a MAPS (Monitoring Avian Productivity and Survivorship) station, which basically means I catch birds in the breeding season with a standard array of nets following a standard protocol. I get an idea of how old the breeding population is, how experienced they are and also how many young are produced each year. Not absolute numbers but an index. And I have trained, experienced bird banders leading it, and then we take on volunteers, usually college students, sometimes high school students, or non-students to assist with the running of the station; setting the nets up, taking them down, recording data, removing birds from nets and bringing them to the bird

banding station. My kids love coming out and getting involved with that. So, my son has been bird banding with me since before he was one at least once a year. And this MAPS station is something that the Blue Ridge Parkway has requested that I do as a service for them so that they can get an idea of how bird populations are doing up in the spruce/fir forest, the highest elevation forests. It is a great opportunity for my kids, it's a great opportunity for me to still get to out in the field. Right now I've got a dead moth right next to my phone here in my office that I found dead out on the steps a few days ago that I'm needing to key out and figure out if this is a new species for Yellowstone. So, I still get to do a few things.

As far as the future goes, I suspect that I will probably stay in my current position. That I have in the Smokies. I will hopefully still get to work with young people, old people, anyone whose interested in getting out to collect data with me or take on projects that I might be able to find. I hope that I will be able to periodically get out and see neat stuff and then share it with people. Eventually I will retire and I will get to do the stuff...I will get to ignore all the stuff with moving the electrons around the universe and focus on stuff I really care about: education, science, citizen science and science communication, science education. I don't get too worked up about the boundaries of these things but but the education of science.

Individual Cases

The remainder of this chapter is devoted to the five individual cases for this study. Whereas the oral histories provided an in depth time line and description of the evolution of citizen science within the curriculum at Tremont, these individual cases will provide a more focused look at the themes that are found within this context.

Case One: Tricia – if excitement were contagious she would have everyone connected to nature.

> "W*e really want to get people outside in the natural world and allow them to have hands on experiences and use all their senses to um explore and discover and um...and hopefully, um...through doing that an having that experience they'll be able to start to learn about the environment, have their own connection with a place, have a memory with a place, hopefully it is a good connection. And um...hopefully that will, in the future, when they go outside they can remember they've been through a good experience and then they can share that with other people. And, hopefully, make good decisions when they are faced with decisions about what they want to do. Even if it's just, you know, in their backyard. Or even if its just cut all the trees down and have a lawn or um are we going to leave some place for wildlife, so that we can preserve things, but basically getting out there and having some experiences, having some kind of connection that they bring home with them (Tricia, second interview)."*

Theme one: Moving beyond the local: Connecting Tremont to a larger environmental context. The guiding philosophy of GSMIT is 'connecting people and nature.' Tricia expressed her belief that if teacher-naturalists were going to be successful in facilitating the development of such connections amongst their students it was first necessary for them to have a personal relationship with the Smoky Mountains. She described this as: "*And so if I don't have a connection to the Smokies, I don't know how I could show them this place. I feel like I need to be just as enthusiastic and just as in love with this place as I want other people to be. Um...and that*

just comes with time and living here, like...we actually live here is another HUGE connection. This is our, this is most of our staff, at least our teaching staff live here and this is our home. So, this is our backyard and this is a national park and hardly any other people live right here (Tricia Interview 2)." She felt that if the GSMIT staff was going to be successful in inspiring people who are visiting the park to not only connect with the Smokies, but to also be compelled to connect with their own local communities and environment then the teacher-naturalists must model this by being connected to their own backyard. In the case of many of the teaching staff at GSMIT, they live within the boundary of the park. The teacher-naturalists at GSMIT work to first build the connection to Great Smokey Mountain National Park and then teach students and teachers how they can make similar connections at home. Working to increase student comfort and understanding of the natural world within context of the park formulate the desired connections. According to Tricia, *"Well, its definitely a hands on experience to the Smokies, so they'll be connected to the Smokies through that."* This connection to the Smokies transcends a simplistic meeting of educational objectives and standards. *"I'd say that I would rather them have a really good time here and think this is something worth caring about, like, the Smokies are worth caring about, then come here and learn a million new words."* Yes, she wanted students to learn about science, nature, and the park, but she is hoping to spark the formation of something more profound, a love of nature and the park.

Tricia noted that one of the primary goals at GSMIT is creating experiences for students that will not only provide connections to Tremont and to Great Smoky Mountain National Park, but also to form an association between those places and their home communities. The teacher naturalists prepare extensively for each group's visit. This means that they can make the students' lessons extend beyond GSMIT and Great Smoky Mountain National Park to being relevant to

their hometown. *"...I think it is good for them to understand how we fit in to this place where we live and how it sustains us and um...start to realize that everything really is connected to one another and if we do something to one thing it is going to effect the other part, um, so I think its important for adults to realize that so that, because they are making decisions every day about what's going on in their world and its good for them to be educated and to have some kind um...I guess...like have a previous experience so that they can make knowledgeable decisions (Tricia, second* interview)." Tricia commented that in order to facilitate these types of connections to issues outside of the park, the teacher-naturalists explicitly make those associations between the lessons at GSMIT and their home communities. "*And also, before they come, if we are doing a geology lesson, or we are doing a stream lesson we try to look up where that school is from and see what kind of green spaces they have or state parks, or what watershed they're in and if they connect to us through waterways, um...or if they have similar geology as we have here, and we try to connect um...natural things that are in their area to our area. Or we'll say 'when you go to lake such and such and that's in their town and you surveyed the stream you could find similar macroinvertebrates and then they look at you like, how do you know that we live near that? So, so, there's a lot of planning before hand to just make sure we know where they are coming from."* In Tricia's opinion, the advance preparation by the teacher-naturalists helps them to make connections with the students' home communities during class time. Clearly, the teacher-naturalists have significant challenges in making those ties to the students' home communities, but Tricia made it clear that she still felt that it was an important aspect of their work. And, according to Tricia, all of that preparation and work could turn out to be a powerful force in a student's life.

Tricia mentioned that it can frequently be difficult for the teacher-naturalists to ascertain exactly what impact they had on their students, but what is not uncommon is for teacher-naturalists to receive letters from participants and/or their parents shortly after a visit to Tremont. According to Tricia, the Tremont staff has occasionally received correspondence from people many years after they have been to GSMIT. Tricia commented that frequently it is these letters that speak to the profound affect that GSMIT had on a persons' life. Tricia explained that the connections made at Tremont are significant and extend well beyond the initial experience. As she described, sometimes former students tell of their Tremont experience as being life changing, *"...their parents will tell us, you know, this child wasn't interested in doing anything in um...and really wasn't really interested in what was going on in their community, and they have done something about it and gone to a um...town meeting on preventing something. Like we've had one of those...Um...there was another women who said that her daughter babysits all the time and all the songs that she learned she's been teaching all the kids that she babysits and um...its like even just a small thing, even if it was just a song, it was some kind of change that the parents saw and said look at this, this is awesome that my daughter is doing this cause she wouldn't normally. And we had someone who was a camper here who's now like 35 or 40 write us and...just recently, and tell us that after their coming to Tremont for a few days or a week that he um, it basically changed his life and changed his career path and that he had just realized. He had done something and was reflecting on what made him, what got him, what got him where he was today and he, he credited the experience at Tremont for a lot of it, that just pushed him in that direction (Tricia, second interview)."* Later in the interview she built upon this association between Tremont and the students' lives beyond GSMIT by saying, *"So, I think its, its sort of, a piece of such a larger education that kids get, and so one of our rules would just be to give them*

that intense experience that they're going to remember and hopefully changes the their mind about how they think about the world around them (Tricia, second interview).

Theme two: Using fun and play to facilitate learning. Tricia emphasized that a "fun experience" is an important part of what teacher-naturalists try to create for participants in the programs at Tremont. This became particularly apparent during the observation that I did with Tricia. On this day she was leading a group conducting Monarch tagging in Cades Cove. This observation occurred on a beautiful July day. What was unexpected is that a mother bear with two cubs had decided to climb a tree just down from the field where the students were to be trying to catch butterflies. Tricia did not hesitate to take advantage of this opportunity. While she was careful to not take the students too closely she made sure that they were able to get a glimpse. Once she was sure that they had all had the opportunity to see the bear family she went back and started helping the kids try to catch Monarch butterflies. If one student seemed to be having difficulty catching a butterfly she would quickly go over to help. Through her actions it was apparent that she wanted them to enjoy the experience. In a later interview stated that they want to create an atmosphere where students enjoy the experience so that those memories stay with them and are more meaningful. She said, *"I think that we just give them that experience, like a great vacation that you remember and you continue to remember for a long time because it was just so intense and so wonderful and I think that's sort of what we give them. That wonderful memory of OH...something was sparked in me there...what was it? Even if they don't realize it until later in life...(Tricia, second interview).* This aspect of creating an enjoyable experience was apparent when Tricia spoke of one of the citizen science projects that GSMIT uses in their curriculum, Monarch tagging. She mentioned that this is one project that she especially loves and described it as *"one of the most joyous things I've ever done (Tricia, first interview)."* In fact, her

face lit up with a big smile as she spoke about it. Monarch tagging is one citizen science project where GSMIT allows participation by the general public. In other words, they advertise that they will be doing Monarch tagging and anyone can come in to take part in the experience. Participants do not have to be part of a program at GSMIT. Tricia commented that these Monarch tagging events usually occur on a Saturday and that she volunteers yearly because she loves the experience. When she was asked why she enjoys this particular project so much she stated, *"I think it has to do with just watching people with a butterfly net running through a field. They look like they're frolicking. And even if you're not the person running through the field trying to catch a butterfly, just watching it, just puts a smile on your face. And, like seeing Dads with their families that come, 'cause those are the ones that are open for the public to come to. Um, like Dads that have wanted to go home, and didn't want to do it, and then they're the last ones in the field. You can't get them to come back when we're done, and they're still catching butterflies (laughter). So, um, it's just, its been a really joyful experience for that (Tricia, first interview)."*

In another example, Tricia stated that she was interested in using the citizen science project known as 'Bee Hunt' during a summer camp program because she thought that it would be fun for the students to photograph and identify insects. *"I knew that eighth grade girls always brought their digital cameras and they love to use them. And so I thought, well, let's show them another way of collecting data instead of just collecting these insects, you can take photographs of them and the plants that they're on (Tricia, first interview)."* She described the fun and sense of enjoyment that comes from participating in yet another of the citizen science projects at GSMIT. *"We do a bird banding in the summer. It is the other big citizen science project that we ask the public, 'come in, do this with us.' And, um, we get a lot of people that will come in early*

morning to do bird banding. But the reward is that you usually get to hold a bird. You get to see a bird close up. You get to touch its feathers and that's, that's, it's awesome to get to watch people do that. We did that with Girls in Science, too. And some of them got to hold the bird to release it and it just sat on their hand for awhile before it flew off and you, the look on their face was like, 'I'm holding a live creature that usually, you can't even see 'cause it's up in the trees.' And so, that's a great project too (Tricia, first interview).” Capturing that sense of awe, and joy seemed to be fundamental to what Tricia tries to create for each of her students through their experiences at GSMIT.

Tricia stated that while it is important for all visitors to have an enjoyable time at GSMIT, she alters her focus and goals depending upon the age group of the students. She described, *“Well, to me personally, I...it depends on what age group we're working with and if we are working with a younger age group, basically, I just want to get the kids outside and allow them to have a good time, just out in the woods, or out in the creek, so to me with younger kids its just about getting them outside and letting them play. And with older students and then adults, and um college students its about helping teach them how things are working, and how um how the ecosystem works, and how everything is related and starting to help them realize those things and experience those relationships and also realize that they are a part of that, um of that nature. That they're not separate from it, so um...yeah...that's how I think. It may not be Tremont's way of thinking (Tricia, second interview).”* When she was asked to elaborate on why she felt that distinction was important she stated, *“Well, I think that um...honestly, I think that kids get bogged down with a lot of problems with the world and so I think its important to just have kids go out and have a good time and start to care for what's out there um...and obviously, I think its important for everyone to do this. That's why I like to focus on 'let's go play and let's*

have a good time with the kids so that they can have some good memories and then with the older people I think its good for them to understand how we fit in to this place (Tricia, second interview).

In regard to the type of GSMIT experience that she would envision for students she stated, *"I'd say that I would rather them have a really good time here and think this is something worth caring about, like, the Smokies are worth caring about than come here and learn a million new words (Tricia, first interview)."* From Tricia's comments it was apparent that, while she wants her students to have fun, she does have a hidden agenda. From many of her comments like the ones above she demonstrated that she was hoping that fun and excitement would lead her students toward a stewardship ethic. As she stated above, she wants them to learn that the Smokies, their communities, and ultimately this planet are worth caring about. She wants them to understand that they are part of the ecosystem and that they have a role in protecting it. But it is also clear from her statements that she does not want to be heavy handed in this lesson. As she stated above she feels as though kids are already overburdened with the problems of the world. She wants them to make a connection to the wild places so that they will want to preserve them.

Theme three: Building sustainable connections by developing meaningful relationships. Tricia stated that the relationships that people form with Great Smoky Mountain National Park, GSMIT, the staff, and each other are an essential aspect of their experience when they visit the center. She said that she feels that the formation of these relationships are important to her as it allows for the teacher-naturalists and staff to build deeper connections with participants. This connection was evident as she described people frequently returning to GSMIT time and time again and bringing family members. *"I really like it when we open it up to the*

public and we get that kind of um, partnership with them and just, they get to know Tremont. And a lot of the same people will come back to those (Tricia, first interview). She went on to express, *"...I think that it allows us to have a connect..., a longer term connection with our own community. Cause there are a lot of local schools that come here, but there are a lot of schools that aren't local too. And I think that when we get volunteers in here, at least in the summer, it's probably a lot of people that are just visiting as well. But those long term studies, um in the fall and the spring, and the salamander study, three of those plots are volunteer run that we have, um, aren't even run by us really any more. Um, we get a longer-term partnership with them. For example, (one family) has been has been at the Pigeon salamander plot for like ten years, and their sons have been interns here. Um...their sons have been interns here, and they have a long relationship with us now. And not only that but, an intern here, she's part of Maryville College, um, Biology Club or Outdoor Club, and they do Ashley Branch salamander plot for the last, at least two years. And now she is working here this summer. So, it's our connection to the outside world, our own community and they are able to come in and do these things with us. Yeah, we love it when people come back because we always have this great relationship when they're here, and we want them to come back and do something else with us, and we miss them when they're gone. You know, we meet so many new people all year, it's really nice when people come back and...we have a few programs that are really good at that, but Citizen Science, I think, um has the potential for that kind of relationship (Tricia, first interview)."* Tricia mentioned that the people who return to GSMIT somewhat frequently are the individuals that the teacher-naturalists seem to have the most profound impact on because they have developed more of a special relationship with them. *"This week we've, I mean, had teacher-naturalist week and usually those, it's like a homecoming for a lot of the older folks and two of our campers who have been coming*

here since discovery camp. Like eight or nine years in a row and they're finally too old for camp so they came to the adult hiking week so that they could still come here for summer camp. It was just adult summer camp...So, um, I think the other people that we really impact are the people who continue to come back, and that's what we've been focusing on recently is just getting people back. They come in, with their school, bring them back for family camp, and we had a teacher bring her kids this year to family camp, you know, come for um...a week with Road Scholars, bring you back...And so, its just, its like making relationships for people while their, when they are here, a personal relationship as well, not just connecting people to nature, but connecting them to this place and to the staff here, and pullin' them back, come again." She seemed to feel that this relationship to GSMIT was important if the educational center was going to have an impact beyond its borders. She explained how the centers wants students, teachers and parents to have that connection to GSMIT but also wants to influence behavior back where people live. As she stated, *"What kind of relationships are happening and what your place is in all of that, and I think that when people come here they get a better sense of what their role is or what their place is in the natural world and what it can be in their community. They start to connect themselves to everything that's around them."*

Tricia expressed that it was necessary for the teacher-naturalists to have a personal relationship with the Smoky Mountain to be successful facilitating such connections with their students and the park. She described this as: "*And so if I don't have a connection to the Smokies, I don't know how I could show them this place. I feel like I need to be just as enthusiastic and just as in love with this place as I want other people to be. Um...and that just comes with time and living here, like...we actually live here is another HUGE connection. This is our, this is most of*

our staff, at least our teaching staff live here and this is our home. So, this is our backyard and this is a national park and hardly any other people live right here (Tricia Interview 2).”

Case one: Discussion and interpretation. As demonstrated by the excerpts described above, the lessons and guiding principles of GSMIT are grounded in ecojustice and place-based education philosophy even though Tricia does not explicitly state it in those terms. According to ecojustice philosophy, education is essential for ensuring that resources are available for future generations and for the revitalization of the commons (Bowers, 2004). As is clear from the themes that emerged from the interviews and correspondence with Tricia, GSMIT is critically involved in both educating the public about the natural world associated at their facility as well Great Smoky Mountain National Park (GSMNP) and the students' home communities. In addition, Tricia hopes to foster a desire within participants to preserve both GSMIT and GSMNP. As described, theme one (Moving beyond the local: Connecting Tremont to a larger environmental context) is central to this work from her perspective. Tricia noted that much of her focus as a teacher-naturalist at GSMIT is designed to create an appreciation for GSMIT and Great Smoky Mountain National Park (GSMNP), but also to instill a desire to protect the natural environment of the park. However, as was discussed above, her hope is that this connection to the commons of GSMNP will not only develop an awareness of issues related to the park, but will also spark an attentiveness for environmental issues back in other places.

According to Juker (2004), this attention to the students' home communities is a critical aspect of an ecojustice educational framework. This is clearly the case with Tricia, as she works to make explicit connections between the park and the green spaces, rivers, watersheds, etc at the GSMIT as well as back home. Furthermore, Juker states that teachers must model the behavior

that they want to see the students embrace. As Tricia mentioned, she lives within GSMNP on the Tremont campus. She expressly stated that she must have a firm connection and love for the park if she is going to be effective at facilitating that with her students. In addition, Tricia's desire to connect the lessons learned at GSMIT to the students' home communities gets to the heart of place-based education. As described by Smith and Sobel (2010), place-based education is “an approach to teaching and learning that connects learning to the local. (p.viii)." By working to develop an association between Tremont and the students' home communities Tricia is encouraging place-based education. Furthermore, by embracing place-based education she is working to increase the awareness of community issues and community connectedness. Smith and Sobel (2010) stated that the United States is suffering from 'community deprivation.' The work that the teacher-naturalists, like Tricia, at GSMIT are doing to connect the lessons learned at their educational facility to the students' home community may serve to diminish this ailment.

As one reads the transcript of what Tricia has to say, it is apparent that she is passionate about citizen science. Tricia firmly believed that citizen science was a critical component of her work at GSMIT. She felt that it served to make connections to the students' home communities, and as Smith and Sobel (2010) note, this is a key aspect of place-based education. The projects in which they participated were not generally ones that could only be done in Great Smoky Mountain National Park. If the students became passionate about Monarch butterflies they could find ways to be involved with their conservation back at home. In this way citizen science can serve as a link between GSMNP and the local ecosystems of the students home. This would surely count as “Connecting People and Nature.”

Case Two: Sarah – Building a bridge between two worlds

"I've always been into nature and anything outdoors. But once I started to learn more about the ecology, how things worked together, um how to identify things, it's like my eyes were opened and I feel suddenly more alive even. I feel more observant. When I started learning bird songs, um, now I hear them everywhere I go, I can't turn it off. Once you learn it, you can't turn it off. And just so being constantly hyper-aware of what's around you, I feel has made me a more observant person in general. Um, so being able to um bring that to other people, I think especially because I've been in the research world for a while, a lot of people would consider themselves non-scientists, like they can't really go there because they're not smart enough or they're not trained in that field, um sort of a different world to them, but I want to make it so much more approachable to everyone. Because it's just, it's just making observations and it's just writing a few things down and really helping out our basic knowledge by doing so. And so, I think that by someone um coming to the realization that they can really contribute to something that's larger than themselves, a larger project where they can actually learn how this salamander population is doing or when the wild flowers are leaping out and budding and blooming across all the years, the fact that they can say, hey I had a hand in that, I really participated in that and this is going to this larger basic knowledge that they're going

to use to inform management decisions down the road, I feel like that could help people to be even more connected. Um, specifically to this place and to these projects, but they can that that home, teachers take that home and can do these citizen science projects in their own school yards, and stuff and I feel like that can just have much broader reaching implications. I mean the whole idea behind citizen science is being able to um reach a larger audience than any one researcher can reach, can do on his own."

Theme one: Constraints of time are a significant challenge in relation to directing citizen science projects. One theme that emerged during interviews and observations with Sarah was that of the constraints created by time. This was not limited to one aspect of her job, but was discussed in terms of being able to effectively collect data, train staff, develop new projects, analyze data, etc. To be fair, this was never a complaint. Instead, it was simply an honest critique of her work environment. If lack of time was a source of frustration for Sarah this was only because she has so much energy and enthusiasm for developing new projects and not enough time to get started on them. As she said, *"I looked at the list of projects that have been done here through the years and I see what's still happening, what's still ongoing and what's sort of fallen by the wayside and I would love to see many more projects be started back up again, or just new projects introduced, but I'm realizing the reality of the situation and probably why a lot of those have been dropped by the wayside...and how hard it is to keep even just the core ones we have juggled up in the air...The main thing is just the time and the resources. Time being the main resource, you and manpower to do things. But, it's pretty awesome, pretty exciting. And so, it is over whelming and it's hard enough just to keep one project in the air usually, um but one*

blessing in disguise is that they're not always all at the same time. Um, but you can often have, get hit by several at once, which is overwhelming... there's always so much going on, one of my biggest uh, difficulties is finding enough time in the office to really do much planning and much preparation, uh, so that's where a lot of my anxiety has been coming from (Sarah, interview 2)." Again, this was not a statement of dissatisfaction. She explained, *"I love just the fact that I feel like when I'm working it's um, it's very much what I want to be doing, and it is not like pulling teeth to get me to do these things. So yeah, I just worked twelve days in a row in a straight stretch, but I was camping at Purchase Knob...and I was going to Tuckaleechee Caverns, and I was banding birds and hanging out in Cade's Cove. Like doing all this stuff that I would just do, you know, in my free time (Sarah, interview 2)."* From Sarah's own words it is apparent that she loves her work, but she also understands that time is limited and that puts constraints on what she can accomplish.

Through interactions with Sarah it became clear that one of the key challenges for coordinating citizen science projects at GSMIT, from her perspective, is time they require. She emphasized that the actual data collection is certainly demanding, as well as the administrative tasks and necessary training that are essential for citizen science projects to run smoothly. Fortunately, she has a lot of help. According to Sarah, *"Each of the naturalists are sort of assigned a project that's sort of their, their baby for upkeep – which is really helpful to me. So, they have citizen science hours that they're assigned like um, I don't even know how often, once every couple of weeks. They have, like a morning or an afternoon, where they have citizen science time. And so I'll send them out there, if they're in charge of the stream salamander transect that'll be their chance to go out there and collect information and stuff from leaf litter bags. Or repair the terrestrial salamander plots."* Sarah indicated that the staff as well as the

participants need to be trained in regard to each of the protocols that will be used, but at GSMIT visitors may only be there for three days and each new group has this same need. According to Sarah, *"There's also, you have kind of, a couple of different worlds: you have school groups that are coming in for one afternoon, and that's it. They might collect information on salamanders, um. But you also have these groups that come, families that volunteer for years, or even just for one year every month. Uh, those groups you can actually invest more time into and you can make sure they are more specifically trained, you can spend more time with them....um, and the birds is one of the hardest parts for them to be trained in. But you can invest more time in people that you know will be coming back over and over and over. So there's sort of different, there's different circles (Sarah, interview 2)."*

Sarah perceived one of the most poignant issues associated with time limitations and citizen science at GSMIT to be that it can actually get in the way of facilitating connections between GSMIT visitors and nature. For example, she said, *"I think that sometimes, especially given a restrictive time frame, you can't do um, you can't necessarily collect information on a particular project um if you don't have very much time you just have to go out and play in the creek. You know, um, a lot of times, it's just so tempting to be like alright, we only have 20 minutes, there's no way we're going to do this transect, just go play in the creek and see what you can find. And it's a lot less intense and less stressful that way because you don't have to worry about, it's not a big deal if you don't really figure out exactly what that salamander is or whatever...So, yeah, it definitely can get in the way in that respect. Um, I think some of our projects, our phenology is one where we have eight plots that have to be visited every week, once a week. And it's hard to fit that in....that don't really fit very well into our, our canned like three hour classes because there's already a bunch of activities that you're trying to get done. So, often*

they have to be sort of squeezed into a hike, like a ½ day or all day hike. And they don't often work with that given numerous circumstances: the group is slow, they need to really just keep hiking, or they, they're just not interested, or, you know they don't feel like carrying all the stuff, or um it rains, you know, just whatever. So, sometimes, it is hard to fit, to fit it in to our educational and other goals. (Sarah, interview 2). Sarah was not trying to insinuate that citizen science was not a valued part of the GSMIT experience, but rather that time restraints could infringe on the desired outcomes. This was something that Sarah mentioned that she must be mindful of because she was well aware that citizen science projects at GSMIT are suppose to enhance the educational experience and not detract from it.

Theme Two: The tension between the goals of science and those of education. As mentioned above, citizen science at GSMIT is suppose to serve the educational objectives of the facility. According to Sarah, *"Tremont's number one mission and goal is education and so we won't take on any um science projects that aren't, that we don't deem um useful for education. For something that's going to be entirely boring, like nobody's going to get anything out of it, then I don't, basically we don't care how important the data is, that's not going to become a citizen science project here...Um, so there has to be uh, there has to be the interest, the um, the fun aspect, the educational aspect, but also, it has to be doable. And that is hard (Sarah, interview 2)".* However, Sarah acknowledged there is an underlying discomfort between the worlds of science and education. When Sarah was asked if she ever had difficulty bridging between the two perspectives she gave an unequivocal 'yes.' She explained, *"That's been one of the biggest challenges for me coming in, and I knew it was going to be. And I'm, I'm ready for the challenge and I've been trying to meet it as best I can. Um, but the reason why, if there is a reason for people to think that they can't really go to the science world or whatever because a lot*

of the information that is collected for these research projects is very specific and you need to be highly trained to do so, um and there's a lot of noise that comes with the data if you're basically trusting in a bunch of non-scientists to collect your information. So, and that just has to be worked out in the wash. So, to me, the biggest challenge has been designing projects in such a way that they are easily um participated in by folks who don't have prior training, um, to where it's useful for education and for science at the same time.(Sarah, interview 2)." Sarah stressed that education, not citizen science or scientific research, is the primary focus of GSMIT. As she said, *"I'd say Tremont's mission, first and foremost is education. Um, so, whatever citizen science we do must have an educational focus. If it's not going to turn light bulbs on, not going to be terribly stimulating, then it's a project that we would have to second guess, like should we really be doing this? Um, but at the same time, it also has to have scientific benefit and conservation benefit and I would like to have an application to it as well, like natural history, gathering natural history information is very important (Sarah, interview 1). So, yeah. I think it* (citizen science) *can get in the way. I think that in a, place like this um, if you have to choose one, education or citizen science, we would err on the education side to give them a positive experience (Sarah, interview 2)."*

The tension between science and education at GSMIT becomes more apparent when one realizes that not all of the teacher-naturalists are excited about citizen science. In regard to staff buy in, Sarah explains, *"Some do and some don't. It really depends on their personality. Um, we've got a few people here now who are just super enthusiastic about it and want to do as much as they can in science, and we've had a few, some that have just recently left, um that could care less and all they want to do is the "touchy feely" stuff with kids and just like be out there teaching and having um really great interactions with the kids, but they don't really care about*

actually collecting any data. Which is understandable, um, but it's hard to get things done sometimes when there is that attitude. But I'm trying to be understanding and, and say, you know, this is, the citizen science, this is a core part of what we do, but it's, those projects are not always a required part of the classes. So, its striking a balance of saying, hey this needs to get done, but I know its not required, I know...It's kind of a weird position to be in....so yeah, it very much varies by training and enthusiasm and by showing enthusiasm as a leadership team for it. And I think right now at the high turnover rate that we're having we have that opportunity to really foster that from the beginning with new folks coming in. And by us showing all that excitement about it, perhaps they can also become just naturally excited about it and see the importance of it and stuff. Um, I think that the most recent staff um, and it's not a bad thing at all, it's just they are more educators than scientists. But, that's what they're here for, they're here to teach, they're here to be educators and so, um, I think even in, if you want to focus on having people who are interested in having both science and education you almost have to focus on having people who are interested in having both science and education you almost have to focus on that when you're hiring them, you know, from the beginning. Um, but at the same time, you've seen people come in who are just 100% educator who didn't ever realize they had such an interest in science and who just want to foster that too while they are here (Sarah, interview 1)."

In this regard, Sarah shared some interesting insights with respect to how she defines herself in terms of 'educator' or 'scientist.' She commented, *"...I'm pretty new to the education world, so I'm a scientist who really likes to educate. So, I'm not first an educator, but I think a lot of folks who consider themselves first an educator don't really want to be bothered with anything else, maybe. I don't know, but I think that also, it's more, it might be more of a mindset thing, like teaching um, teaching just plain identification but not really asking any questions about it...which to me,*

natural history is, you know, learning and identifying things, is very much a science as well. It's just the way you look at it, I guess (Sarah, interview 1).” These labels that individuals give to themselves speak to the tension that is found between science and education from Sarah's point of view. While Sarah self-identified as a scientist who educates she also referred to others at GSMIT as educators who are interested in science. As she stated, some people are more interested in the students having a good time than collecting data, but Sarah wonders how this fits into the context of Tremont's guiding motto of “connecting people and nature.” Perhaps some understanding of this tension can be gleaned from understanding more of why Sarah is at GSMIT.

Sarah suggested that she feels that she is bridging the worlds of scientific research and education. When asked why she decided to move into education from a pure research focus she said, *“I had several experiences doing like workshops with kids, bird banding workshops, or just teaching little kids how to go birding and just loved it so much and just realized wow...this is so much fun. Also, teaching, um, seniors, college seniors ornithology was challenging but fun and I realized I enjoyed the teaching aspect of it and um had a few folks tell me that I was kind of a natural at it, which I was totally shocked. I was like, okay, I guess maybe I should look into this. But, um, more so, it was just realizing its tons of fun, I can still do science, and I can still do research, but I feel like maybe I can have a broader impact um, in having a chance to educate at the same time. And so, I feel like, I feel like all of my passions are being fulfilled...So, yeah, to me it was, it was, it wasn't so much that I was disgruntled with the scientific world, um ' cause I love my research buddies and the specific Currealean Warbler world that I was in for a while, still am part of, um but I just realized that to get the word out you gotta, you gotta bring it to, you gotta make it accessible.”* This was apparent during the bird banding observation conducted with

Sarah. During this class Sarah needed to oversee the catching of birds with mist nets in addition to handling the birds and placing bands on the birds' legs. During this process she was very comfortable talking about the biology and ecology of each of the birds as well making sure that the birds were safe. Sarah was invigorated by the idea of passing along her passion for science, and as such it seems as though blending the worlds of science and education seems perfectly natural to her. However, continuing to identify herself as a scientist seems to perpetuate the division between the two while simultaneously contributing to the artificial dichotomy.

Theme three: Building on legacy: Continuing old projects while starting new ones. There are many ongoing citizen science projects at GSMIT. Some of them, like the aquatic salamander project, started early on in the program. Others, like the phenology project, are new to the curriculum. Still others were started and then abandoned. This legacy of projects is perhaps one of the most unique aspects of citizen science at GSMIT. As Sarah mentioned, it seems that each citizen science coordinator has come to Tremont and started up a project that was of particular interest to him or her. While Sarah is relatively new in the position, she was already starting to ponder what projects she wants to initiate. However, she still looked to the past and wants to tie new programs to old ones. *"I've got some other ideas, um, and plans for research as well. Like, I want to start up some of the old projects that have sort of gotten fizzled out...so, this will be the last year of the bird banding the way it is now, looking for parasites and setting up nets anywhere. Next year and in the following years, there has to be a more, a more directed focus, I guess. But its been going on for a long time, so, my plan to continue the bird stuff is to do the Louisiana Water Thrush research, because we catch a lot of them here and, um, to look at territories and the, how nest success, and foraging observations and things like that, that I could probably do with kids...Uh, but with the ATBI winding down, um, not so much*

winding down, but with a lot of the current projects are, have just finished so their last year, um, there's a lot of things that fizzled out in the past that I'd like to see start back up. I might not know a lot about them yet, but things like Frog Watch and Fern Foray, and Fungi Mapping and those sort of nationwide citizen science projects that we could...Project Nest Watch, I don't think has ever been done here, things like that, you know (Sarah, interview 1)." Clearly, Sarah has no shortage of energy or ideas! She elaborated by explaining that there are lots of possibilities when your laboratory is a national park, nevertheless her ideas are still grounded in what citizen science has been done previously at Tremont and how can that be built upon. This became apparent during the coding process. She repeatedly referred to the projects that had historically been conducted like the aquatic salamander and moth identification projects For example, she explained, *"Like when I came in, there's an understanding that I would continue to coordinate the core projects...and further develop them and keep them going, and, and...each citizen science person, throughout the years, has tended to leave their mark in a certain way, like have their pet project that they would start and be involved in and sort of continue to dabble in even after they leave. So, like [*the last citizen science coordinator]*'s was the phenology project. Um, and since that's his baby, I still coordinate with him on a lot of things, like what do you think about this, think I should do it this way? 'Cause, eventually, I guess he would have the desire to write up the data one day, you know, and actually get it published somewhere. So, um Simon, is with a lot of the aquatic salamander stuff, so while there's direction and needing to do certain projects and keep them going, everything else, sort of, the sky's the limit, you know within our budget and within reason with the permits that we can obtain and stuff. So, um, I pretty much have free reign to design the sort of project that I'm looking into. Obviously, I would need to get it approved and everything within Tremont and then get the permit for it through Matt and stuff. But, like, for the*

Louisiana Water Thrush stuff, and other things that I'm interested in, it's very much, you make, you make it what, you design it the way you see the program working. And, that's one thing I really like and one things they stressed from the beginning, even in the interview process, is that in this position you have the opportunity to develop what the citizen science program here will look like down the road, to think long term and think where, where do we see it going, how do we see it affecting Tremont as a whole, down the road (Sarah, interview 2)?"

Case Two: Discussion and Interpretation. As any teacher knows, time is always something that is in short supply. According to Smith and Sobel (2010) teachers are already overburdened with the prescribed curriculum of most public schools. As such, they are less inclined to embrace new teaching pedagogies, such as place-based education, that requires additional demands upon their time. Citizen science projects, as Sarah reminded us, require a lot of planning and administrative work. The data must be collected, recorded, and passed on to be analyzed by the researcher. This can seem like a daunting task to a teacher who is already feeling overwhelmed by her/his current work load just as Sarah described is the case for her at GSMIT. This is further complicated by the fact that place-based education, by virtue of being place specific is not easily centralized and standardized for a region or country. What works for one educator in one school will not work for another educator in another. Due to the very nature of place-based education, individual teachers must take responsibility for developing lesson plans, developing activities, planning field trips, etc. In addition, they may have to convince parents and school administrators of the benefits of such a curriculum. Furthermore, workloads cannot be easily dispersed amongst many individuals, as may be the case with more traditional curricula. This alone may discourage enthusiastic teachers from participating in such endeavors. As Gruenewald (2003) reminds us, contemporary school reform has striped the typical classroom of

virtually all connections to the students' place. Developing a place-based curriculum requires time, which is a scarce commodity. Class time has become reduced, there are more students per class and due to liability issues teachers are seldom allowed to take students beyond the schoolyard (Gruenewald, 2003). All of these factors converge to make it difficult and challenging for educators to try something new and different.

Introducing citizen science into the mix just further complicates the matter. Teacher will most likely have to develop their identification skills and become much more knowledgeable about the project topic than they would need to be if they were just following the standardized curriculum. This is similar to what Sarah described in regard to her job responsibilities at GSMIT. She has deadlines, expectations, prior commitments, and responsibilities that all must be met and yet she described that she still feels the pull and desire to expand the offerings of citizen science at GSMIT. Fortunately, Sarah is excited about these challenges and feels that if lack of time is her greatest concern then all is going well. However, Gruenewald (2003) cautions us that getting too caught up in the events of our lives, or in this case workload, can cause us to become disconnected from our place. This may sound counter intuitive given that logic would dictate that we are naturally rooted in our place. Unfortunately, as Gruenewald reminds us, even though our "place" is everywhere, we retreat from it as become entangled in the logistics of our lives and our routines. In fact, it has become increasingly common for people to be living in one place, but working remotely somewhere; having meetings via conference calls with people around the world, carrying on relationships with people far away. How can one be rooted and grounded in their community and place when their minds are so far removed? In affect, we forget to see the forest for the trees. In terms of the challenges associated with time and work responsibilities, one must begin to wonder if Sarah struggles with her own connection to place as she works so hard

to build them for others. Feeling the pressures of not having enough time is just one more challenge that can prevent teachers from reaching out of their comfort zone.

Perhaps these challenges are part of the reason there seems to be this tension among teacher-naturalists' goals for their students. On the one hand they want them to simply have a great experience at GSMIT but they also want there to be an emphasis on science. Sarah very clearly identified herself as a scientist. She was very comfortable talking the language of science, and did not hesitate when she described the types of projects that she would like to see started at GSMIT. She was very clear about why those projects would provide data for interesting scientific questions. And she is also certain that she was a scientist first and an educator second. This seems to indicate that, at least in her worldview, there is a definitive line between the two. However, beyond Tremont it seems that one of the enticements for individuals to become involved in citizen science is that it somewhat blends the line between those two worlds. More specifically, it lessens the distinctions between professional scientists and non-professional scientists. According to Miller-Rushing, Primack, & Bonney (2012), the critical aspect of citizen science is the public's participation in genuine scientific research. They explicitly state that this research does not have to be hypothesis driven, although it can be, but it may also involve natural history observations, or monitoring activities. Regardless, they are careful to point out that the important characteristic of citizen science is not the level of involvement by amateurs versus professional scientists. In fact, they go on to emphasize that one of the advantages of citizen science projects is that non-professional scientists are willing to investigate questions and collect data on projects that typically would not be taken on by professionals. It is not a case of the work not being important, but instead it may be too narrow in focus. For example, a local water quality problem is just too regionally specific for most professional scientists to investigate. So, this

provides opportunity for the blending of the worlds of professional and non-professional scientists. It opens the door for educational opportunities at the local level that may not be available if the work was only being done by professional scientists and their paid assistants. Citizen science is more broadly viewed as a way to improve scientific literacy, and educate the public. Bonney et al (2009) claim that many projects are now being started simply for their educational value. Beyond the strict interest of science however, this blending of roles between scientific identity and educator identity positions the use of citizen science in the classroom nicely in a place-based education context. According to Bartsch (2008), students learn best when the information is meaningful to them and relevant to the world beyond the classroom. As stated above, citizen science addresses real world questions and looks to expand scientific understanding, so it seems plausible to assume that students would find the information associated with their citizen science projects to be useful. It was apparent the interviews and observations with Sarah that she feels that this is most definitely the case. In her interviews it became abundantly clear that this was her opinion. She frequently referred to the value of citizen science in terms of making science relevant to the lives of students. This topic came up in both interviews numerous times. She has worked at finding her sense of balance between scientist and educator, but it was obvious that she felt that a merging and cooperation between those two perspectives was critical. She wants an authentic scientific experience to be part of what makes for an exciting and memorable visit to GSMIT.

Case Three: Stiles – Using Citizen Science to Make Science Relevant

"Because uh I studied environmental education, the framework is, is, is the environmental education based, the idea of people have, usually have some level of awareness of and an awareness of what's out there, you know, on some level

deeper or shallower. Um, um, but uh, well connecting them to it is usually learning something about it, but also having some, having some emotional connection to it it as well. So usually they'll go hand in hand, and oftentimes the more you learn about something or spend time with it, observe it, get to know it, you start to develop that, that sense of empathy or that other kind of connection to it. And I kind of think that's what we're talking about, that's what I'm talking about when I talk about the connection to nature. It', it's like, suddenly you realize that, whatever that thing is, whether it's the river or a tree or, or a butterfly, it becomes important to you in a way that it wasn't before. Or more so, and so, um, because I just, I just know that what's, that's where the tipping point is, where you change from. Well that's all really neat to "wow, uh my life has an, we impact each other, you know, in such a way that I can do, I can live differently or I can behave differently because I value that," the National Park, or the butterfly or whatever it is that you felt connected to. Uh, I think that that's just the part where you change as, you change a little bit as a person, your outlook and the way you act. (Stiles, interview two)."

Theme one: Citizen science enhances the programming at GSMIT. Citizen science projects are increasingly being implemented to improve scientific literacy (Bonney et al, 2009). In fact, citizen science is viewed by many as being a logical interface between traditional science and education (Henderson, 2012). Stiles felt that the inclusion of citizen science in the curriculum of Tremont elevates the level of programming, as well as the interpretation skills and content knowledge of the teacher-naturalists. He said, *"It's a, it's a way of, the educational programs we do are strengthened in a lot of ways, by having on going citizen science projects.*

Strengthened for the participants, the students primarily, who can, the teachers can sign up and they can be a part of different projects. But it is also strengthening for our staff to be able to participate and have the expertise to, to like this morning, just knowing salamander identification to a level of doing these protocols just brings our staff to an expert level that I like. I really like that about this program. It forces a rigorousness, I guess, to our staff's nature study and their own naturalists abilities. So, it has that professional development side of it. (Stiles, interview one)." According to Stiles, citizen science increased the knowledge base of the teach-naturalists at GSMIT, and this allowed them to be more effective in their role of leading student groups who are tasked with the collection of data in some of these projects. The staff increased their own naturalist abilities partly because of leading the groups as they participated in these projects, but also because they underwent periodic training so that they could lead these activities effectively. For example, Stiles mentioned that the staff must go through occasional training to comfortably lead fifth, sixth, and seventh graders on citizen science projects; *"for citizen science we try to do trainings throughout the year. Like we'll have somebody come like Simon and...we're going to do salamander training, we want everybody there and so everybody comes to the stream. Sarah has done some of this with birds. We're going to have a bird song um bird song training this spring because that's part of our phenology monitoring um project. We need to learn X number of bird songs. (Stiles, interview one)."* Stiles emphasized that having a staff that is knowledgeable and comfortable with the subject matter of these projects is important for numerous reasons; most importantly it helps to ensure that the kids are collecting reliable data. *"We hope in all of our projects there is a staff person looking over everybody's shoulder to kind of and usually, they, most of the staff, on each project that we are going to do a lot…kind of know what we are going to get. If they, if the kid says something like with the phenology plots.*

Lot of times the kids will go to their tree, they have the map, they find their tree, they learn about it when they're there and then they report back, and we try to check on each tree and give it, give it a look and see if we agree. So, um...I think in that case we're still learning, but if something comes back that seems like out of the ordinary they would go and confirm that. Um...So, there's a certain level of oversight. Some of the time its more, you know, careful oversight than others, um and I think it depends on the afternoon, or the day, or the staff person. But in theory when we collect this data on a lot of the data sheets it will say, "who collected the data." Um...and a lot of the, some of the ones it will have the group, all of the kids names will be on there, and then the school, and the staff person who went out with them. Um...some of them its more like, this staff person was responsible for the data and they're saying its what, its what the kids said it was...so...I think that somewhat depends on the project too (Stiles, interview one)." Beyond that, Stiles believes that citizen science provided GSMIT a competitive advantage in terms of attracting groups to the facility. He stated that participation in these projects is not done at many environmental education facilities, *"Well, here's the thing that I realized between Yosemite and here. It's another way that we can say that we have a uniqueness. It's another way that when a school is looking at coming here versus coming to Camp Wesley woods just down the road, if they're looking for their kids to get involved with science or they're looking for teacher development in doing field science, we've got something to say: 'They do great programing, we do great programing, but a). We're in the park, b). We've got these ongoing science projects that you can get involved with.' So, part of it is just setting us apart, it's a little bit of a niche market for environmental ed centers. Um, you know, it doesn't hurt to have an occasional publication, or to be able sort of tout that. I think that the push right now in education, the whole STEM education push. We are realizing that our students are just not cutting it in science. And they're*

not, you know, we're not producing high school graduates that are interested in going into field science, and that have experience enough to go into and want to be biology majors or, you know...so, again we are kind of providing this niche where we do that, and we do it real well (Stiles, interview one)." In a later interview he stated, *"But the short story is that teachers value, a lot of teachers, that's a big value that they want to, um, they want to take advantage of here (Stiles, interview two)."* In his opinion, citizen science, overall, raised the quality of the programming at GSMIT. He felt this was demonstrated through the enhancement of naturalist abilities within the staff as well as benefiting science education efforts. As he pointed out, teachers get excited about these projects and want their students to participate in them because they see the value they hold in an educational context.

Theme two: Transforming two dimensional textbook science into three dimensional authentic science. According to Zoellick, Nelson and Schauffler (2012), there are several compelling reasons for the use of citizen science within the context of science education. One of the most cited reasons for this is that citizen science is authentic science and therefore students enhance their understandings of science through participation in ongoing scientific research. Stiles agreed with this assessment, but added that there are also significant amounts of excitement and fun that students feel by participating in these projects; *"When kids are doing citizen science I hope that they take back a totally new or somewhat of a new understanding of science. When you learn it, like I can remember, distinctly learning (mocking voice) it has these three, no six stages and starts here and it does that and does that (end of mocking voice). You know, that is such a two dimensional, flat version of science. I hope that when kids leave here they are like, "Wow! I remember learning about these steps, but what we were doing was we were catching salamanders, and measuring them, and looking carefully at, you know, where this*

and that was, and identifying them. And that was a part of this, you know, in that step process, that fit in here (Stiles, interview one).” Later he went on to say, *“If they have a sense that that they’re doing something related to science or they’re doing science, and they also know that they had an awesome time that afternoon, just having those two things associated is a, is a, good thing. I think that’s another thing, like having a positive experience, that’s nothing to do with a lab coat, Bunsen burner or anything else, ‘cause mostly what I remember from grade school and a grownup doing science, it was oh, you’ve got to go to the lab, you’ve got to, oh it smells weird, there’s these chemicals, there’s stuff you didn’t quite understand, but, you know having a fun experience that takes advantage of kids kind of natural exploration and curiosity and they realize that at some level this is a science project, that’s cool (Stiles, interview two).”* From his point of view, for students, citizen science takes science from being something that only exists in textbooks that they will be tested over to being an activity that taps into their natural enthusiasm, curiosity and excitement. Yes, they are taking measurements. Stiles explained how in the aquatic salamander project the students weigh the salamander, measure its length, and identify the species, clearly science, while at the same time working in a creek in Great Smoky Mountain National Park and handling salamanders. According to Stiles, *“The big project we do is the salamanders, aquatic salamanders and you know, just whether they are excited about the science project or just the fact that they see a salamander; get to catch a salamander. I mean I don't know if you want to, if you can parse those two out. That's part of the whole fun of it. You get to see a salamander up close. Or, the same thing with bird banding. I mean, you get to hold a bird in your hand. Or...you know...I mean...how much more connected to nature can you be? That's where those moments are like crystallizing moments for people. (Stiles, interview one).”* In other words, Stiles explained kids have a real life, personal experience with science through the

salamander project. Science becomes something that they have positive associations with instead of just being something boring that they do in a classroom and, according to Stiles, involves a room that smells weird. This excitement can lend itself to a deeper appreciation of science, according to Stiles,*" ...just the excitement of anytime you are doing science you're gonna have to make careful observations and anytime you are making careful observations you're connecting. You are getting mental pictures, you're getting...you know like, when we do salamanders, birds, our newest phenology project. There is not any sexy animal involved with it, but they're getting up and close with these trees and they're getting to see trees at a particular phase in the year. And it is kind of like, this is my tree now (Stiles, interview one)."* The students' participation leads them to developing a relationship with some aspect of the natural world and Stiles was certain that these experiences are deeply profound and can alter a persons' perceptions. For example, he explained "*And those moments, when we talk to any of our adults and ask them for this, "what was that moment when you really knew you were excited about?" It's usually those kind of moments, "oh, when I saw..." One of our staff was just saying, "I saw rabbits, you know baby rabbits when I was, when I was ten." Or whatever. And that's what...but I can just imagine a lot of our students, "you know, when I held that black throated green warbler and it flew off, that was one of those moments." I just feel we create those, and its not the citizen science, per say, that does that, but the projects that we're involved with, the reason we started is because they can provide that opportunity (Stiles, interview one)."* Stiles pointed out that by making science more real and less abstract it becomes something that sparks excitement, curiosity, and deeper connections to the natural world in students. It is that spark that will stay with them and possibly lead to a life long relationship with science

Theme three: But is it science? Working toward a better understanding of what is defined as citizen science. Stiles indicated during interviews that he felt strongly that citizen science benefited the programming and supported the educational objectives of GSMIT; however, he vacillated in his definition of citizen science. He indicated that, in his mind, the definition is an idea that is somewhat still in flux. When discussing the various citizen science projects that are ongoing at GSMIT he hesitated when he started to describe the longest running project and said, *"It depends a lot on how you define citizen science. There's stricter and loser definitions of it you know...(Stiles interview one)."* When asked how he defined citizen science, Stiles responded, *"it depends on who I'm trying...you know...what I'm trying to convey. Like what I said initially, for me citizen science is a way of connecting people, its a great tool for education in a lot of ways. Um...I know it's more than that, um but Jeff might say, you know, we've been collecting phenology data since 69 or you know 75. We've been...by that I mean somebody's been out, we've been out listening for the first, you know when migratory bird species return. Listening for the first um Eastern Phoebe, or whatever bird we're listening for when it first arrives. And we've got data on that for... 30 years of data, on first blooms of things, first birds that arrive, um so that phenology data set is something that we've been collecting. But there was no, there was no, you know there was researcher at the beginning of that saying, this is the question and this is the protocols. We're just like listening for the first of things and making note of everything we notice (Stiles, interview one)."* Ironically, even though Stiles questioned whether that phenology data could truly be classified as citizen science he acknowledged that the park service is now very interested in them. According to Stiles, "*Yeah, and so, so now there's some interest, in the last few years there's been a lot of interest from the park service like, oh wow...you've got 30 years of data on something!! (laughter) We want to see it! And so, you know*

there's been some, yeah... people looking back at that data now and trying to get information from that, but...so I guess that's what I'm saying. Like some people and I've worked with people who would say, it's not science if you are just collecting things for the sake of collecting things and there's not a reason why the data is being collected and a protocol how its being collected you know, all very clearly laid out. You're just doing something that might become...so, I don't know...I guess. I'm not, I'm not a scientists (laughter) and very...you know, anybody who is, I make sure that's clear at the beginning. I think science serves our purpose, um and citizen science in particular serves our purpose because our program participants can do it and um that and yeah, that's exciting (Stiles, interview one).” The National Park Service thinks that the phenology data at GSMIT is interesting and potentially useful, but as Stiles indicated, what he is most interested in is whether the projects are beneficial to the attendees of GSMIT. And even though he seemed to feel that science must begin by asking a question he stressed that science does not have to occur in a top down kind of way. In response to a question about this he grappled with the idea of exactly what constitutes citizen science. He stated, “*the same me that says its a great tool for education says…but then yeah it goes back to is it really citizen science or are you just going through the steps of the scientific method for the sake of doing something interesting and fun. I think um when we do these inquiry, sort of an inquiry based activity where the kids are asking questions and then going to collect data and trying to answer a question. They're doing all the steps of the scientific method, and they're answering a question, which is great! They're defending that this is why I think this, but it wasn't science...it was very loosely called science and it...and the conclusions they may might firmly believe and defend based on their observations might be totally wrong. But...um...you know, I, I guess some people would say that, that, that's not citizen science. That's just doing an inquiry activity. Um...but you could*

argue, you know, sure there's a lot of bias, and these are not scientists doing this, but they are doing, they're using the skills and going through the mental process of trying to answer a question using the scientific method, yeah...I mean, I don't think anybody would call that citizen science, but its certainly is in realm of developing those skills and for me educationally it's, it's pretty great too. So, yeah...I don't know. I'm probably schizophrenic in that. (laughter). It really...It would depend on really who I was talking to and what about. Because I know that scientists get pretty serious about the data, and if the data is not good quality data then, you know, somebody's wasting their time. (Stiles, interview one).'' Stiles was open to expanding his definition of citizen science but he was not certain exactly where the line should be drawn. Furthermore, he was equally certain that he should not be the one to make the delineation. Instead, Stiles seemed to indicate that professional scientists are the ones that are qualified to delineate exactly what is and is not citizen science and that the non-professional scientists need to just go along with their decision.

Case Three: Discussion and interpretation. Stiles believed that citizen science is an integral component of the educational programming at GSMIT, and he valued its attributes as both an educator and as an administrator. The reasons for this are many, but as discussed above he felt that citizen science benefited the students, the staff, and the programming. It isn't surprising that he saw the benefits of using citizen science in such an educational context. Place-based education has been shown to enhance educational experiences for both students and educators (Smith and Sobel, 2010). According to Smith and Sobel (2010), the body of research related to place-based and community-based education indicates that these methods enhance student engagement and achievement. In addition, these same trends have been found to apply to teachers as well. The notion that students learn better when they have a sense of connection

between what they are learning and the subject matter is not a new one. This idea can be traced all the way back to John Dewey when in the late 1890s he warned of the disconnect between education and community (Smith and Sobel, 2010).

> "From the standpoint of the child, the great waste in the school comes from his inability to utilize the experiences he gets outside the school in any complete and free way within the school itself; while, on the other hand, he is unable to apply in daily life what he is learning at school. That is the isolation of the school—its isolation from life. When the child gets into the schoolroom he has to put out of his mind a large part of the ideas, interests, and activities that predominate in his home and neighborhood. So the school, being unable to utilize this everyday experience, sets painfully to work, on another tack and by a variety of means, to arouse in the child an interest in school studies. (Dewey, 1959, pp. 76–77)"

According to Dewey the process of education becomes isolated from the lived experience. In traditional formal education, as described by Dewey, we line the students up in rows of desks and the entire educational experience is oriented toward passive learning. The students are suppose to obtain knowledge by listening to their teacher, or reading their textbook. Traditional educational settings are not oriented in such a way that students can learn in active ways, particularly not from lessons learned through their experiences. As such, a schism is created between the two worlds of education and life. Dewey (1959) noted students soon decide that the lessons of the classroom are not applicable to their lives, nor are the experiences outside of school relevant to their formal studies. Stiles believed that citizen science at GSMIT explicitly works to reconnect these two aspects of the student's world. As students are out in the field taking measurements of salamanders, tagging Monarch butterflies, recording phenology and

weather data amongst other things, Stiles believes they are participating in authentic science, which should enhance the overall educational experience. While he acknowledged that students are not necessarily doing things in their home communities, he felt it is likely that as a result of their experiences at Tremont they will notice a Monarch butterfly as it flies through their neighborhood, or when leaves start changing color and fall in autumn. From Stiles' perspective these events will connect student experiences with citizen science at Tremont to their lives in their own communities. As discussed in Chapter two, studies have indicated that when schooling is grounded in place or community, student engagement and achievement increases. According to Smith and Sobel (2010), students who are involved in place-based or community-based educational experiences develop behaviors that are markedly different from those who participate in traditional learning methods. Teachers describe students who participate in place-based activities as having more self-discipline, better able to work in groups, and are more inclusive of peers of varying abilities. In addition, they are described as having greater analytical and problem-solving skills. When projects are linked to activities that extend beyond the school grounds students exhibit an increased interest in environmental stewardship and civic participation (Smith and Sobel, 2010). As an interesting note, studies have found that teachers also benefit from participating in place-based or community-based educational experiences.

As was mentioned previously, Stiles felt that having citizen science as part of the programming at GSMIT improved the caliber of their curriculum. He observed that the teacher-naturalists were more confident and increased their naturalist skills. Lieberman and Hoody (1998) found that teachers who adopted the environment as an integrating context for learning (EIC) practices reported increased excitement about teaching as well as improved interactions with students. In addition, these teachers exhibited a renewed interest in participating in

professional development activities and an increased openness to trying new instructional methods. In another study, teachers who were interviewed by the Place-based Education Evaluation Collaborative (PEEC) indicated that they felt a sense of revitalization once they adopted place-based education strategies in their classrooms (Smith and Sobel, 2010). Smith and Sobel claim that 'No Child Left Behind' has left teachers feeling disenfranchised in their own classrooms, as if they are the problem instead of the solution. Lessons are increasingly more and more scripted and teachers are having less voice in the structure of their classes than ever before (Smith and Sobel, 2010). Place-based education allows teachers to become collaborators with their students in developing the lessons, which, in turn, forces them to learn right along with the pupils. This is exactly what Stiles described in terms of teacher-naturalist development as the result of citizen science at Tremont. While the teacher-naturalists still have significant autonomy, according to Stiles, in the development of their classes, many of them are not as confident with the identification of many species that they will encounter during the phenology or salamander projects. As a result, they have to develop their naturalist skills to be able to confidently lead groups of students through the data collection of citizen science projects. Hopefully, similar trends will be found with the students' classroom teachers who accompany them to GSMIT. According to Stiles, GSMIT uses a cooperative teaching plan where the Tremont teacher-naturalists teach about half of the students while teachers from the schools work with the other half. He stated that this is not always possible with the citizen science projects, " *I don't know if you've heard about the way we do our teaching, cooperative teaching is the word we use for it, but it, when a school group comes, most of the school groups, when they sign up for classes, their teachers are going to teach half of the class. So, they'll go out to do 'Life in the forest' and they'll have a big group of kids and our staff will be with them and they'll have one of their*

teachers will be with them and at some point they'll split up and our staff will take half the group, their teacher will take half the group and they'll teach. And so, this is not citizen science related, but just in terms of our educational program, we try to help train classroom teachers so when they come they are ready to do the classes that we have, um, and we invited teachers up for professional development here and we do trainings with the teachers themselves on our program so they can come and be really good at what they're doing. But, when we're doing citizen science projects we don't train the teachers to do that, so it ends up being something that our staff need to do, need to be able to do and we can't necessarily count on teachers to be able, classroom teachers to be able to do that (Stiles, interview one).” Stiles explained that even though the classroom teachers do not instruct during the citizen science classes he was hopeful that they will carry some of what they learned back to their home communities. He acknowledged, however, that this might be challenging, as they may have to alter their own preconceived notions regarding how teaching should occur.

Lowenstein, Martusewicz, & Voelker (2010) state that teacher development, when done within an ecojustice framework can be challenging as it must facilitate the development of social justice understandings. This is exacerbated by the fact that teachers must confront their own beliefs surrounding social and ecological issues. Stiles alluded to a similar issue in relation to training teacher-naturalists to lead citizen science lessons. He said, *“Whereas somebody like Betty or some, you know, some of our other staff that are just, they try to shy away from it, that do it kind of, you know, they’re, they’re not going to get, just not going to get as much out of it. The kids aren’t, it’s just not going to click as well (Stiles, interview two).”* Stiles emphasized that citizen science is not some panacea for teaching naturalists skills at GSMIT and most likely it won't cure all of the woes of science education. He did not elaborate on why Betty shies away

from citizen science, but it would not be difficult to imagine that she simply is not comfortable with science and would prefer to teach different classes. This would be similar to those ecological issues that Lowenstein, Martusewicz, & Voelker highlight. Stiles noted that if a staff member has preconceived ideas of science or teaching then he/she would likely have to confront those biases in order to fully embrace an alternative method. This concept was succinctly expressed by Lowenstein, Martusewicz, & Voelker when they wrote, "Ecojustice and community-based education requires that teachers change their understanding of their own role, a role that sits at the center of what it means to be a teacher (2010, p. 105)." Furthermore, research indicates that as teachers' sense of self-efficacy increases that they will be more likely to engage in more difficult tasks such as moral and civic education (Milson, 2003). In other words, as teachers become more confident in their understandings of science and further develop their naturalist skills they will be more likely to engage in more difficult lessons than they would have otherwise. In that case, they may be more willing to incorporate citizen science projects into their classroom.

Citizen science changes the two-dimensional science of the typical classroom into three-dimensional authentic science according to Stiles. This is an aspect of citizen science that has long been considered one of its most appealing, at least in an educational context. According to Trautmann, Shirk, Fee, and Krasny (2012), citizen science can increase science literacy in students as it encourages them to make connections to their "place" through careful observations, data collection, and possibly independent scientific study. According to Means (1998), while the science education community agrees that involving students in authentic science enhances classroom experiences educators have struggled with identifying the key characteristics that are necessary for such activities in the K-12 setting. Regardless, involving students in citizen science

in a formal educational context has been demonstrated to increase their motivation toward doing science (Zoellick, Nelson, and Schauffler, 2012). Again, this is not a new idea. As mentioned previously, John Dewey was advocating for this type of educational experience in the early part of the 1900s (Dewey, 1938). Dewey was careful to note, however, that students also have experiences and learn from them in traditional school settings. They just are not the types of experiences that reinforce the lessons that educators hope that the students will learn. Instead of having experiences that excite and engage the students' curiosity they discover that learning is boring and repetitive. He also stated that educational experiences must be linked in such a way that lessons are cumulative and not disconnected, random experiences that prohibit the majority of students from making the connections between them (Dewey, 1938). As Coughlin & Kirch (2010) remind us, students do not have these experiences in a vacuum. Instead, they come as part of larger lessons which include their past experiences and world views. They also include those of the educator and other participants. In other words, as Coughlin & Kirch (2010) note, "What we mean by place-based education is an always co-evolving collaborative activity that makes salient the cultural, historical, political, economic, environmental, social, and physical aspects of what and how we teach (p 918)." Stiles felt that citizen science, as conducted at GSMIT, addresses both of these concerns. Citizen science at Tremont is typically part of a larger experience. Students stay at Tremont for three to five days and while every topic covered is not explicitly linked to each of their lessons, there are common threads that run throughout all of them to facilitate connections. In addition, the citizen science projects at Tremont are specifically chosen so that they will be interesting to the students and volunteers. The participants are actively involved and not just sitting on the sidelines and watching someone else. This type of immersion is an important aspect of place-based education. As Dewey (1938) reminds us, if we

fail to make these experiences part of the students' larger life experiences and neglect to connect it to their other perspectives then we will simply be perpetuating the mistakes of the traditional classroom. Students will have these experiences, but they will not be part of the larger fabric of their lives and will just become another disconnected irrelevant dot in their educational history.

The third theme, "What is citizen science" or even "Is it science" seems especially relevant as the scholarly community of citizen scientists is currently grappling with just this issue. Recently, a conference focusing on citizen science was held in conjunction with the annual meeting of the Ecological Society of America. This meeting, however, was called Public Participation in Scientific Research instead of citizen science. According to Mueller and Tippins and (2010), what is termed "science" has more to do with power and ideologies than with its usefulness or role in society. Mueller and Tippins, in this context, are discussing "science" in relation to Traditional Ecological Knowledge (TEK), but this is just as relevant in terms of educators discussing whether their data collection in a class setting is to be considered "science." For example, Stiles was hesitant to say that the phenology data that has been collected over the last thirty plus years should be considered as genuine "science." And truly, is it any wonder when leaders in the field like Janis Dickinson and Rick Bonney of the Cornell Lab of Ornithology directly state that

> "We feel strongly that citizen science projects should engage professional researchers at the outset to ensure that there is an authentic intention to publish results based on project data. The balance between research, recruitment of new audiences, and educational goals varies among projects, but if researchers have no interest in the project, or in analyzing its data, then we would consider a project unsuccessful (2012, p.2)."

This seems to be a narrow and unfortunate view of science. In fact this sentiment of Dickinson and Bonney appears to be intent on maintaining the privilege of "professional" scientists. As Stiles pointed out, now that the Park Service is aware that Tremont has approximately thirty years of phenology data they are most interested in the data set. Should that data not be used simply because professional scientists did not develop a research question at the beginning of the collection period? One must remember that society is not always certain what questions will be important twenty, thirty, or more years in the future. When the teacher-naturalists at Tremont initially started collecting the phenology data, global climate change was not part of the collective consciousness, but now it is and that data is incredibly valuable. Certainly Tremont's phenology data would not qualify as a controlled scientific study. There was no prescribed protocol when data collection began, but it is still useful and relevant data. For these reasons Stiles' perspective about what counts as science was expressed with care taken to not offend members of the scientific community. For instance, he said, *"I'm not, I'm not a scientist (laughter) and very...you know, anybody who is, I make sure that's clear at the beginning (Stiles, interview one)."* In the second interview Stiles again stated that he "isn't a scientist" and so he was asked about this directly. His response was, *"'Cause I've met scientists and I, what they do is, and what they're able to do is very different. 'Cause people, sometimes people assume like, oh I'm leading a Citizen Science or I'm talking about this, I must be a scientist. And then, then you know they sort of make that next jump and like, okay, and I just want people to know that's not the case...Cause I can't even talk the talk. Like I'm not, if I sit down with Matt and some of these researchers, I'm just, you know…interested, but I'm not just gonna jump into the fray. (Stiles, interview two)."* He did later acknowledge that he does consider himself a naturalist, but that he feels that is a big difference, in his opinion, from being a scientist. Mueller and Tippins (2010)

argue that the definition of science and thereby 'who is a scientist' is too restrictive and needs to be broadened. They are critical of Hurd's 1958 version of scientific literacy, which paints science as what is done by the paid professionals, and is then used by citizens. From the perspective of GSMIT and more specifically, Stiles, the projects that are currently underway are science because they have been prescribed from top down and have the "official science stamp." In other words, Stiles does not have to worry that their current projects will be critiqued and criticized as not being rigorous science because professional scientists developed the protocols. This is what Mueller and Tippins feels needs to be expanded. Science is a process, it is what is done, but there is nothing about it that says that it must be conducted by individuals with graduate degrees working in research labs. Citizens, students, and educators can all be scientists in this world envisioned by Mueller and Tippins. If that is true, then must these citizens, students, and educators be dependent upon *professional* scientists to determine what they study? Historically, this has been essentially what has happened in citizen science projects. The professional researcher identified a question and protocol and then enlisted volunteers to collect data for them. This top down approach to citizen science has been heavily criticized with some individuals saying that researchers were simply using volunteers as unpaid lab techs. The good news is that this seems to be changing. Dickinson and Bonney state that, "In the best of cases, citizen science blurs the distinction between scientists and nonprofessional participants, while at the same time maintaining rigorous scientific approaches to understanding processes and solving problems that neither group can solve on its own (p2)." Of this we can all agree. However, that does not mean that citizen science is currently in its most perfect form. Many projects simply involve volunteers at the data collection level. This particular version of citizen science has been termed the contributory model (Bonney, Ballard, et al, 2009). From a place-based perspective, Karrow and

Fazio (2010) state that while the contributory model has certainly been successful at meeting the objectives of professional scientists it lacks the depth of experience that would truly connect students to their place. Stiles felt no conflict regarding whether these contributory projects qualified as science, and acknowledged that this is the primary model of citizen science conducted at GSMIT. Karrow and Fazio go on to state that these types of projects would be more meaningful from the student perspective if they facilitated connections between humans and their environments. Mueller and Tippins assert that this connection is well served from an ecojustice philosophical stance as it merges the interests of humans, non-humans, cultures, ecosystems, and even the biosphere. Martusewicz, Lupinacci, and Schnakenberg (2009) draw our attention to the use of labels in language and remind us our words form our understandings, biases, and cultures. In relation to science they succinctly state,

> "While the aims of scientific investigation - validity, replicability, predictability, measurability, for example - lead to important insights into specific phenomena, they are incomplete ways of knowing by virtue of being embedded in a specific cultural (and thus symbolic/language) system. These ways of knowing have a history linked to particular interests and power structures that may be unrecognized by those who take them for granted. They can thus take on a life of their own, and are clearly influencing what we define as a strong education (p. 12)."

Stiles went to great lengths to separate himself from "science," almost as if he that he was not worthy or capable of determining what is science and what is not. This is perhaps indicative of the privileged status of science. It is something that is separate and distinct from the lives of citizens. And individuals are only deemed worthy to participate if it serves the scientific community or the gatekeepers have approved them. The fact that Dickinson and Bonney (2012)

argued that in order for citizen science to be rigorous it must be acceptable to the scientific community reinforces the privileged status of science and that Stiles has good reasons for choosing his words carefully.

Case four: Simon – Addressing Nature Deficit Disorder through Citizen Science

"It matters because if you look at our world, one of the stats I recently read was that if we live, that if everyone on earth lived like the average American, you need 5 earths. Um, I think there's a real disconnect about um, you always hear, we need to grow the economy, we need to get jobs, but no one makes the connection that a growing um economy needs a healthy uh, ecology, a healthy earth and that you can't really continue to grow an economy without continuously diminishing the resources and, and increasing pollution and stuff like that. So, I think there's a real disconnect about um, understanding that we're depleting our natural resources and polluting the oceans. There's more...there's more plastic particles than plankton in a lot of part of the oceans...So, and again, um...if you don't know about nature you're not going to protect it. And so, I think that's the big, one of the big things. And, and so I think it's not just, you know, kind of a feel good fuzzy warm feeling thing, but it's also critical."

Theme one: Incorporating the outdoors into learning is essential for creating an engaging educational experience. Simon, a former Citizen Science Coordinator at GSMIT, is passionate about incorporating outside educational opportunities into educational curricula regardless of whether these activities happen within a formal or non-formal situation. Of course, while employed at Tremont he worked in an informal educational setting whose primary focus was getting people outdoors; however, he stated that he feels that such experiences are valuable

in life as well as formal education contexts. From this perspective he asserted that citizen science is a fantastic tool for engaging students in authentic science experiences and providing an avenue for forging stronger relationships with nature. This key aspect of Tremont's program is what initially attracted him, as he explained,*"(I) just really liked the idea of taking kids out in the woods and teaching them things (Simon, interview one)."* Simon stated that from his perspective, insulating students from the outdoors during educational experiences serves to further the disconnect between them and nature. He illustrated this point by adding, *"I think that is one of the things that citizen science does is that it gets kids outside and that's what I like. Because even in rural counties you'd think the students would be getting outside, but I've found that they're just as inexperienced as someone from an urban center… So, you know, when we're in the creek, I pull up a crayfish and half the kids are wondering what it is. And here they are living in, with creeks all around them and they just never get outside. So, its the same thing with butterflies, Um, I've had more than one student ask if the butterfly can sting. So, so you have that type of insulation from nature, um, at least getting them outside. I mean they may not remember the name of the butterfly, but at least they know it doesn't sting afterward (Simon, interview one)."* In other words, Simon lamented the fact that the youth of the United States lack familiarity with the flora and fauna of their own communities. He wondered how kids would develop an interest and excitement about natural history and science if they were not aware of it in their own lives. According to Simon, citizen science could expand students' understandings regarding the inhabitants of their surroundings. In his words, *"There's still a lot of kids that don't get outside. So, you know when we're in the creek, I pull up a crayfish and half the kids are wondering what it is. And here they are living in, with creeks all around them and they just never get outside. So, it's the same thing with butterflies. Um, I've more than one student ask if the butterfly can sting.*

So, so you have that type of insulation from nature, um, at least getting them outside. I mean they may not remember the name of the butterfly, but at least they know it doesn't sting afterwards. So, I think Citizen Science can do that to you. (Simon, interview one).” In his opinion citizen science could remedy this disconnect because, in many cases, it requires students and volunteers to be outside in order to participate. Furthermore, Simon felt that citizen science could also be beneficial for teaching science content within a formal educational context and produce similar outcomes. In other words, participation in citizen science does not have to require field trips to environmental education centers in order to be a meaningful part of educational. According to Simon, *“I think it's easier to get into the schools if you, if you go in with citizen science, because you know, you can talk about the scientific method and you can get the teachers, 'cause the teachers are under such enormous pressure to, to uh, get their curriculum and, and you have the end of the year testing and, so, um, they're not willing just to go on a, on a necessarily just a play trip where you're just you know, that doesn't have any meaningful academic, that you can't relate academically. So, citizen science can kind of help, help do that (Simon, interview one).”* Simon envisioned citizen science within an educational framework as involving students in ongoing scientific studies. According to Simon this would facilitate teachers' abilities to include such activities in their lessons thus allowing for students to engage in outdoor educational experiences within a traditional framework. He elaborated upon this point when asked to describe his vision of citizen science within the context of science education, *“In a dream world, um there would be citizen science at every school and the teachers would have to get out of their comfort zone a little bit and learn to teach outside...I think we teach teachers to be in a classroom and um, we (GSMIT) have a, uh pretty strong, um, science, um teachers naturalists, science, oh I can't remember the name of it, um, where teachers are here for a week in order to be outside. But most*

of those teachers, I mean they'll tell you, they're nature lovers and like to be outside anyway. But it's getting those ones to, who are uncomfortable being outside, and there's a lot of people who are uncomfortable being outside, particularly with students and not having the students be. Citizen Science with kids is a little bit of controlled chaos. (Simon, interview one). He felt strongly that one of the most significant impediments to getting students outdoors in most school settings is that many teachers simply do not feel comfortable taking students out of the classroom. For this reason GSMIT developed a program where they bring teachers to their facility for a week to develop confidence and experience with teaching outside. However, in his opinion, most of the teachers who attended such programs were nature lovers anyway and were already comfortable being outside. The trick, according to Simon, was to get those teachers who are not comfortable being outside, and especially teaching outside, to have positive experiences, and hopefully develop some enthusiasm for engaging their students outside of the classroom. According to Simon, teaching outside is very different than a traditional classroom. As Simon described, *"Citizen science with kids is a little bit of controlled chaos...because they're not sitting down, they're not, you know, so I think teaching teachers to better uh, to get their students outside. There's lots of stuff they can do outside, but they may not be, they may not have the, know about these activities or have the skill yet to do them. The teachers, I mean that's what they do, they teach. And so they can take something and, and run with it. They just have to have that something and, and the proper training. (Simon, interview one)."* Simon clearly felt that citizen science could be, and even should be, an important aspect of students' science education experiences; however, he understood that there are several hurdles that must be cleared in order to make this a viable option. As he indicated above, citizen science must tie into the stated objectives of the science curriculum, and teachers must be given the experience and training

necessary to become confident teaching in an informal outdoor setting. This is possible, but will require dedication and time on the part of the science teachers.

Theme two: A tension between increasing non-professional participation in the scientific process and data reliability. Frequently, when the topic of citizen involvement in the scientific process is broached professional scientists quickly question whether the data collected will be reliable enough to be considered for peer-reviewed publications. Simon claimed that, *"part of the criticism of citizen science is that there's lax quality control. Um, which is, which is, which is pretty accurate in most cases, but there's ways you can put quality control, um, in the system (Simon, interview one)."* In fact, Simon mentioned that data reliability is an issue with the aquatic salamander project at GSMIT. He commented, *"Um, one of the problems I'm having is that I don't have confidence in the identification of the different species. So, you know, ultimately that's my call, you know if something's on paper and it says that this is, you know, black bellied salamander, not everyone has been trained the same and the, the dichotomous key, the salamander is difficult to i.d., even, even by the experts. And um, so that's unfortunate because we, based on climate models, um, the black bellied salamander, which is kind of the largest salamander in those head water streams, is the most sensitive to changes in temperature. So, we expect it to fall out, particularly in, you expect it to fall out in the lower elevation streams first. Then um, in Tremont, it's perfect 'cause it's, they're low elevation streams. And that could really help inform the park, but I just don't feel, I just don't have enough confidence in those data to make...I do have confidence, we do have, we do see trends...So, you know, you have 15 years of data and you can't, you can't, I just feel uneasy trusting those identifications (Simon, interview two)."* This is an important issue, as researchers need to have confidence in the data; otherwise, there is no reason for them to be collecting it in the first place. But, as Simon mentioned, this is

something that could and should be addressed when planning the implementation of a citizen science project. In regard to the aquatic salamander project specifically, Simon elaborated by saying, *"Salamanders are charismatic and interesting. But it's also nice to have something; an organism, that people can i.d. relatively easy and can perform relatively easy with just simple instructions. So, the, they can certainly get in the bags and wash them out and getting the salamanders is easy, but it's the i.d. part that's kind of the thorn in the side for this particular project (Simon, interview two)."* Of course, any project is going to have its issues, but according to Simon thorough training of facilitators and participants could mitigate these potential problems. In fact, requiring training of volunteers is fairly common within the citizen science community, and in Simon's view more thorough training would significantly increase the reliability of the data collected by participants in citizen science projects. He stated, *"So, just today we did a training, I came here for a training session to train the naturalists on how to, to accurately identify salamanders so that they could then can be the ones who are doing, not letting, to, to give the students a key and have them try to key up the specimen, but then following behind them and, and um, being the final say. So that when they record them as that, the data sheet, you know that it's, it's something right. And if they, if the naturalist doesn't know and the students know, then they just put unknown instead of just blindly guessing. So there are some quality control measures. It's not, citizen science you're not going to have a completely clean data sheet. But in science in general, especially field science, you never get that. So, um, you just have to keep putting a few more, um, quality control measures to ensure that that, that the data are, are, are gonna be worthwhile and, and you're gonna be, have some scientific merit you know, in them (Simon, interview one).* It is interesting that Simon pointed out that even in professional scientific research errors are made; he argued that this is not sufficient reason for

researchers to not embrace citizen science. Instead he maintained, they needed to work to develop protocols that produce high quality data just like they would for any project. As Simon mentioned, *"Um, if I was up there now, I would probably have 3 streams that would be, there needs to be just more oversight in terms of making sure the i.d.'s are correct, and I don't, I would, even training you'd have to have it, like a core group of naturalists that were kind of devoted to that and willing to train, be trained more than just a one hour session ...I think probably the only solution is for someone like me, or someone's who's really familiar is to go back and survey the streams themselves and then use that as kind of a standard to look at the other data and see if it kind of matches up (Simon, interview two)."* Simon felt that if they had a standard to compare the data to he would know more about the reliability of the data. He also saw this as being a problem that is somewhat specific to the nature of environmental education. When asked how he would try to improve the project going forward he stated, *"I mean I thought about that, and, and we did have a training session just this past spring, or I guess it was early summer, with the new summer staff. And we went through, but that was just a day and you have a high turnover rate at Tremont, um, and that's just kind of the nature of environmental education, I think. And Tremont actually, keeps their naturalists probably longer than anyone else. Um, so I don't know the solution (Simon, interview two)."* Simon did mention that one family who is local to GSMIT adopted one particular creek in the park and sample that creek monthly, and have done so for many years. As a result, Simon stated that he feels much more confident in their data, *"and their data is much, shows much more clear trends than streams that have been collected by different groups. Because, and it makes sense, when you have a consistent, the same people are going every month to the same stream. They have their methods down pat and you get a new group in and you never, you never know... (Simon, interview two)."* This speaks to what Simon

perceived as one of the challenges associated with citizen science projects at GSMIT. Every three to five days new groups come in and that means that the teacher-naturalists are continually having to train new participants for these projects. As Simon mentioned above, when you have one group that repeatedly collects data for a project the reliability of that data is much more consistent. When you are dealing with organisms that are difficult to identify to species to begin with, having a steady stream of new participants further reduces data reliability.

Theme three: Connecting people to nature can facilitate the development of environmental ethic. When asked why he felt that getting kids outside was so important he stated, *"Because I think there's, there's a lot of connection, um. Technology's kind of-when I say technology I'm talking about t.v. And i-pods, and anything that's square and has a picture around it that's moving. And I'm, I'm afraid that's going to be, they're going to lose sight about what's around them (Simon, interview one)."* In other words, Simon believes that encouraging kids to play, and study outdoors is critical for facilitating the development of environmental ethics within young people. Simon claimed that he increasingly sees this as being more difficult to achieve as more and more people, not just children, spend more and more time inside. He said, *"I think today more and more people are staying inside, you know, connecting with computers, connected to Facebook, and they've lost, um, not only their own connection, but realizing that they really are connected to the outdoors. So, um, in terms of mission at Tremont, it's just getting people, students and adults, outside and uh teaching them about um, the outdoors. And just having that experience, I mean, just making them, reconnecting them to the outdoors."* He also mentioned a documentary that he had just watched that addressed just how much time children are spending connecting to technology and electronics. *"I just watched a, um, documentary called, 'Playing In.' It's pretty good. It's about um, getting kids outside and it's basically um,*

kind of the no child in the wo-, no child left inside. That angle. But, talking about how much time kids spend on computers and screen time, it's great. It's about 40 hours a week –screen time. It's only increasing. And so it' following these kids in a camp, kind of a wilderness camp and it's the first time a lot of them have been outside [in the woods]. It's pretty cool. Well, they tracked them, the kids. For the most part all the kids had a positive experience outside and they gave them a challenge to fast from technology when they got back. And one kid didn't do it at all, I think the most it was like eight days...did not look at a screen or. . .I mean this one girl said that, she said, five hundred text messages a day....Just couldn't, you know, they can't, they always have to be connected. (Simon, interview two)." For Simon, the priority is to get kids out into the outdoors and having positive experiences because, in his words,*" research shows that particularly um kids and adolescents and pre-adolescents, if they don't make, get that connection early in life, them it's unlikely that they, they're gonna make that connection later, in terms of having meaningful um deep appreciation of the outdoors."* He was clearly disturbed by this trend. As he mentioned in the quote that began this case, *"I think some people, and I probably count myself among those, just can't – once you have that connection you can't uh, if you don't get outside or get out in the woods, then you feel kind of, I get a little antsy and just. . .And I think the research shows that particularly um, kids and adolescence and pre-adolescence if they don't make get that connection early in life, then it's unlikely that they, they're gonna make that connection later, in terms of having a meaningful um deep appreciation of the outdoors (Simon, interview 1).* This matters in terms of developing environmental consciousness and ethics because, according to Simon, *" if you look at, at our world, one of the stats I recently read was that if we live, that if everyone on earth lived like the average American, you'd need 5 earths. Um, I think there's a real disconnect about um, you always hear, we need to grow the economy, we need to*

get jobs, but no one makes the connection that a growing um economy needs a healthy uh, ecology, a healthy earth and that you can't really continue to grow an economy without continuously diminishing the resources and, and increasing pollution and stuff like that. So I think there's a real disconnect about um, understanding that we're depleting our natural resources and polluting the oceans. There's more plankton, um there's more plastic particles than plankton in a lot of part of the oceans when they do their nets. So, and again, um, if you don't know about nature you're not going to protect it. And so, I think that's the big, one of the big things. So, from Tremont, it, it, it get's buy in from the teachers, and um, in, in terms of you might be um, meeting curriculum guidelines in terms of some of the activities that we do for citizen science, talking about the scientific method, um, while also, you know, connecting those kids to nature through that activity (Simon, interview 2)." From this excerpt it seems that, according to Simon, citizen science can be one aspect of connecting youth to the natural environment. In addition, by working to form these connections Simon felt that GSMIT is also laying the foundation for deeper environmental ethics within students.

Case Four: Discussion and interpretation. It is Simon's belief that students should have nature experiences incorporated into their educational experiences. He stated that, in his opinion, people are spending too much time inside connected to television, video games and the internet instead of out in the natural world. Simon is not alone in that claim. Scholars within the place-based education community have echoed this sentiment. According to Louv (2005) and Gruenewald (2008) disconnection from community is directly related to the increase in interaction between individuals and technology and decrease of time spent in nature. Louv and Gruenewald both indicate that individuals are perpetually connected to some form of technology all day every day whether it is smart phone, laptops, electronic tablets, televisions, games, etc.

This is not the case while visiting Tremont. While at GSMIT connection to technology is limited. The campus does have internet access available in the dining hall, but time spent there by students is very limited. There is virtually no cellular service at the site, so texting and playing on the internet via smart phone is not really possible. This isolation from technology means that students and visitors to GSMIT are forced to put away their electronic devices and interact with the other people and natural environment at the facility. By interacting with each other and truly experiencing the place that is GSMIT they may begin to form those connections and ethics that Simon described as being essential to preserving a healthy planet and community. According to Gruenewald (2008), corporate sponsored media found on television and the internet is one of the most influential forces in separating learners from their communities. While Gruenewald asserts that corporate branding is ubiquitous and includes everything from stadiums to lecture halls, this is not the case at GSMIT. Their visitors and teacher-naturalists talk about experiencing the world that is just outside the door, not a virtual world or some location far away. At Tremont students are encouraged to play in the creek, hold a living bird, and a catch a migrating butterfly instead of logging on to a computer for an experience that is saturated with corporate sponsors that endeavor to entice them to purchase the latest and greatest gadgets. Simon felt that as students interact with the environment of GSMIT instead of technology they develop deeper connections with the natural world. According to Tuan (1974) places acquire meaning and character when people interact and develop relationships with them. For instance, a large old oak tree may not have any special meaning to a community unless individuals meet there, relax there, and begin relationships there (Tuan, 1974). It is then that the oak tree becomes something special to that community. Tuan also claims that these places become more meaningful when people have interacted with them for long periods of times. Great Smoky Mountain National park has a long

history and it can be assumed that it has touched many lives, as has GSMIT. As Simon noted if people find something special in nature and develop a feeling of belonging and peace there then they are more likely to work to protect it. This and others relationships with GSMIT make the place special from Simon's perspective, but would the visitors of Tremont have the same experience if they could not unplug from their cell phones, email, internet, and television while there? Generally, the students are only at GSMIT for three to five days. By being removed from home and their electronic devices they can begin to make those connections that will ground them to GSMIT as well as their communities. And while Tuan states that the only way to truly know a place is to have a long-term relationship with it, one must acknowledge that such associations begin somewhere. In other words, a student who visits Tremont for three to five days will not truly know that place but it will be a start.

Ecojustice philosophy also critiques the use of, or obsession with, computers and other forms of technology. Bowers (1995) states that, "a technology mediates human experience through its selection/amplification and reduction characteristics (p. 79)." He does not limit this to electronics, but reminds us that any technology distances our senses from the event and alters the experience. Yes, they amplify our reach and lessen our workload, but we must be cognizant of their impact upon our lives. As an example, Bower mentions the telephone. Yes, it allows us to talk to people over a great distance, but it changes the nuances of that interaction. When talking to someone on the telephone you are not able to make eye contact and read his or her body language. Communication via computer is even more complex. Consider how email and texting, standards for communication in today's society further separates people from the world beyond their living room and computer screen. In addition to losing the information that is conveyed in face-to-face discussion, with email you lose the subtle messages that can be conveyed with

changes in tone of the human voice. At GSMIT these technological distractions are removed. Kids cannot hide away in their cell phones and computer games. They are allowed to, and even encouraged to, have fun outside interacting with each other and the world around them. This gets to the heart of both ecojustice and place-based education. Furthermore, a greater connection to nature and community can be a critical component of the development of environmental ethics with students. As Orr (1992) reminds us, all education contains an environmental context. Students learn their place within the natural world, in part, based upon what teachers emphasize or ignore. Likewise, this is true of values and ethics. According to Haury (2005), schools are not students' primary source for environmental information. Instead, the majority of students obtain environmental education from television (Haury, 2005). He goes on to state that schools should not attempt to compete with television in this regard. Instead, he argues that educators must "provide a different sort of learning experience that focuses on evaluating and using information to inform personal decisions and actions (p.186)." As such, citizen science, as asserted by Simon, can facilitate the development of environmental ethics in addition to formulating strong community bonds. As Haury reminds us, environmental education should not be a separate and distinct subject taught within the school day; instead it is part of holistic education where the ultimate focus is upon the students' relationship with community and culture within the context of the natural world.

Case Five: Hannah – Citizen Science of just one tool used in "Connecting People and Nature"

"I think they get to see it more as something that people do to take care of nature. Um..As far as just like conservation and monitoring things, um...and just a new way of engaging. So, they're use to engaging their mind really at school, and here, you know they do a little bit but

sometimes, they're more...they think they're playing even though they're not, but citizen science they don't think they're playing any more. And so it's just engaging a different part of their brain (Hannah, interview 2).

Theme one: Tension between the benefits of having students participate in authentic science versus the challenges of integrating it into the curriculum. Throughout conversations with Hannah it was apparent that she truly valued citizen science projects but she also sometimes felt that student participation in such projects might, in fact, hinder the formation of connections with nature. When asked about the role of citizen science in 'connecting people and nature,' she responded, *"I think they get to see it more as something that people do to take care of nature. Um...as a far as just like conservation and monitoring things, um...and just a new way of engaging. So, they're, they're use to engaging their mind really at school, and here, you know they do a little bit but sometimes, they're more...they think they're playing even though they're not, but with citizen science they don't think they're playing any more. And so, it's just engaging a different part of their brain (Hannah, interview 2)."* However, she felt that citizen science sometimes gets in the way of formulating such connections an noted, *"sometimes...well, like today with salamanders, they just wanted to play up and down the river and its hard to force them to go back and stuff their bag full or make sure they're doing the right number or weighing things the right way. Um...when I...sometimes just wish that we just had more time to just play. (Hannah, interview two)."* She mentioned that one of the challenges associated with utilizing some of the citizen science projects with school groups is that the protocols are too complex. According to Hannah, *"I think if maybe some of the projects were simpler. Um...if there was maybe just not so many different aspects of things that were were trying to do. So for example, phenology, um...if we were just trying to look at trees leafing out. Um...instead of trees and then*

birds, and then flowers and then everything else. There's just so many hoops that you have to jump through sometimes (Hannah, interview two).” She went on to state that her ideal use of citizen science at Tremont would involve more volunteers or possibly having local school groups adopt a particular project or stream. Hannah stated that these changes would improve the implementation of citizen science at Tremont. She commented, *“I think involving, involving maybe more volunteers would be cool. Like people that...or maybe like a local school groups who could come in and take on a project and just come in and do it. Like maybe if we had Townsend Elementary that was in charge of one of these streams and really get to know it (Hannah, Interview two).”* In her opinion this would benefit citizen science at Tremont *“...because it seems like sometimes you spend so much time explaining how a project works and they don't always really get it. They're just kind of doing what you tell them to and then once they've done it a couple of times they really learn it and they get more benefit from it and the project probably would too because they know what they're doing a little bit more (Hannah, interview two).”* During another interview she stated that there is one perceived negative associated with the integration of citizen science into the GSMIT curriculum. She explained, *“Sometimes, I feel like I have to rush through a different part of a lesson so we can get enough time for the projects or we can't play with caterpillars and millipedes because we have to go do this specific thing. Um, to the project um, I mean I can see how sometimes our data is not particularly accurate. We're rushing through or a thunderstorm comes up or something.”* However, while Hannah acknowledged that there are challenges and frustrations associated with conducting citizen science projects with students she does feel that they are beneficial. She stated that one of the ways that citizen science has changed at Tremont is through an increase in the number of programs. She went on to say, *“I think it's good, especially in the school year.*

Because I think it brings our programs up a little bit to have those projects and to have science for the kids to be involved with. I think that because we have this data that we're responsible for giving to whoever it is we are giving it to...um...that we take some ownership of it and we want to be sure that we're teaching the kids up to the level to where they are getting good data, I think, and also that they, that the kids are getting from that I mean, we've got now a scientific method class which we didn't have before (Hannah, interview two).” Throughout conversations with Hannah she seemed somewhat conflicted on her views of citizen science. She expressed that she thought it was valuable and yet she felt that it could get in the way of participants making genuine connections to nature and understanding science. For example, when asked why citizen science was important to the curriculum of Tremont she said, *“It's just more of that hands on science with kids. I mean, its one thing to learn out of a textbook, it's another to learn out of just doing a project. But I think it's another thing entirely to learn out of doing a project that somebody's going to use, um, and I think also it's helpful to the park for some things (Hannah, interview one).”* From this statement it is obvious that Hannah viewed student participation in citizen science projects as a valuable aspect of their experience. From her words it seemed that she felt that participation could facilitate a greater understanding of science than a more classical teaching approach, i.e. learning out of a textbook or from a lecture. However, from earlier statements it is also clear that she finds citizen science to be too structured; when she just wants kids to have some time to play and enjoy being in the woods. This was apparent on the day that I observed one of her aquatic salamander classes. On our hike to the stream where we to begin collecting data she stopped at another stream and instructed the students to look for salamanders. She talked to them about how to find them by looking under rocks and in leaf litter. They got to look for salamanders for about 10 minutes and then we proceeded to the data collection site.

When she was asked about this in a subsequent interview she commented that, *"So, like today where we got to catch salamanders a little bit before hand, so I try to plan and give 'em a little bit of play time (Hannah, interview two)."* In fact, Hannah's entire demeanor changed between the two locations. At the first site, the "play" site she was as excited as the kids, but at the second location she was much more serious. She was still happy to be out and obviously enjoyed being with the kids, but she was not as relaxed. She kept having to remind the students She mentioned that during the aquatic salamander

Theme two: Not seeing beyond the "top down" approach to citizen science. When asked to describe her understanding of citizen science Hannah responded, *"Um, it has to be that they are collecting data that someone is really going to use, I think, and that they are working, maybe directly, with the scientist. I'm not a scientist, but that I have a scientist who's told me what to do and that the protocols are set out and we have pretty clear instructions on what we're going to do and what information that we want (Hannah, Interview one)."* Further evidence of her general acceptance of a top down approach to citizen science was found when she discussed protocol development. Hannah described, *"I think, I mean it depends on the project. If there is some scientist who just wants us to collect some certain information he would probably get with our Citizen Science Coordinator and say, "here's what I want," and she would work with him to figure out how we wanted it. If it's something like, last year when we were developing our phenology thing, the Citizen Science Coordinator worked with some of the park people, so I think it's just a lot of collaboration with the people who are running it (Hannah, interview one).* However, it is interesting to note that during her description of citizen science and the development of the protocols Hannah did not see, at least at this time, a place where students could possibly act as the catalysts for the development of new citizen science projects. In fact,

while she described the teacher-naturalists as taking more ownership of the data, she also described her role in terms that are reminiscent of a technician. For example, when she discussed the training required for her to lead participants through data collection for a citizen science project she came across as somewhat passive and simply following the direction of others. She said in regard to training, *"yeah, it's pretty much focused on each project, so whenever we have a new project come up, or if there's some issue in a project that we've been doing, our Citizen Science Director will take us out and show us how things should be done and show us where the data sheets go and all that (Hannah, interview one)."* When asked what types of issues would catalyze such training she said, *"Maybe if we're not identifying things right, or if we're not putting the data sheets the right way, or just not being as precise as we should be (Hannah, interview one)."* This sounded as though Hannah viewed even the administration of the citizen science projects as very top down in nature. While, as stated above, Hannah felt that she takes ownership of the data this did not always come through in her discussions about citizen science. In fact, Hannah gave the general impression that while she sees the value of citizen science she is not all that excited about the logistics of involving students in projects. There seemed to be further evidence of a personal disconnect from the projects when she was asked what happens to the data that was collected from the various projects. Her initial response was, *"I don't know (Hannah, interview one)."* And then she goes on to state, *"I think some of it goes to the park, um, the phenology, the um, I think the snake tins might go to the park (Hannah, interview one)."* She just did not seem to be very invested in the citizen science curriculum.

Case Five: discussion and interpretation. As discussed in theme one, Hannah seems to be somewhat conflicted regarding students' participation in citizen science while they are at

Tremont. Yes, she saw that citizen science had benefits, but she also felt that sometimes having students involved in these scientific projects actually detracted from the overall mission of GSMIT, which is "connecting people and nature." We can talk about the role of citizen science at Tremont, and its value in terms of science education, but in reality Hannah makes an interesting point. It is important to remember that the goal of Tremont is not to teach a science curriculum, or to educate about the nature of science. Their objective is to get people out in nature and to facilitate the development of deep connections with that place. According to Louv (2005), this connection to nature is something that is sorely missing from today's educational endeavors. Furthermore, Louv reminds us that, "Most of all, nature is reflected in our capacity for wonder (p.9)." It seems that Hannah wanted students to connect with nature so that they could possibly begin to capture that sense of wonder when they leave the confines of a building or a city. In her mind, when students are told that they cannot just play in the creek, but that they have to find man made bags, empty them, look for salamanders, measure them if they find them, etc. this detracts from just walking in the water and flipping over rocks. And then, worst of all, she may have to nag them to refill the bags with leaves and return them to the exact same place that they found them. In Hannah's opinion, children have far too few opportunities to just relax and explore nature. This has led to an epidemic of what Louv (2005) describes as "nature deficit disorder."

According to Smith and Sobel (2010), high stakes testing, and the focus on information and events that are largely removed from students' communities and lives, has served to marginalize many students. If a student does not perform well on standardized tests they may adopt a negative self-image (Smith and Sobel, 2010). Because of the punitive nature of No Child Left Behind teachers and administrators are fearful of allowing students to explore topics that

they find interesting but may not appear on the end of course tests. However, place-based education asserts that allowing students to investigate topics in which they are interested enhances their learning rather than detracting from it (Smith and Sobel, 2010). Smith and Sobel also claim that the chance to explore topics and embrace experiences that are meaningful to students allows them to become personally invested in their own education. Of course, students must find what is interesting to them. Is it such a stretch to think that looking for salamanders, or chasing butterflies in Great Smokey Mountain National Park could spark such curiosity? Hannah alluded to this in one of the interviews. She stated, *" Okay, we're all just going to flip over these cookies and look for salamanders, and they're having fun looking for salamanders, but if we, we really make sure they are paying attention to their data sheet and really go over things ahead of time, then I've had kids ask me, 'Hey, could I do this for a living? Like is this something that people do?' (Hannah, interview one)."* From this exchange, it seemed that at least some participants at GSMIT are making connections between their experiences at Tremont and their lives back home as well as possible future careers. It is interesting to note that Hannah felt that student participation in the project was a key aspect of their viewing collecting salamanders as a possible career path.

According to Bowers (1995), Western society and its educational norms perpetuate the claim that change, unlimited growth and progress are the acceptable ideal. Conversely, ideas and traditions that are grounded in ideals of sustainability and limited growth are discouraged. As described by Lowenstein, Martusewicz, & Voelker (2010), teachers who embrace an ecojustice philosophy will move away from the traditional western philosophy of growth and change and will instead embrace ideals that encourage students to protect all aspects of the environment and the community around them. Lowenstein et al go on to remind us that Ecojustice, when used in

conjunction with a community-based or place-based curriculum, encourages students and teachers to consider the places where they live and work and to consider how their activities and practices impact the living and cultural systems around them. Do these activities and practices support those systems or do they degrade them? It may seem counter intuitive to keep these aspects of Ecojustice in mind while considering Hannah's comments regarding citizen science getting in the way of 'connecting people and nature," but her thoughts actually get to the heart of the matter. From Hannah's perspective her desired experience for students and participants at Tremont are pushing against the cultural norms of western educational expectations. According to Bowers (2005), it is this western way of thinking that is especially problematic for our ecology. Hannah wants her students to be able to just play in nature, to enjoy being in the place that is Tremont and the Great Smokey Mountains; she is troubled by societal expectations of the need for defined educational outcomes from the experience. She would rather have students relax and have a good time while at Tremont. As Louv says, "If environmental groups, along with Scouting and other traditional outdoors-oriented organizations, wish to pass on the heritage of their movement, and the ongoing care of the earth, they cannot ignore children's need to explore, to get their hands dirty and their feet wet (p. 147)." This is precisely Hannah's point. Yes, citizen science is great, and yes, it has a role to play in 'connecting people and nature.' But, from Hannah's perspective, if it becomes the only tool then kids are not going to really make those connections that may allow them to develop a deeper attachment to the natural world.

Summary of Chapter 4

Chapter 4 began with two Oral Histories that shared the history of GSMIT from its very beginnings though 2011. They also gave a thorough description of the start of citizen science at Tremont as well as how its presence has changed since 1999. The individual cases of the other

participants followed those oral histories. These cases included a development of the emergent themes as well as a thorough discussion of those themes. Chapter 5 includes the cross-case analysis as well as a discussion of the data in relation to the initial research questions. Chapter 5 concludes with a discussion of the implications for this study in terms of science teacher education as well as science education.

CHAPTER 5

CROSS-CASE ANALYSIS, DISCUSSION AND IMPLICATIONS

Chapter 5 begins with a cross-case analysis. This cross-case analysis resulted in the development of several themes that emerged from data. Those three themes are: 1) Place as a fluid construction of the lived experience of GSMIT occupants and visitors, 2) Place as undergoing transition, 3) Citizen science contributes to an illusion of democratization. Following the discussion of these three themes is a summary discussion of the research questions. Finally, Chapter five concludes with a section, which considers the implications of this research for science teacher education.

Cross-case analysis themes

Place as a fluid construction of the lived experience of GSMIT occupants and visitors. *"Educating the mind without educating the heart is no education at all (unknown)."* This quote, while of uncertain origin, seems to be at the heart of place and place-based education (PBE). It suggests that if students continue to acquire information through their educational experiences, but those events do not influence their emotions and ethics then it is all for naught. This is why educational philosophers such as Dewey, Bowers, and Gruenewald have long held that learning needs to be grounded in students' lived experiences if it is going to be effectual at influencing their social and cultural development. Beyond that, however, a sense of place changes with every experience that a person has. If a student or visitor to a community has a new and different experience even if they have lived in that specific geographical area for their entire life they are, hopefully, going to have a slight shift in what their place consists of and means to

them. This is what Tremont is striving for with their programming. As mentioned previously, Tremont's motto is 'connecting people and nature.' But through the course of this research it has been apparent that they are hoping for much more in terms of connection than a simple awareness of nature and Great Smokey Mountain National Park. GSMIT is hoping that their visitors, whether student, teacher, or volunteer, will be changed by their experience at Tremont. They are hoping for a connection that translates into a caring in the way two people feel connected to one another. As Matt said, "*I believe it's part of the goal to increase peoples uh feeling of ownership and uh, you know, this is my national park, these are my resources that are being protected for me and for everyone else. And that's what we want (Matt, interview 2).*" The staff of GSMIT understands, however, that no two people will have the exact same experience nor will they take home the same understandings and lessons from their time in the park. It does seem though, that when the Tremont staff talks about their hopes for what their participants will take home with them it is more about connecting on a deep level with the world around them than GSMIT specifically. One must question, what does connecting deeply mean exactly? When contemplating the construct of place the concept of home seems to leap to mind. However, the construct of home is as problematic as 'place.' And as one delves into this notion they should quickly realize that home, like place is more than just a physical address. There are often many places where one feels at home and there are most likely people who feel homeless even though they have a house with a physical address. Meridth Graves, a punk rock musician, recently said, "And home is where you're supposed to feel the safest and home is where love happens and home is where you're supposed to feel best about yourself (YouTube, 2014)." While this notion of place as home may sound romanticized, it is difficult to conger the idea of home without feeling a sense belonging and stewardship. Home is a place that you are connected to, and

something that you care about. Home is a place to which you want to return and if you were to find that it had been destroyed you would be devastated. David Orr even refers to place as home in the following quote,

> "A world that takes its environment seriously must come to terms with the root of its problems, beginning with the place called home. This is not a simple-minded return to a mythical past but a patient and disciplined effort to learn, and in some ways, to relearn the arts of inhabitation. These will differ from place to place, reflecting various cultures, values, and ecologies. They will, however, share a common sense of rootedness in a particular locality. (Orr, 1994, p. 170)"

But these ideas of home, place, and rootedness all seem to be intertwined and in someway inseparable. They each must become part of a person through the lived experiences. A person cannot feel at home or rooted in a place without immersing themselves in experiences there. In fact, these concepts seem to be at the heart of the place-as-being that Karrow and Fazio discuss. If we expand our thinking of place to include pedagogy of place-as-being it is necessary to consider how a person begins to think of a setting, with its people, places, animals, plants, and cultural norms as home. How does that development influence the development of their being? What about that scenario allows them to feel that they belong?

Karrow and Fazio (2010), remind us that place based education began with a focus on the natural realm and gradually expanded to include a person's community. That, according to them, is a simplistic notion of place that is in need of expansion. Does simply being grounded in a geographical location within a community fully encapsulate what educational philosophers are referring to in terms of place? Karrow and Fazio say no, and this research supports their assertion. The idea of place needs to be expanded. Little has been considered in the context of

ontology (being) of place. Place-as-being is a critical part as it brings in the human element, the living, changing, and adapting that becomes the sum of a person's experiences. It formulates who they are and who they become. Karrow and Fazio (2010) assert, "whether place is associated with land and/or community and/or difference grounded by respective natural and cultural realms, what appears to be downplayed in the discussion is a consideration of the ontological realm. (p. 197)." They go on to advocate for 'place-as-being' to address this deficiency. Smith and Sobel (2010) explain that, "What place- and community-based education seeks to achieve is a greater balance between the human and non-human, ideally providing a way to foster the sets of understanding and patterns of behavior essential to create a society that is both socially just and ecologically sustainable (p21)." To attain this however, it seems clear that the experience must influence the ontological nature of the participants. If we only consider place as the physical location of study or even a person's community then we are still allowing for "place" to be too two dimensional. It is simply a place. But this concept of place is so limited. Over time, this idea of place has become more nuanced, but as Karrow and Fazio state it is time that we examine the construct of place more closely. This construct needs to be further complicated, more representative of what place-based education truly consists of. Yes, the notion of place can simply be considered as a geographical location; however, when educational philosophers talk about place they are meaning something more ethereal, something that David Orr mentioned in 1994 when he said, "A world that takes its environment seriously must come to terms with the root of its problems, beginning with the place called home (p170)."

Home can be a place on a map, an address, but that isn't all that the mention of "home' ignites in a person's consciousness. We must also consider that the construct of home is not static. It is continually changing and evolving. The people and circumstances that make up the

construct of "home" can morph. Even the physical location of 'home' may shift. A person's childhood home is frequently vastly different from their adult home. Can't a person have multiple homes? What about that old adage that 'home is where the heart is.' This is what the Tremont staff is trying to achieve. Home, for many, denotes what Karrow and Fazio refer to as "place-as-being." It is this more complex vision of PBE that can be useful as a model for GSMIT. While yes, it is true that it is important to the Tremont staff, past and present, that participants in their programs develop a connection to Great Smokey Mountain National Park they also want students to develop an understanding of their home communities, nature, and the world. They want them to feel at home in their environment and not feel separated from it. Matt was probably the most clear about this. He stated that he wanted them to begin to see it as 'their' park. The reason for this is two-fold. Yes, he wants people to learn about the park and begin to care about it so that, hopefully, in the future they will want to continue protecting the National Parks. Matt wants people to care about the park as well as have a sense of ownership. In this sense, place is created through what Tuan (1977) describes as "fields of care" that result from peoples' emotional attachments. Tricia spoke of the happiness that people get while chasing butterflies through Cades Cove with a net, and Hannah spoke of just wanting participants to have time to enjoy and play in the park. They are trying to facilitate a fundamental change in their visitors that begins with them simply enjoying being in the natural environment. They are trying to formulate that emotional connection that Tuan refers to as being critical to creating a sense of caring. It is their hope that visitors will take these experiences and build upon them once they leave them park. In fact, they are hoping that students will use their three to five day visit to the park as a foundation for a lifetime of care about the places that they inhabit and that they call home.

Place as undergoing transition. One key aspect of 'place' is that it cannot exist without external forces acting upon it. Whether it is a place like Tremont, a school, a town, a neighborhood, or even a house; there are always entities that alter the way that a place is managed, what programming they offer, what personal is working or still employed, different visitors, or even just change to the physical nature of the place. For instance, maybe a building has been constructed or a bridge built since the last time someone visited. This is a natural component of any place. Anytime someone returns to a place, while there will be many aspects of it that are familiar and comfortable, there will also be aspects that have changed. This is true for several reasons. To begin with, all places are confined by their own notional boundaries. Of course, this is true in the geographical realm but it extends beyond this to ideological notions as well. Let us consider the case of GSMIT. Tremont, like all physical places, has geographical boundaries. Tremont Road and the Middle Prong of the Little River bound GSMIT on one side. The remainder of the campus has boundaries that are less obvious. Since Tremont is located within Great Smokey Mountain National Park, it does not possess its own property. As a result, you can walk on a trail, leave the campus and never realize it. There are no signs saying that you are now leaving GSMIT or that you are entering the national park. As such, the geographical location of GSMIT can be somewhat blurred with those of GSMNP. The two are separate, but one simultaneously.

This intimate connection to the National Park influences the goings on at Tremont. As both Matt and Jeff mentioned, it was Tremont's connection to the park that ultimately was responsible for the introduction of citizen science into Tremont. Jeff said,

> *"Keith with the park service, who was working with All Taxa Biodiversity inventory, who is an amazing biologist and amazing guy, started to talk*

with us and Keith said, 'you know, it's not worth me...he was being real straight...for me to pay my staff to come over and basically talk to your groups because my guys have got to do their research. It's really not beneficial for you to send a group to them because my staff won't be able to get their research done when you're tagging along. BUT I think it probably is worth it for me to send like one of my people over to train your staff in some of these things.' And then, I think, the light went on for him. And he started beginning to think about, "oh, okay, maybe there are some things that we can get information on that are those kind of things that aren't my front burner things that I am going to get funding and I've got to get my researchers working on, but that's kind of...wouldn't it be cool if we knew about stuff." He began to get the idea that, okay, there's got to be either something that Tremont participants could do where we give Tremont the right protocols for doing something then we can be part of this data collection even if we're not doing A to Z. So, Keith, he was really trying to figure out how to make that happen (Jeff, oral history)."

Jeff had previously observed the value of having his staff involved with the researchers in the park, but it took having the park service realize that benefit in order for it to really happen. While it would seem from this discussion that we are continuing the traditional definitions of PBE, place as object, this is not true. Instead, we are continuing to problematize this notion of place. One cannot assume that every visitor to Tremont will be experiencing the same place as everyone else. If we are going to accept the notion of educating-within-place we must accept the fluidness of places. Adams et al (2010) point out that we have to look at the whole when

considering place. Adams et al liken this lack of context to museum exhibits that fail to mention the role of plants and animals in their ecosystems when discussing biodiversity. Similarly, it would be foolish to consider the notions and relevance of place without examining all of the forces that are instrumental in its formation. For instance, since the data for this study were collected, Jeff has left Tremont and moved out west. Jeff was the executive director of GSMIT for over 30 years. Surely, his absence has resulted in some changes at Tremont and it seems reasonable to assume that those changes will influence the experience of GSMIT for their visitors. How such a change will affect the ontological sense of place is unknown, but it is reasonable to assume that his absence will result in a difference in the experiences of visitors to Tremont.

Furthermore, it was the fact that the park service made funds available to GSMIT that they were able to create the position of Citizen Science Director and hire Matt initially. This clearly demonstrates that while the two entities are separate and distinct they exert influence upon one another. There are federal policies that apply to all national parks and since GSMIT is housed within the boundaries of the park they must adhere to them. Of course, this influences the practices, lessons, and experiences that Tremont provides. As policies of the National Park Service (NPS) change this can cause GSMIT to alter their practices. Both Matt and Jeff discussed the influence of NPS administrators on Tremont. According to them, some park administrators saw Tremont as a partner while others viewed GSMIT as a separate entity. This has had significant impacts on the running of GSMIT. In fact, Tremont went for a significant period of time without having a Citizen Science Director due to funding issues. While the physical location of Tremont has not changed, policy changes, personal changes, etc. certainly have influenced the place that visitors experience when they visit GSMIT. Beyond that how do

the interactions with other participants and staff influence the lived experience of place at Tremont?

It does not seem unreasonable to assert that the people with which one comes in contact have a profound affect on sense of place as well as influence on place-as-being as described by Karrow and Fazio (2010). It is broadly accepted that people have a profound impact upon establishment of a person's interests and values. This is why parents are so particular about who their kids come into contact with. Imagine that you are away for a retreat. If you are surrounded by people that you connect with and enjoy it is expected that you will have much more positive feelings about the experience than if you found the company more disagreeable. Likewise, the instructors or retreat leaders will influence your interpretations of the experience. The people with whom you come in contact have a significant impact on how you feel about a place and whether you formulate positive or negative connotations. Of course this is true at Tremont as well. Throughout this study I heard much about the positive feedback that the staff of GSMIT received, and it is not uncommon for Tremont staff to receive letters from parents of former students, or even from students years after their GSMIT experience. Of course, it is difficult to truly assess how each one of those individuals viewed their sense of place about Tremont or how their experience there informed their view of place when they returned home and continued with their lives. What is apparent is that each person's interpretation of place will be different. It is likely that each person, even from the same group would have slightly different recollections of their time at Tremont and would describe their place in nature differently. As Adams, Ibrahim, and Lim (2010) describe, if we view educating as an action, place as an object, and students as the subjects then we are, in actuality, going against PBE philosophy. In such an instance, we would be, as Adams, Ibrahim, and Lim suggest, “educating about place but not in place (p.

221).” Instead, if we adopt Karrow and Fazio’s (2010) construct of educating-within-place we will begin to erase the boundaries between object, subject, and action. They become all part of the more inclusive construct of place. This is exemplified at Tremont. At GSMIT their intent is for the students and visitors to form connections with nature that they can take with them when they return home. The teaching, and location are blended together to accomplish this objective. However, it would be foolish to assert that the different teachers, lessons, and even the weather for the day would not influence the sense of place for the students. If we are going to argue for educating-within-place we must accept that each person will interpret that place based upon his/her own experiences. While this is acceptable to most who argue for PBE, it is easy to see how teachers who are faced with meeting rigid standards and benchmarks may be reluctant to embrace such a notion.

Citizen science contributes to an illusion of democratization. Citizen science contributes in particular ways to participants' evolving sense of place. As discussed above, while these places are in transition and part of the lived experience, there is hope that citizen science will lead to the democratization of science. While visiting Tremont students participate in various classes, one of which will likely involve citizen science. Citizen science is incorporated into the curriculum for multiple purposes, but it is considered an integral part of the goal of 'connecting people and nature.' Citizen science is also a critical component of students beginning to develop a sense of place in nature while at Tremont. Of course, citizen science is just one component of a comprehensive curriculum. The classes at GSMIT are diverse and are designed to invoke all of the participants’ senses. Some classes may have an art component where students are doing leaf rubs and drawings, some have students writing, and some just have students being still and quiet outside. This last activity may be the most challenging for many. As such, citizen

science is just one aspect of a visitor's experiences while at Tremont. Citizen science allows participants to obtain a deeper level of understanding regarding nature and the ecosystems of Great Smokey Mountain National Park. Instead of simply focusing on the aesthetic quality of the park and an enjoyment of nature it allows participants to study specific organisms in detail. For instance, instead of simply seeing a salamander and appreciating it for its beautiful colors a participant in the aquatic salamander citizen science study would handle the specimen, take measurements, and hopefully get a better understanding of the role of that organism in the ecosystem. While this sounds like a positive outcome for both science and Tremont, some of the research participants for this study were almost critical of the rigidity that citizen science imposed upon them. For instance, Hannah said, "Because it seems like sometimes you spend so much time explaining how a project works and they don't always really get it. They're just kind of doing what you tell them to and then once they've done it a couple of times they really learn it and they get more benefit from it and the project probably would too because they know what they're doing a little bit more. We don't affect as many people that way, I don't think (Hannah, interview 2)." She explained how she would like to see more volunteers or local school groups involved in their citizen science projects because she felt that incorporating citizen science into classes with new groups every few days was a challenge. She felt that having local groups adopt certain aspects of the project would allow those individuals to really get to know the project. However, one has to wonder if this doesn't defeat the purpose of having citizen science at Tremont. Tremont administrators consistently noted that they believed that having these programs in their curriculum raised the level of their programming. In fact, it was believed that participant involvement in citizen science facilitates the development of a sense of place in science. How would this be achieved if these projects were farmed out to local groups that only

submitted their data to GSMIT? Several research participants expressed that this was an important aspect of why they have students involved in citizen science projects. They stated that they wanted students to be able to visualize themselves involved in authentic science. For instance, one participant stated " *I mean with our salamander monitoring I could just tell just tell them, Okay, we're all just going to flip over these cookies and look for salamanders," and they're having fun looking for salamanders but if we, we really make sure they are paying attention to their data sheet and really go over things ahead of time, then I've had kids ask me, "Hey could I do this for a living, like is this something that people do (Hannah, interview one)?"* While Tremont's primary objective was to facilitate student comfort and understanding of nature, it is also true that they wanted to also connect people and science. As has been discussed previously, it is thought that much of the US population feels excluded from the discipline of science. They feel that it is something for 'really smart people,' or relevant only to professionals. Citizen science, as indicated by Tremont's experience, can work to tear down some of the walls that the public sees surrounding science. Participation in citizen science projects can allow students to see themselves involved in science as a profession or hobby. This is a nice sentiment, but does it really work? While conducting interviews at Tremont it was apparent that there was still a divide amongst the "scientists" and "non-scientists" even amongst the GSMIT staff. Many participants were quick to say that they did not consider themselves a scientist while those who had formal training in science were comfortable with the descriptor. One must wonder, in this case, if citizen science truly does lead to the democratization of science. If the very individuals who are advocating for its inclusion in educational curriculums are still resistant to claim their place in science how are those who are only exposed to citizen science once or twice as students or volunteers going to adapt their way of thinking? It is possible that the student participants may

not yet have adopted a view of their place in science or that their project leaders may not alter the students self identification, but we must be aware that leader bias may influence student perceptions. One must also question whether citizen science participation is truly capable of influencing scientific identities if it has not changed how these individuals define themselves.

One critique of citizen science has been that it perpetuates a top down approach to science. This certainly is the case at Tremont. In order to get buy-in from the park service to start citizen science projects it was necessary for Tremont to work with established scientists who were involved with the ATBI. While GSMIT had started some independent projects it was and continues to be very top down in nature. This seems to be primarily due to the transient nature of their visitors. Since most students visit Tremont for three to five days, it would be highly unusual for one of those students to be able to suggest and implement a program. As such, most citizen science projects come through the Citizen Science Coordinator. That person is there year round and charged with starting and maintaining programs. Unfortunately, this tends to perpetuate the participant as technician model of citizen science that has been the mainstay of citizen science since its beginning. This also fails to increase the democratization of science. Democratization requires a more inclusive nature, and while this top down approach does increase the number of technicians it fails to enable participants to envision a place in science beyond this low level of participatory science. In fact, it could be argued that this model tends to perpetuate the notion that volunteers and students, while they can be beneficial to science, are not really part of the fraternity of science. They can only offer a support role that allows them to watch the professionals at work. Mueller, Tippins and Bryan (2012) maintain that the incorporation of citizen science into the science curriculum will increase community involvement and student achievement. While this is a logical argument, this study cannot directly speak to it, as their

model of citizen science is completely different from that argued for by Mueller, Tippins, and Bryan. It is important to not simply abandon the use of citizen science in the classroom because this one model does not support the ideal. What Tremont does offer in terms of citizen science is initial exposure. Virtually every participant in this study stated that many teachers inquired about how they could incorporate citizen science into their curriculum. As such, citizen science serves as a launching point that may have more significant impacts than this study indicates. If teachers are in fact beginning to use citizen science in their curriculums it is there that we may see the true democratization of science. Those teachers will be able to offer consistent citizen science experiences that can have even greater impacts.

Summary Discussion of Research Questions

What assumptions frame the GSMIT staffs' definitions of "Connecting People and Nature?" In order to understand the implications of citizen science within the curriculum at Tremont we must first tease apart the assumptions of the GSMIT staff regarding "Connecting People and Nature." To begin, from discussions and interactions with the Tremont staff it is clear that they consistently accept that most people are disconnected from their natural environment. The staff, in general, seems to believe that the majority of students are suffering from what Louve (2005) describes as Nature Deficit Disorder. Furthermore, they all believe that through Tremont experiences that students will begin to reconnect with the natural world. However, as Jeff said, *"I've always looked at connecting people and nature as not just about getting people out into nature, but helping people to realize that they are a part of the natural system and that we um, I think a lot of our environmental issues are a cause of us thinking about things as people AND nature rather than thinking of we're in this together. We're part of the system. It's not like "man against nature." Its, its um...even though sometimes it is, but in terms of sustainability.*

Sustainability is people and nature existing as if people are a part of nature not as if we're a extra or different or optional component (Jeff, interview 2).” This is a consistent message amongst all of the participants. The GSMIT staff believes that the experiences students have at Tremont are critical to developing a population that is aware of their placement within the ecology of the world. Furthermore, they believe that these experiences will serve to counteract much of the lived experiences of these students prior to their arrival at Tremont. There is a general acceptance amongst the current and former staff that most students are spending significant amounts of time playing computer games, texting, and interacting with technology instead of being outdoors. As such, the staff at Tremont sees it as imperative that they provide lessons that will engage students without technology and electronic devices. The GSMIT staff also accepts that a key aspect of countering Nature Deficit Disorder is allowing students to have relaxed, fun, positive experiences in the woods away from urban environments. In fact, Hannah expressly stated that one of her concerns about incorporating citizen science into more programming at Tremont was that it would get in the way of students' experiences. While she understands that teachers need to address educational standards and meet course objectives, she worried that if the GSMIT curriculum became too focused on those aspects that they would not have the opportunities to allow children to simply relax, explore and enjoy the woods and streams of GSMIT. As Tricia stated,

> *“Honestly, I think that kids get bogged down with a lot of problems with the world and so I think its important to just have the kids go out and have a good time and start to care for what's out there um...and obviously I think its important for everyone to do this. That's why I like to focus on let's go play and lets have a good time with the kids so that they can have some*

good memories and then with the older people I think its good for them to understand how we fit in to this place where we live and how it sustains us and um...start to realize that everything really is connected to one another and if we do something to one thing it is going to effect the other part, um so I thinks important for adults to realize that so that, because they are making decisions every day about what's going on in their world and its good for them to be educated and to have some kind um...I guess...like have a previous experience so that they can make knowledgeable decisions (Tricia, interview 2)."

According to Matt, the simple act of giving the students a place to be in the natural park is often the most powerful tool they have to offer. It removes kids from their routines and hopefully allows them to see a part of the world that they are not as familiar with. The GSMIT staff emphasizes that this change in place combined with positive experiences will influence change in the behavior of the students throughout their lifetimes.

How has the GSMIT staffs' interpretation of "Connecting People and Nature" been expressed historically? The Tremont motto of "Connecting People and Nature" has been part of the school's ethos since the very beginning. According to Jeff, the slogan came about almost 25 years ago when the staff was trying to name their first lesson guide. He explained how the slogan 'connecting people and nature' summed up Tremont's core principals and that it has not changed in any appreciable way since then. In Jeff's own words,

"I think that little slogan came up when we were, we were trying to think of what, what to call our first lesson guide when we were putting together our lessons. So, that's been, yeah its been 25 years probably that we've had that

> *and, and, you know, in terms of has that changed any? No, I mean I think that's the core of what we do. It's it's 'connecting people in nature in Great Smoky Mountains National Park.' You know, its certainly the national park is why we're here and its key to our mission. It's the vehicle that we're using to spark that wonder, to connect people and nature. And its not just about, I don't know if we've talked about this before, but I've always looked at connecting people and nature as not just about getting people out into nature, but helping people to realize that they are a part of the natural system and that we um, I think a lot of our environmental issues are are a cause of us thinking about things as people AND nature rather than thinking of we're in this together. We're part of the system. Its not like "man against nature." Its, its um...even though sometimes it is, but in terms of that's sustainability. Sustainability is people and nature existing as if people are a part of nature not as if we're a a extra or different or optional component (Jeff, interview 2).*

From Jeff's perspective the primary goal of Tremont has essentially remained unchanged since the very beginning. Of course, there have been changes to the overall curriculum. They are emphasizing participation in citizen science projects, summer internships, multidisciplinary approaches, yet Tremont's overall objective of 'connecting people and nature' has remained. Most of their school programs run for three to five days. They do have some weekend groups and summer camps, but the school groups are their main focus from September to May. It is a residential camp. This means that students spend the night at the camp. From the staff

perspective this means that the entire time that the students are on campus is about facilitating an understanding that humans and nature are intricately linked.

Matt, who has been associated with GSMIT either directly or indirectly since 1999, echoed those sentiments. He explicitly linked 'connecting people and nature' to the multidisciplinary methods in use at Tremont. He stated,

> *"The basic idea of connecting people to nature is that uh, uh there are a lot of different ways of getting people a person uh relationship with the natural world of the Smokies. And that is what the programs at Tremont try to do. Connecting people through physical experience with backpacking trips, through uh scientific understanding, uh and hands on experience with physical science programs, through um artistic experience of uh arts weekends, um you know a variety of different, you know, just being in it uh, and uh of camp weeks, uh all those are different ways of getting people to have a better rapport and connection to the natural world of the Smokies which…I believe it's part of the goal. To increase peoples' uh feeling of ownership and uh, you know, this is my national park, these are my resources that are being protected for me and for everyone else. And that's what we want (Matt, interview 2)."*

This is a powerful perspective! Matt's words provide a vivid insight into what 'connecting people and nature' has meant both currently and historically. His words lend support to the assertion that this focus on 'connecting people and nature' has remained virtually unchanged throughout the history of GSMIT. The driving tenant of their message is that if there is no connection to the natural world, if every human desire and emotion can be fulfilled through

technology and commercialism then there will be no motivation for protecting our natural ecosystems. Matt and Jeff have been committed to this philosophy for decades. The methods that the staff at Tremont may use to meet this object have certainly changed and been modified over time. It seems reasonable to assert that there were numerous changes in the history of Tremont. The curriculum has been tweaked. They initiated citizen science opportunities, developed summer camps, internship programs, and there have been personnel changes. Certainly there have been lots of changes at GSMIT since it first began, but Matt and Jeff indicated that the primary focus of facilitating a bond between their visitors and Great Smokey Mountain National Park has remained the same. However, it seems that the longtime desire of those at Tremont has been to transcend the boundaries of the campus and park. While the focus of the curriculum at Tremont is connecting people and nature in Great Smokey Mountain National Park, as discussed previously, the hope is that the experiences that visitors have at GSMIT will be the beginning of a greater relationship with the world at large.

How is the GSMIT staffs' interpretation of Connecting People and Nature" expressed today? Every staff member, whether past or present, was passionate about this notion of 'connecting people and nature.' As it has from the beginning, this simple phrase seems to encapsulate the essence of the work and curriculum at Tremont today. Tricia, Hannah and Sarah are all relatively new to GSMIT, but they all spoke eloquently about the overarching mission of their work. Tricia explained,

> *"I guess our stand point is that we really want to get people outside in the natural world and allow them have hands on experiences and use all their senses to um explore and discover and um...and hopefully, um...through doing that and having that experience*

they'll be able to start to learn about the environment, have their own connection with a place, have a memory with a place, hopefully its a good connection. And um...hopefully that will, in the future when they go outside they can remember they've been through a good experience and then they can share that with other people. And hopefully make good decisions when they are faced with decisions about what they want to do even its just, you know, in their backyard or even if its just cut all the trees down and have a lawn or um are we going to leave some place for wildlife so that we can preserve things, but basically just getting out there and having some experience, having some kind of connection that they can bring home with them (Tricia, interview two)."

Tricia, at the time of this interview, had been working at Tremont for approximately five years and yet her sentiments perfectly mirrored the responses of Matt and Jeff in regard to the role of 'connecting people and nature.' She is passionate about informing the decision making process of the individuals who visit Tremont. As with Matt and Jeff, she wants the students to have positive experiences in nature while in the park, but that is just the beginning. It is clear that in her view, the primary objective is to have that connection to serve as a bridge. She wants that connection to inform visitors' decisions once they return home and, as they become participating citizens in their communities. Hannah added to that sentiment and stated that 'connecting people and nature' involves,

"*Direct hands on experiences instead of watching it on TV or doing like, dissecting animals in the lab or something. And it is also*

connecting them to where they fit into nature. So, like where, where their food comes from, for instance. And also, trying to connect them not only to being here [in the park] and experiencing it, but also thinking about that they can do it when they get back home. We talk a lot about what it's like, asking them what it's like back home. Like do you play outside at home? Can you…have you ever been camping? Do you go hiking? And a lot of 'em have. And a lot of 'em say, "oh, we have woods in the yard. I never go into it." Or...sometimes "we go in the woods", or, um..." yeah…I guess I could do this at home." Which is cool. And then some of them, I mean, city kids don't, but, you know, they might have a city park or something that they could go see (Tricia, interview two)."

As is made clear from Hannah's comments, Tremont's philosophy is grounded in the act of doing. It isn't about lecturing and telling students what is wrong with our current environmental policy. The staff does not spend a lot of time preaching to visitors about their environmental responsibilities. Instead, they want visitors to begin to formulate the beginnings of an environmental ethic on their own stemming from positive experiences in nature. Tremont wants to create an affinity for natural environments with their visitors so that it sparks the beginning of a stewardship ethic. Tremont does not want to create a zoo experience where individuals merely come and look at nature while remaining separate from it. They want students to immerse themselves in the ecosystems of the Smokies. They want to challenge their visitors' assumptions about what being in nature in means. They want students to begin to evaluate the choices that they are making. If they have visitors who spend lots of time with technology and indoors they

want to convince them to put down the electronics and step outside. They want natural ecosystems to become something that their visitors are intimately familiar with. They want to formulate a deep connection. They want the natural environment to become home.

This development of sense of place in nature, this feeling of being at home in the environment is what Jeff started out hoping to achieve 25 years ago. It is amazing that this continues to be the over-riding objective today. The environmental issues of the day may have changed but Tremont's approach to addressing them holds steadfast in formulating a 'connecting people and nature.' As Sarah noted,

> *"To me it means having an opportunity to uh really have these intimate experiences with people in nature who might not otherwise have had that opportunity. But we have such an array of different types of people coming here that no matter what, they're all having an opportunity to really experience this place and specifically the Smokies, but nature as a whole through the various programs that we offer. Um, so you know with the inter-city high school kid from Cincinnati going and getting her feet wet in the creek in the middle of winter time you know for the first time, or um or a kid from a high school or an elementary school that has an environmental focus, they're out hiking all the time but they come here and they get to hold a bird in their hand for the first time or they get to find the salamander you know that they've never seen before, it's different experiences but it's all connecting people to nature. I think that um it's just so uh, I don't know, it works. It works and it happens almost*

without really having to try too hard. Um, and yeah that's our motto and we might not even think about that on a daily basis as we're out teaching stuff, but that's exactly what's happening and that's why it's so appropriate (Sarah, interview two)."

"I think that to me giving them, like one of our other parts of our mission statement is having a sense of place. Um, and being aware of this place and having a chance to experience it on a much deeper level than what most visitors to this park experience it. But I really also think it's important for them to in the same time while they're developing the sense of this place to apply that to their place, where ever they're from, back home. And to say, wow, well there is that city park that I just kind of walk through some times. Um, there's a creek there, I wonder what sort of little critters live in that creek, you know? Or, to think about just to bring what they learn here back home and apply it. And I think that it will not only, it not only has the opportunity to get people away from their present situation, like I was talking to our campers last week, many of them don't want to go home because of some of the difficult situations they are going back to, so giving them a chance to sort of retreat from their daily norm, um but at the same time giving them the tools to be able to retreat to nature back home. If they can find places like that and also to be interested in taking care of it, to sort of pass on that conservation ethic, I think is really important. And um if people feel

connected with nature they are more likely to be connected where ever they're at, to find a connection where ever they're at, and then to do something about it, to make it better (Sarah, interview two)

How is citizen science used as an educational context at GSMIT to foster the goal of "Connecting People to Nature?" Citizen Science is very important to the curriculum at Tremont, but it is just one aspect of a highly varied program. Repeatedly, the administrators commented that having citizen science as part of their offerings increased the quality of their programming. While this may not directly impact 'connecting people and nature,' if your staff is not comfortable with the programming, or your curriculum is not well regarded by your customers, it is much more difficult to facilitate a successful education experience. In addition, as was mentioned by both Jeff and Matt, citizen science allows the programming to take the scientific content to a deeper and more personal level. Instead of students simply watching and identifying birds, they can actually be part of data collection for a research program. They can be part of the weighing of birds and searching for parasites. If they are incredibly lucky they may be able to hold a bird just before they release it back into the woods. This garners a more nuanced and developed understanding of the organisms and their ecology. Beyond that, it fosters conversations that may not have occurred if the students were to just go out on a walk in the woods to look at birds. Sarah's words supported this assertion. She said,

"I see that as a way to um really bring nature alive. Um to me, I've always been into nature and anything outdoors. But once I started to learn more about the ecology, how things worked together, um how to identify things, it's like my eyes were opened and I feel suddenly more alive even. I feel more observant. When I started learning bird songs, um now I hear them

everywhere I go, I can't turn it off. Once you learn it, you can't turn it off. And just so being constantly hyper-aware of what's around you, I feel has made me a more observant person in general. Um, so being able to um bring that to other people, I think especially because I've been in the research world for a while, a lot of people would consider themselves non-scientists, like they can't really go there because they're not smart enough or they're not trained in that field, um sort of a different world to them, but I want to make it so much more approachable to everyone. Because it's just, it's just making observations and it's just writing a few things down and really helping out our basic knowledge by doing so. And so I think that by someone um coming to the realization that they can really contribute to something that's larger than themselves, a larger project where they can actually learn how this salamander population is doing or when the wild flowers are leaping out and budding and blooming across all the years, the fact that they can say, hey I had a hand in that I really participated in that and this is going to this larger basic knowledge that they're going to use to inform management decisions down the road, I feel like that could help people to be even more connected. Um, specifically to this place and to these projects, but they can take that home, teachers take that home and can do these Citizen Science projects in their own school yards and stuff and I feel like that can just have much broader reaching implications. It's helping us out, but I think it's helping them to have more of an ownership of it, too (Sarah, interview two)."

Once individuals experience participation in citizen science it is something that can travel with them. For instance, if students participate in the Monarch tagging program at Tremont they may seek out similar activities once they get back home. If they participate in the water quality testing of the river at Tremont they may become interested in evaluating the health of their local streams. They may be able to access data online, or read scientific publications related to the projects with which they have worked. As Sarah explained, it can help them take ownership of the science, which can strengthen the connections forged by their time spent at Tremont. Tricia reinforced this assertion when she noted,

> *"I think its because citizen science in general can...is very available to anyone who could get on a computer, its probably even available to more than just that, but um...there's so many sites that you could do at home like the Great American Backyard Bird Count through Cornell's website, so its something that doesn't have to stay here, it can...we can say, oh if you really liked doing this, here is another project that you could do and you could do this in your backyard. Or you could do this in a park nearby if you don't have a backyard, um...so I think citizen science helps connect them to this place while they're here because its hands on, but then it allows them to, if they're interested enough, to do something in their own home town too, its not something that has to stay at Tremont. Its something that could go with them (Tricia, interview two)."*

At the very least GSMIT staff believe that through engagement in citizen science students will have a more profound comprehension of the ecosystems within the park than they would have if they had experienced GSMNP on a more superficial level. Yes, simply walking and playing in

the woods is an incredibly valuable way to foster appreciation of the natural world, but when you examine the ecosystems more closely, like one does when collecting data, a person begins to gain insights into the complexity. That appreciation of the nuances of the natural world can lead one to understand that while forest, lakes and streams are big and strong they can also be incredibly fragile. They may have signs of stress that would go unnoticed until someone looks at them closely.

Even though the staff and administrators at GSMIT believe that citizen science is an important aspect of their goal of 'connecting people and nature,' they consistently agreed that they would not want participation in such programs becoming the main focus of their programming. As Tricia explained,

"I wouldn't want it to be in every single class that we do. I wouldn't want it in everything because the citizen science um...is so much more technical, there's protocols, there's all kinds of equipment and you have to teach the equipment and teach the protocols and be there for every step of that and I think that if, if all of our programs the kids brains would never really get a break and then for us in, as far as of preparation, we would never get a break either. So, I think there needs to be a good balance of having some experiences you'll be connecting through this science project where we'll have an actual question or specific question that we are looking to answer and you might just be part of a bigger project. Um...and short of connected to everyone else that's been to Tremont that's done this project and that can be a good connection too, but then we also need those classes where we're just out here to discover and explore and figure out our own questions that we have and try to figure out what the answers to them and then we need those classes where they can just go out and just sit, and just be and have a rest...from all the mental work, so I think we're doing a pretty good job and not making it across the board science

all the time. It makes it, it makes it more, more of an experience that the kids want cause oh...we get to be part of this. If its collecting data you're using worksheets and math and um...just precise measurements and it can just get really taxing. We don't want them to remember this trip as oh...we just did a whole lot of science and math and that's not what I want to do, like...we want them to be able to connect in different ways too (Tricia, interview two)."

Too much of a good thing could have the opposite effect of the one you are looking for. In other words, citizen science needs to be one aspect of a well-balanced, multifaceted curriculum. The entire program at Tremont is built around the motto of 'connecting people and nature,' and the GSMIT staff wants to be sure that they don't cause people to have a negative reaction instead of a positive one. They want to build the students' interest so that they will seek out similar experiences when they return to their home communities. From this research it is important to consider the possible implications for science education and science teacher educators.

Implications for Science Teacher Educators

It is clear that the inclusion of citizen science at Tremont has been beneficial to GSMIT and their curricular objectives. Citizen science has become an important part of their goal of 'connecting people and nature.' What we must consider now are the implications for the inclusion of citizen science in curricula for science teacher educators and science education.

Citizen science can engage students in science in authentic ways. According to the website www.nextgenscience.org the new Next Generation Science Standards state that:

> *"Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:*

- *Have broad importance across multiple sciences or engineering disciplines or be a key organizing concept of a single discipline;*
- *Provide a key tool for understanding or investigating more complex ideas and solving problems*
- *Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledgeable*
- *Be teachable and learnable over multiple grades at increasing levels of depth and sophistication (http://www.nextgenscience.org/three-dimensions)."*

During this era where standards and testing scores have become a critical component of what teachers do in the classroom it can be difficult to convince teachers to try something new. However, this study indicates that incorporating the use of citizen science into curriculum can be an effective method of meeting standards. Simon described this when he said,

> *"The National Science Foundation had a keynote speaker and it's just about Citizen Science. So, um, I think it is getting recognition as being a useful tool, not only to help inform science, I mean this is the National Science Foundation, but they also, um spoke about the importance of getting kids outside and this is another way where, again focusing on schools, the teachers might be wary of just letting the kids go outside to just catch butterflies. But if you can link it to a real, that you're collecting data, um, then it makes much more easy for the principal to say yes to (Simon, interview two)."*

There is a ground swelling of support and interest in citizen science. As Simon mentioned, citizen science is not just being seen as a tool to benefit professional scientists; rather it is being

widely accepted as a way to educate students and volunteers alike. If science teacher educators will incorporate citizen science projects into their curriculum it increases the likelihood that inservice teachers will utilize such projects when they are in the classroom. Walker (2012) in his dissertation research at Tremont found that it was critically important to have pre-science teachers become comfortable leading students in an outside environment if they are going to be likely to utilize such activities once they enter the classroom. If pre-service teachers gain experience with various citizen science projects then they will be accustomed to the protocols and feel comfortable leading students in collecting data. As has been seen at Tremont, this will enhance both the overall science program as well as student understanding of the nature of science.

Inclusion of citizen science in will serve to foster more interactions amongst participants and local communities. As described above, if a teacher is comfortable teaching outdoors he/she will be more likely to move beyond the confines of his/her physical classroom and perhaps seek out opportunities within the school's community. As was discussed previously, the critique of citizen science has been that participants frequently serve as little more than project research technicians. They collect data for the "professional" scientists, but they typically have no input into development of the questions, protocols, data analysis, and conclusion formulation. These other aspects of scientific inquiry are critical components and by excluding volunteers from participation it severely limits the opportunities for their developing a complete and thorough understanding of the nature of science. Classroom teachers need an opportunity to develop these skills so that they can foster an understanding of the nature of science within their students. But if they are not comfortable with these aspects of scientific inquiry they may be reluctant to move beyond the walls of their classrooms. Conversely, as pre-service and classroom

teachers become more comfortable with monitoring students during data collection it is likely that their increase in confidence will translate to a curiosity and desire to begin projects in their own communities. Community water quality monitoring is a great example of this. Typically, there are groups that recruit volunteers to assist with the collection of water quality data. Once teachers become proficient with the skills that are necessary for such projects it is easy for them to bring those skills back to their schools where classes can monitor local waterways. Then they can facilitate inquiry where questions and projects are student driven. So, while many citizen science projects that have national recognition are very top-down with little volunteer input they could serve as a springboard for more community driven projects later.

This is why it is critical for science teacher education programs to stress the importance of active participation in many of these bigger programs. If pre-service teachers are exposed to these protocols, and even better many protocols like the National Phenology Network, Monarch Watch, water quality monitoring, bird banding, much like the participants are at Tremont they will have their own curiosity peaked and perhaps experience a thorough immersion in scientific research. They will likely develop a comfort with data collection, scientific rigor as well as being outside in an educational context. In this scenario pre-service teachers would be ready to take authentic scientific inquiry to their various schools and communities once they become classroom teachers.

Incorporation of citizen science projects allow for more socially engaged and community focused curricula that tears down the walls between non-professional and professional science. Mueller, Tippins and Bryan (2012) assert that participation in citizen science acts to democratize the science classroom as well as encourage community activism. This claim is closely linked to the goals of the staff and administrators of GSMIT. While the

motto of Tremont is 'connecting people and nature,' that is just the beginning of their grander, less nuanced objective of hoping to facilitate the formation of active engaged citizens. As was discussed previously, the individuals who participated in this research repeatedly maintained that their hope was to inform engagement in democratic processes. It, of course, is their hope that citizens will incorporate an understanding of their fundamental connection to nature in their decision making process. According to Mueller, Tippins, and Bryan participation in citizen science can be a foundational aspect of this democratization. Mueller, Tippins, and Bryan maintain that the very skills that are acquired during participation in citizen science are critical to a person becoming fully actualized as engaged citizens. The aspect of citizen science that is missing from this process is the continued exclusion of participants from the designation as "scientist." Teachers, students, and volunteers need to quit dancing away from the label of "scientist" and reclaim this title. In order for this to happen science teacher educators must facilitate and model authentic science. It is imperative that science teacher education programs instill pre-service teachers with the skills and support required to allow students to think democratically. In other words, teachers and their administrators need to be become comfortable with the uncertainty of outcomes that inevitably occur when you allow and encourage students, classes, or grade levels the freedom to ask and investigate their own questions. This is a critical aspect of the democratization of science and the classroom. Teachers need to trust their scientific literacy enough to know that they are capable of guiding students in scientific investigations while still meeting state standards. This too finds parallels with researchers at Universities. Researchers can find themselves conducting experiments and projects where their primary motivation is funding. However, the reality is that the majority of researchers are not going to stay in a field if they are not naturally curious and interested in the subject. Why then do we take

a more prescriptive pedagogy with students? Young people frequently ask some very interesting questions. We need to give them opportunities to explore these questions and encourage them to move beyond the boundaries set for them by the prescribed state standards. High school students may be given the autonomy to investigate such questions once or twice. This is generally only allowed within the context of a science fair project. Unfortunately, the reality of those projects is that there is no meaningful end product. Nothing, generally, is done with that data. Science fair projects are a very contrived exercise, in most cases. That is not true of citizen science. The fundamental definition of citizen science requires that the data be meaningful beyond the desire for a passing grade. Someone needs to be able to do something with that data. If teachers can incorporate citizen science into their classroom then true democratization of science will occur. However, this also requires that teachers be given the latitude to open up their curriculum to citizen science and have more freedom in addressing prescribed standards.

Tremont serves as a powerful model of what can be achieved in terms of citizen science. Is it a panacea for the many issues contained within the field of science education? As the case studies of GSMIT indicate citizen science can allow students to accept that they can have a place in science. They can have science as a profession, or a hobby. Citizen science can involve students in the content material in such a way that it is only natural that they want to ask additional questions, explore possible outcomes, and investigate possibilities. Tremont has been a leader in the incorporation of citizen science into science education, but science teacher educators can introduce it to a population who can use it to revolutionize science education.

Conclusion: Putting it all together

The role of citizen science in the eventual democratization of science through science literacy. When we look at the data in this study within the context of ecojustice and place-based education the benefits and limitations of the current definition of citizen science became apparent. To begin, let us consider citizen science through the lens provided by Tremont. Tremont's primary objective is environmental education not science education, but these two fields intersect. As was made clear by Matt, Sarah, and Jeff, while citizen science is valued, it must meet the educational goals of the Tremont if it is going to remain part of the curriculum. However, as environmental education and science education are woven together at Tremont it is apparent that citizen science is valued, in part, because it helps visiting teachers meet their yearly science standards. Recall that Simon stated that it is more and more difficult for teachers to justify fieldtrips, but that having citizen science in place allows them to address their science objectives and get buy in for the trip. This allows Tremont to connect people to the park and nature while simultaneously working toward developing science literacy amongst their clientele. Each of the participants mentioned that having students exposed to authentic science was important. Hannah stated that she had students inquire if scientific inquiry were something that they could pursue as a career. Stiles commented that it raised the quality of their programming. Matt has spent his entire career working to make science approachable by students. Why is this an integral part of their values? Why is each one so passionate about having students participate in ongoing science investigations? Fundamentally, it is that each of the participants believed that the development of science literacy amongst the larger population is critically important.

Science literacy is important if we, as a civilization, are going to understand and solve problems such as climate change and address other issues with environmental degradation. We need a scientifically literate populace if we are going to continue to move away from an energy infrastructure that is dependent on fossil fuels. But possibly most important we need individuals to be scientifically literate when they vote for elected officials. Of course, climate change is not the only environmental issue that the globe is addressing, but it is the one that is most pressing. If the citizenry is not scientifically literate then they can/will allow others to tell them what to think about critical environmental topics instead of making up their own mind. And we need a scientifically literate citizenry so that they will think critically about what politicians are telling them. A scientifically literate populace is necessary if science is going to be reinhabited by the general public as the definition of citizen science and science in general is expanded.

As mentioned previously, the administration and staff of Tremont view citizen science as an important tool in addressing these issues with science literacy; however, it is also clear that the participants in this study still hold to the traditional definition of citizen science as well as science in general. In that they are looking for researchers to tell them what projects they would be willing to allow Tremont visitors to participate in. Unfortunately, this narrow definition, that is the traditional one of citizen science, fails to empower its participants. As is apparent from the interviews with some of the participants, involvement in citizen science projects has failed to empower them to own 'scientist' as a personal descriptor. Instead they still feel the need to step away from the term and give the accolades to the "trained" scientists for fear that they would not measure up. But as Bell et al (2009) state, "informal settings for science learning are themselves embedded in cultural

assumptions that may tend to privilege the world view, discourse practices, and contextualizing elements of the dominate culture. People from nondominant cultural groups may tend to see these institutions as being owned and operated by this same group (pp. 232)." This quote seems especially relevant within the context of this study as we consider the divide between those participants who identified as scientists versus those who did not. If we consider those individuals who are not trained scientists as the nondominant culture then it logically follows that they would want to distance themselves from any notion that they are claiming status within that community. Of course, as Bell et al (2009) remind us, often science instruction also serves to reinforce the dominant culture that is white, middle/upper class and male. So, when Stiles emphatically announces, more than once, "I'm not a scientist," it is clear that he is letting people know that he is not trying to intrude on anyone else's territory. This is precisely why the definition of citizen science needs to be expanded and why science curricula need to include it. These two acts will facilitate the decolonization and reinhabitation of science by non-professional scientists and hopefully will broaden the appeal to those individuals that are more marginalized. As Bell et al state it is necessary for the nature of science to shift so that these different and nondominant cultures can rebalance the power structure. This will bring us closer to the vision of Mueller, Tippins and Bryan's (2012) democratization of science.

A broader view of citizen science would encapsulate the theoretical perspectives of both ecojustice and place-based education. From Gruenewald's (2003) perspective, places are social constructs that are formed by history, ideologies and experiences. This is as true for Tremont as it is for any other place. One of the key aspects of this research is to examine the history of citizen science and 'connecting people and nature" at Tremont to develop an

understanding of what that construct entails. Through this study it became apparent that the expression of citizen science at Tremont was intricately linked to the participants' views of science and their place within that community. Some individuals were at home with their role in the field of science whereas others felt as if they were guests. Of course, the citizen science coordinators/directors were comfortable embracing science, but in general all other participants were quick to distance themselves. This is one of the most powerful ideas that emerged from this research. If we consider science as a construct that has been dominated and "colonized" then the reluctance of those that deem themselves "outsiders" makes more sense. First, let's consider how one could view science as a colonized territory. Remember that, historically, scientific discovery and natural science was the purview of the hobbyist or non-professional scientist. The argument can be made that science, like many other communities, became colonized when it became intrinsically linked to capitalism and economic gains. As such, the average naturalist has been disenfranchised from the realm of science as it developed in the late 20th and early 21st centuries. Instead, a scientist became someone who had to attend graduate school and, preferably, earned a PhD in a very specialized field and then pursued research. As grant funding has become more difficult to obtain those researchers who could benefit the development of economic growth (cellular research and pharmacology) were likely to be given financial support but as Jeff mentioned, there has been less emphasis placed on natural studies (entomology, ornithology, etc). It is likely that this has seriously narrowed the breadth of research being conducted. This economic focus, or course, is not limited to research funding but also applies to non-profits such as Tremont.

At the most basic level economic considerations drive decisions made at Tremont as they do at most businesses and non-profits. As Jeff stated, funding determined whether citizen science would become a formalized part of the curriculum at Tremont. Further more, Jeff clearly stated that he continually struggled with getting citizen science to pay for itself. From his prospective as the Executive Director if it was not financially viable then it was going to have to be cut. According to Jeff there was a lack of funding that caused Tremont to cut their citizen science director position for two year, and he was clear that this lack of oversight by a coordinator set their program back. Stiles mentioned that having citizen science as part of their curriculum gives them a competitive advantage when attracting clients. Yes, having citizen science in place enhances their programming but it also feeds the economic engine that allows Tremont to continue to thrive. Gruenewald (2003) and Bowers (1993) are both critical of this economic centric model, but how does a facility escape it when they must pay their bills to stay in business?

With that in mind, let us expand our view to consider how this economic growth model has also conscripted scientific research. "The ambitious aim of eco-justice is to develop an ethic of social and ecological justice where issues of race, class, gender, language, politics, and economics must be worked out in terms of people's relationship to their total environment, human and non-human. (Gruenewald, 2003 p. 6)." While Tremont is in some ways held captive by this capitalistic focus, it is simultaneously attempting to dismantle the human obsession with acquiring 'stuff' and economic growth. As Hannah mentioned in her first interview one of their daily activities is based around food waste. They try to get their visitors to think about how much they are wasting every meal and what the environmental ramifications are. They are working to develop a deeper connection to the non-human

environment in hopes that it will facilitate a change. As Gruenewald notes, in order to address our current state of environmental degradation an educational framework must be constructed that examines the intersection of urbanization, racism, classism, sexism, environmentalism etc. This is one place where Tremont is lacking and could move closer toward their goal of connecting people and nature. It seems that due to economic constraints that they are not in a place to truly challenge and expand the boundaries of this deeper cause of environmental degradation. As Gruenewald states, if the environmental crisis is going to be reversed then issues of social justice must be considered. Yes, formulating an affinity for natural environments is a great first step, but there needs to also be an acknowledgement of many of these other issues. This seems particularly true in the realm of the status of "science" and the tendency of these citizen science leaders at Tremont to not even give voice to the notion that perhaps they are an integral part of the scientific community. But if we consider that science is a field that has been colonized then in order to democratize it must first decolonized and reinhabited. According to Gruenewald, decolonization may require the unlearning of what the dominant culture has put in place. Perhaps this is why Stiles, Hannah, and to some degree Matt and Tricia are resistant to embracing the descriptor of scientists. They have accepted the current culture that says that to be a true scientist you must have a graduate degree and be working for a research institution. Gruenewald goes on to say that decolonization requires learning more ecologically sustainable ways of existing on this planet. If we consider that the citizen science projects being conducted at Tremont are not those that are driving economic growth but instead are grounded in educating a more scientifically literate and environmentally conscious public then it is logical to assume that their research is

encouraging ecological sustainability. While it doesn't seem that the decolonization of science is their overarching objective, it makes one wonder if it may achieve that goal over time. Then the field of science can be reinhabited in a more democratized way perhaps more inline with the way that it was practiced in the past with non-professionals leading discovery.

Citizen science and the Next Generation Science Standards. As was mentioned previously, the Next Generation Science Standards (NGSS) were released in July 2011 (http://www.nextgenscience.org). The intent of these new standards were to develop guidelines that would encourage science education be conducted in such away that students would demonstrate proficiency of content knowledge while simultaneously showing an understanding and mastery of the nature of science. However, if, as this research indicates, citizen science participants continue to only serve as data collectors and technicians to "professional" scientists then this is incommensurate with the intent of NGSS.

For instance, if we consider Dimension 1 (Practices) of NGSS it states, "the practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world…(http://www.nextgenscience.org/three-dimensions)." But, as citizen science was described at Tremont the only aspect of scientific investigation that students are part of is the data collection. Yes, they will be able to discuss the protocol that they utilized during the data collection process, but there is no evidence that indicates that they will have any notion of what scientific practices created that protocol or what happened to the data once it had been collected. In fact, even the teacher-naturalists at Tremont were not completely sure what happened to the data once it was collected.

Secondly, Dimension 2 states that, "Crosscutting concepts have application across all domains of science. As such, they are a way of linking different domains of science (http://www.nextgenscience.org/three-dimensions)." It is unclear how interdisciplinary the inclusion of citizen science is at Tremont. Certainly, it is incorporated into various classes such as forest ecology, scientific inquiry, and aquatic ecology. But as the students are only collecting data there is no clear indication that they are relating this experience to other fields of science. Again, if students were to move beyond the role of technician to were they were actually interpreting the data or trouble shooting issues with protocols they may begin to be able to make connections to other fields. For instance, if participants were to assist with protocol development or trouble shooting then they would be active participants in the scientific process and most likely would have to at least think about the complexities of variable isolation and what could influence the data. If they had been involved in the development of the aquatic salamander protocol they would have had to thought through issues associated with how to secure the Polly bags so that they would not get washed away during flood events. If participants were involved with, or at least exposed to, data analysis and interpretation then they would begin to gain some understanding of the role of the field of statistics. This is not to imply that they need to become experts in such fields but this would be a nice introduction to the interdisciplinary nature of science. Unfortunately, if participants are never allowed to move beyond the technician role then they will only view science in this decontextualized manner.

Perhaps most relevant is Dimension 3 (Disciplinary Core Ideas). Dimension 3 states, "Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science (http://www.nextgenscience.org/three-dimensions)." Within Dimension 3 there are four key criteria. In order for a concept to be

considered a core idea it needs to meet at least two of these, but they it would be best if it met all four. These key criteria are listed above in this chapter. As one reads these while contemplating the idea of student involvement in citizen science, it seems apparent that the citizen science would serve to meet these criteria. The first criterion states that in order to be considered a core principal that the idea should be "a key organizing concept of a single discipline." Citizen science, once participants are allowed to participate beyond the technician level certainly meets this requirement. The nature of science and the scientific process are certainly key organizing concepts. Science education as mentioned in Dimension 1 has adopted these aspects of science as critical for meeting our instructional goals. Citizen science is authentic research that can serve the needs of a local community as well as the larger scientific community, while at the same time helping students to understand the nature of asking good questions, identifying variables, developing protocols, etc. But they must be empowered with the tools, confidence and support of the educational and scientific communities to do that. As Chandler and Swartzentruber (2011) reported positive experiences in nature correlated to improved science scores. From what the participants at Tremont describe, if citizen science is expand to include more aspects of the nature of science it seems logical that students would gain a more holistic view of science. The third criterion states that the idea must connect the concept or task to students' personal lives or to society. As discussed earlier Mueller, Tippins, and Bryan (2012) are already making the case that by allowing for a more bottom up approach to citizen science we will begin to see more civically involved students. Furthermore, by encouraging students to develop projects related to issues that they are concerned about they will advance their own personal educational goals. The fourth criterion states that the idea must be approachable by multiple grades at differing levels of difficulty. This is truly one of the best attributes of citizen science. Like at Tremont where they

have visitors that range in age from nine to senior adults, these projects can be adapted to meet each group at the appropriate level. Maybe the first time a student is exposed to citizen science they only participate in data collection, but over time they can begin to expand their contributions to the project and even offer ideas for their own projects. Then they can act as the instructors for the next generation. The community itself can begin to grow organically. Remember that Brody and Tomkiewicz (2002) found that socially constructed knowledge was more complex and indicated the development of deeper understandings. This speaks to the value that participation in citizen science may have if given the latitude to do so.

Opportunities for future research

As this research concluded it became apparent, as with most projects, that this is a beginning not an end. This study served as a launching point for what I hope will be many more research projects. One area of research is Tremont specific. During the course of this study it became apparent that in order to fully understand the implications of citizen science and 'connecting people and nature' at Tremont one needed to speak to long-term participants of this work. There are several possibilities in this regard. First, there is a family that has been participating the aquatic salamander study for over a decade. They could provide a unique and in depth view of their experience. Secondly, Matt mentioned several teachers at local schools who also participate in the salamander study. They and their students (current and former) could provide valuable insights.

Other future research may involve a study examining the role of their summer science camps or even adult programming. Several of the participants in this study mentioned that they have many individuals who come back year after year to pursue interests in science and participate in citizen science. These individuals generally do not live locally so they would

provide an interesting perspective of how their relationship with Tremont and Great Smoky Mountain National Park effects their actions and interests when they return to their home communities.

There are also research possibilities that are not associated with Tremont. While this study provides some insights into the tensions and relationships associated with introducing citizen science into a science curriculum, it does not tell us what may or may not happen in a more formal context. It would be interesting to conduct a study examining the role of citizen science in established formal science education classrooms.

Summary of Chapter 5

Chapter 5 contained an examination of themes that emerged from the cross-case analysis, a summary of the data in regard to each of the study's research questions, and concluded with a discussion of the implications of this research for science teacher educators. This chapter ties together the key aspects of the oral histories and individual cases to provide an overall understanding of the role of citizen science at Great Smoky Mountain Institute at Tremont.

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APPENDIX A

Sample form, consent for participation

I, _____, agree to take part in a research study titled "A case study of citizen science in Great Smoky Mountain National Park", which is being conducted by Lynda L. Jenkins, Department of Science and Mathematics Education at the University of Georgia (706-264-7831) under the direction of Dr. Deborah Tippins, Department of Science and Mathematics Education at the University of Georgia (706) 542-1763. My participation is voluntary. I understand that my participation is voluntary. I can refuse to participate or stop taking part at anytime without giving any reason, and without penalty or loss of benefits to which I am otherwise entitled. I can ask to have all of the information about me returned to me, removed from the research records, or destroyed.

The reason for this study is to understand how and why citizen science is used as an educational context at Great Smoky Mountain Institute at Tremont. If I volunteer to take part in this study, I will be asked to do the following things:

- Answer questions and discuss my experiences of citizen science and "Connecting people and nature" while working at GSMIT. The interview will last approximately one hour and will be audio-taped.

- Be observed while working with students who are collecting citizen science data.

- Submit any documents that I feel are relevant to the use of citizen science and "connecting people and nature" at GSMIT

- Someone from the study may call me or email me to clarify my information.

I do not expect any individual, personal benefits from participating in this study

No risk or discomfort is expected from my participation in this study.

No individually-identifiable information about me, or provided by me during the research, will be shared with others without my written permission, except if it is necessary to protect my welfare (for example, if I were injured and need physician care) or if required by law. I will be assigned a pseudonym and will only be identified by this pseudonym on all research documentation and publications unless I give written permission for my name to be used. The audio-tape will be erased as soon as the tape has been transcribed. Only those individuals directly involved in the research project will have access to these tapes and transcripts.

The investigator will answer any further questions about the research, now or during the course of the project.

I understand that I am agreeing by my signature on this form to take part in this research project and understand that I will receive a signed copy of this consent form for my records.

_____	_____	_____
Name of Researcher	Signature	Date

Telephone: _____
Email: _____

_____	_____	_____
Name of Participant	**Signature**	**Date**

Please sign both copies, keep one and return one to the researcher.

Additional questions or problems regarding your rights as a research participant should be addressed to The Chairperson, Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address IRB@uga.edu

Appendix B

Interview protocols:

Protocol for interview one

How long have you worked here at Tremont?

Why did you decide to come to work here?

What was your experience prior to coming to work for Tremont?

What is your current role here?

Please, describe your typical day.

What does Citizen Science mean to you? How would you define it?

What does a typical citizen science lesson look like?

What projects do average students participate in as far as Citizen science goes here?

Please describe how citizen science has changed here at Tremont over time.

What are your perceptions of citizen science and students' reactions to that?

Describe feedback that you have gotten from participants regarding citizen science

Describe your experience with staff training in regard to Citizen Science?

Why do you think citizen science is included in the curriculum here at Tremont?

What happens to that data once it's collected?

What are your thoughts about data reliability and citizen science projects?

Will you describe benefits that you see to students participating in Citizen Science here at Tremont and possibly beyond Tremont?

What are some possible negatives to having students participating in citizen science?

Protocol for interview two:

What is your favorite part of working here?

Please describe what you perceive to be Tremont's educational objects and goals for the groups that come to visit?

In terms of Tremont's motto, "connecting people and nature," what does that really mean to you? Why is that important to you?

How do you think that a person's experiences here at Tremont relates to their overall lives once they get back home?

When you go out and with a group what kinds of things do you do to ensure that your lessons are working towards connecting people and nature?

What kinds of preparation do you do to try to make sure you're trying to make those connections for students?

How can you tell if a connections been made?

Why do you think a relationship with between Tremont and its visitors is important?

What do you see the role of citizen science projects in that "connecting people and nature?"

How do you think the use of citizen science could be improved, particularly in relating "connecting people and nature?"

In the context of "connecting people and nature," what is the most challenge aspect of your job in relation to doing that?

Do you ever think that citizen science gets in the way of connecting them to nature?

That is all that I have for you today. Thank you for taking time to talk to me.