A Qualitative Study of the Great Smoky Mountain Institute at Tremont's Citizen Science Youth Internship Program

By

Zena A. Tenenbaum

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Thesis Advisor: Dr. Kim Cleary Sadler

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Thesis Committee:

Dr. Kim Cleary Sadler

Dr. Cindi Smith-Walters

Dr. Amy J. Phelps

Dr. Charles R. McGhee

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ABSTRACT

The Great Smoky Mountains Institute at Tremont (GSMIT) has supported citizen science summer research internships since 2001 through the Summer Youth Science Leadership (SYSL) program in cooperation with area industries, selected universities, and the All Taxa Biodiversity Inventory. The goal of the program is to provide communities with new leaders in environmental fields and/or responsible, scientifically literate citizens. To determine the impact of SYSL program objectives, a qualitative narrative and constant comparison interview technique was selected. Results supported that most participants gained new knowledge of environmental stewardship, natural history, and science process skills. Some interns reported new interests in biology field research and teaching. Many interns also started environmental programs at their schools after the internship.

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Introduction

The subject of this qualitative study is the perceptions of youth and young adults who participated in a summer internship program at the Great Smoky Mountains Institute at Tremont (GSMIT), a private 501(c)3 Environmental Education (EE) center. The name of the program is the Summer Youth Science Leadership (SYSL) internship and the purpose of this program is to provide local youth with applied biology field experiences. Although GSMIT is a residential facility applicants were required to live within commuting distance because boarding is not provided. Located within the boundaries of the Great Smoky Mountains National Park, GSMIT's motto is to "connect people with nature" through experiences that provide a sense of place, opportunities to understand biodiversity, and stewardship ("Great Smoky Mountains Institute at Tremont: Our mission," 2013). Institute's leadership and local industry supporters, such as Alcoa, wanted to cultivate an interest in biodiversity and stewardship among people who live in the region. The Great Smoky Mountains Institute at Tremont became involved with research associated with the All Taxa Biodiversity Inventory (ATBI) project and other citizen science research projects that met GSMIT's educational mission. For these reasons the SYSL internship was established to involve local youth and to assist the GSMIT citizen science coordinator with data collection and analysis for citizen science research projects.

Citizen Science

Who can be a scientist? What do they do? How do I become one? These are questions that children or young adults may ask themselves, parents, teachers, or adult mentors. Adults and children hear about threatened species or environmental problems on the news or at school and ask, "How can I help or what can I do to learn more?" For generations curious people have engaged in science practices without formal science training, particularly as it relates to natural history. Some of our nation's most famous naturalists such as John Muir and Henry David Thoreau lacked formal science training and yet contributed to early publications about natural history and ecology (Dickinson & Bonney, 2012). Further evidence of the contribution of lay people to science is seen in star-gazing discoveries and vast natural history collections maintained by amateurs that range from insects, plants, shells, and fossils.

Scientists recruiting the assistance of lay people for sampling, collecting, observing, or preserving has historically been limited to the outreach capability of that particular researcher. The mobilization of the internet as a communication network capable of accepting data on a larger scale led to broader participation of the public in scientific research. Scientists could establish specific protocols for data collection and receive input from a range of geographic areas that would not previously have been fiscally or physically possible.

The term citizen science cannot be found in the dictionary but a current internet search will bring up many organizations that identify with this term. Credit for coining the term citizen science goes to Rick Bonney (Bonney, 1996) who used it to describe public participation in organized research efforts. The director at GSMIT who oversees the citizen science programs defined citizen scientists as "…anyone who can collect data that help scientists solve and understand problems in the world" (personal communication from Jason Love, 2008). Public participation in scientific research (PPSR) has three categories that differ in the level of participation: (1) contributory projects are designed by the researcher and data is provided by the public; (2) collaborative projects are designed by scientists but receive feedback about the design and data from participants; and, (3) co-created projects are designed by the scientist and public, with the citizens having a significant amount of input with the scientific process (Bonney et al., 2009). Interns served as citizen scientists in the contributory capacity in that research projects were designed by scientists and interns collected and mapped data which was provided to the researcher.

There are numerous citizen science biology projects around the world that are sponsored by a variety of national and international organizations. For example, the World Environment Federation and International Water Association holds a World Water Monitoring Day to encourage citizens to test water quality in nearby lakes or streams for safety in drinking, recreation, and wildlife. The GLOBE (Global Learning and Observations to Benefit the Environment) program is a federally funded program that reaches out to school children around the world to monitor local soil, water, air, cloud cover, and other microclimatic conditions through the internet. Bee Hunt is a program funded by the U.S. Department of Interior's National Biological Information and Infrastructure and the National Science Foundation to study the ecology of pollination anywhere in the world. The organizers of this program claim that data gathered by non-professional researchers follow strict research guidelines. The Duke University Department of Biology set up a Global Garlic Mustard Field Survey to sample areas for this invasive plant in parts of the world that cannot be accessed by scientists because of limited funding; data will be used to study control of the species ("Scientific American™: Citizen science," 2009).

Data gathered by citizen scientists have been published in peer-reviewed biological journals such as *Conservation Biology* and *The American Midland Naturalist*. Examples of articles include a monarch butterfly larva monitoring program in the United States and Canada in which participants studied monarch egg and larval densities (Oberhouser, K., Gebhard, Cameron, & Oberhouser, S., 2007). Citizen scientists assisted with a conservation program in Tanzania by monitoring mammals, birds, and trees in a protected area (Mulder, Caro, & Msago, 2007). A national program called Nature's Notebook developed by the USA-National Phenology Network to study environmental effects on plants and animals was used for research projects with an introductory biology class in Colorado (Posthumus & Crimmins, 2011). The Ecological Society of America devoted the August 2012 issue of *Frontiers in Ecology and the Environment* to featured citizen science programs that attempt to address the tension between scientific endeavors and educational needs (Silver, 2012).

Environmental Education

A definition of Environmental Education (EE) developed by the North American Association for Environmental Education (NAAEE), describes how biology and other fields of inquiry such as sociology and anthropology are encompassed within it:

> EE is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness amongst people, their culture and biological and physical surroundings. EE also entails practice in decision making and the self-formulation of a code of behavior about issues concerning environmental quality ("NAAEE-UK: Definition," 2013).

Environmental Education encompasses the goals of many citizen science programs because the projects connect volunteers with the environment as they facilitate research projects with scientists.

According to a March 2005 report to Congress by the National Environmental Education Advisory Council (NEEAC) on the status of EE in the United States, there is a need for environmental literacy among citizens to help solve environmental problems (NEEAC, 2005). Many problems such as air and water pollution, the depletion of natural resources, and the diminishing diversity of animals and plants are in large part due to human activity and cannot be addressed effectively by professional scientists acting in isolation. Environmental literacy involves understanding environmental problems and applying knowledge to solve them

(National Environmental Education & Training Foundation, 2005). Solutions are found through increased student involvement in environmental literacy because the human role in environmental problems can be more broadly analyzed. Scientific literacy is defined as understanding science and being able to apply knowledge to scientific problems outside the classroom (American Association for the Advancement of Science, 1993). Citizen science is one approach to increasing environmental and scientific literacy in formal (public and private schools) and informal (nature and EE centers) educational settings.

There are mixed results regarding participant benefits of advancing scientific and environmental literacy in formal verses informal educational settings. In one study, students who experienced formal science education with supplemented informal science education were shown to have a greater understanding of scientific processes than students who had not experienced supplemented informal science education (Gerber, Carello, & Marek, 2001). However, another study found that formal science education was more effective than informal science education in getting students to act in a more sustainable way (Zelezny, 1999). These findings make sense in part based on time; more time is spent in formal education settings. To address misunderstanding about informal learning environments, and provide tools for the intersection of formal and informal education, Bell, Lewenstein, Shouse, and Feder (2009), developed a framework for formal educators that described how informal environments support science learning.

Career Choice in the Sciences

There are a number of studies about experiences that influence career choice in science in youth and young adults. Kardash (2000) analyzed the undergraduate research intern experience at Carnegie University and its effect on student learned investigative skills for a future career in the sciences. The study found improvement in these skills for both males and females as a result of their undergraduate research experience. Adaya and Kaiser (2005) determined that parents, especially fathers, were more influential than teachers in a girl's decision to pursue a career in a STEM (science, technology, engineering, and mathematics) field. A large, longitudinal study of middle school students by Tai, Liu, Maltese, and Fan (2006) demonstrated how an interest in STEM at this age influences career choice given that nearly half of students reporting a career interest in STEM later earned a baccalaureate degree in this area. Middle school students who expected to have a career in science were nearly twice as likely to earn a degree in life science and 3.4 times as likely to earn a degree in another STEM area. Armstrong, Berkowitz, Dyer, and Taylor (2007) explored African-American interests in the field of ecology. They found three factors influenced career choice: family encouragement, ecology research experience, and knowledge that a career in ecology is worthwhile. These findings were of interest to this study because one of the objectives was to examine SYSL intern career choice. Since intern participants worked closely with research scientists and the GSMIT citizen science coordinator on ecology-related projects, they had an opportunity to obtain research experience from a science professional.

Qualitative and Quantitative Methods

Program evaluations at EE centers such as GSMIT benefit from qualitative and quantitative methods to fully capture multiple dimensions of programs that connect students to nature. Many EE centers focus on the results of short-term goals and/or the goals of their financial sponsors because such results are quantifiable and useful for grant funding. To keep management staff focused on the original purpose of their program, it is equally important to evaluate the achievements of long-term goals. One tool used by education program planners to identify a program's achievement of its vision and short-term goals is the logic model (Kuner, Butler, Bucy & Lowe, 2007). The model is a map of ideas that organizes short-term and long-term goals in a one-page graphic design. A logic model (see Appendix A) was developed before the study was in progress to better describe with a visual model about GSMIT's long-term goals and guide the purpose of this study. The SYSL internship connects to one long-term goal which included developing responsible citizens who have an appreciation for nature and share that knowledge with others or have leadership skills in an environmental field.

The achievement of some long-term qualitative goals is difficult to measure quantitatively because meaningful survey questions should require more information than a one or two word response. Since researchers cannot predict answers to more open-ended questions, quantitative statistical analysis is not the most appropriate tool for evaluation or for analysis, especially when the number of participants is relatively small. Efforts should be focused on investigating long-term goals qualitatively because this type of analysis provides more meaningful data with extremely high internal validity about the participants' perspective. One type of qualitative research analysis called constant comparison analysis studies human problems in society by researching the responses people give in an interview at a setting chosen by the researcher. Constant comparison analysis looks for common themes in the participants' responses. It also includes thoughts by the researcher about the societal problem because this is the lens through which the analysis is done (Creswell, 2007). This study used a qualitative design to evaluate whether the SYSL internship program met the long-term goals of GSMIT based on the perspective of the interns.

Qualitative methods differ from quantitative methods in several ways. They are descriptive research designs (not experimental) which do not include non-parametric statistics, controls, and cannot be replicated. The conclusions at the completion of the study do not necessarily answer the research questions at the beginning of the study due to the nature of unpredictable human responses. This uncertainty makes hypotheses and guiding questions difficult to formulate prior to data collection for this reason it looks different from what traditional experimentalists expect. Qualitative research design involves using guidelines that establish the integrity of the data through high degrees of internal validity and triangulation of results (Lincoln & Guba, 1985).

There are many studies in biology and medicine that have used a qualitative design when dealing with human subjects. For example, one study used qualitative methods to develop a conservation project in Kenya with the local community (Roth, 2001). In another study, qualitative methods were used to learn how to motivate students in a biology course to solve environmental problems (Darner, 2007). There are also numerous qualitative studies in health and medical journals covering topics such as contraceptives (Ay, et al., 2007), breastfeeding (Meier, Olson, Benton, Eghtedary, & Song, 2007), Body Mass Index screening (Kubik, Story, & Rieland, 2007) and brain injury (Jumisko, Lexell, & Söderberg, 2007).

Theoretical Framework for Study

Qualitative theoretical models are often developed in the social sciences to describe the culture of a group of people such as participants in a chemistry classroom (Phelps, 1994) or in this case, interns at GSMIT. These theoretical models may not be proven or disproven with controlled experiments, but they do assist researchers in analyzing data due to the high level of internal validity from participant responses (Lincoln & Guba, 1985). Because qualitative research is based on the words of the subjects themselves, this more nearly insures that the views of the participants are accurately reflected; that what they said is what they meant. Instead of testing a theory as in quantitative analysis, qualitative researchers develop theoretical models that may be tested later if appropriate.

The theoretical model that frames this study is based on the work of Lev Vygotsky, a Russian psychologist, who developed the Social Development Theoretical Model from observations made while working with children (Vygotsky, 1978). He is recognized for a learning approach known as constructivism, where the learner constructs meaning from experiences that build upon each other. There are three themes to his model. First, he believed that the child's intellectual development occurred through the child's social experiences with others before the child develops intellectually from internal experiences of his own. Secondly and thirdly, he invented two psychological terms known as the Zone of Proximal Development (ZPD) and More Knowledgeable Others (MKO). The ZPD is the area between the level of learning achieved independently by one and the level of potential learning with the assistance of MKO (anyone with a higher degree of knowledge than the learner). Vygotsky's Social Development Theoretical Model has been tested by other researchers and is applied to this study. During the interview with SYSL internship participants, they discussed their level of knowledge of science or nature and environmental stewardship before and after the internship. They also discussed their level of knowledge gained from working with more knowledgeable peers, GSMIT staff, and scientists on science projects.

GSMIT and the SYSL Internship

Great Smoky Mountains Institute at Tremont celebrated its 40th anniversary in 2009 and over 5,000 participants (children, young adults, and adults) stay annually to engage in outdoor educational program. Built in the 1960s as a Job Core facility, GSMIT evolved into the premier residential environmental education center that is today under the guidance of the Great Smoky Mountains Association and Ken Voorhis, who was hired as director in 1984 (Linzey, 2008). Part of the mission of GSMIT was to develop programs that help participants increase their knowledge of flora and fauna within the park while learning how and why to protect them. To provide public participation in science research, GSMIT offered several biological monitoring programs that incorporated citizen science for all ages. Those included aquatic and terrestrial salamander monitoring, monarch butterfly tagging and migration study, emerald ash borer trap monitoring, and phenology monitoring of seasonal changes. The resulting data was shared with collaborating scientists and GSMNP resource managers, and much of the research contributed to the All Taxa Biodiversity Inventory (ATBI). A good example of the value of these data came from the first research project at GSMIT involving the study of moths. Little was known about them in the park and it was a suitable project for students; this research led to the discovery of more than one hundred unrecorded moth species in GSMNP (Jenkins, Walker, Tenenbaum, Sadler, & Wissehr, 2013).

The Great Smoky Mountains Institute at Tremont assesses the success of all of its programs by reviewing evaluations given to program participants shortly after their visit. Changes and adjustments in programs and projects are made based upon the evaluation results. For example, the citizen science coordinator established an ozone garden to monitor the impact of ozone on vegetation in the park. Meaningful data was generated for researchers but students found gathering the information uninteresting, so the study was halted for another that would meet GSMIT educational goals (Jenkins et al., 2013). In 2008, a three-month follow-up study by Virginia Tech University was conducted to measure the effectiveness of GSMIT programs on participant environmental consciousness. The survey was conducted with children (n=300) who visited GSMIT previously with their schools. The surveys revealed that students significantly improved their sensitivity to nature, stewardship, interest in cultural history, and interest in gaining knowledge. Students who spent five days at GSMIT retained more environmental consciousness than those spending just three days (Stern, Powell, & Ardoin, 2008). One reason for improved sensitivity to nature, stewardship, and interests in cultural history and gaining knowledge may be related to a study of the GSMIT curriculum model where classroom teachers or parent chaperones lead lessons (assigned in advance of the school trip to GSMIT) show topics align well with GSMIT goals of connecting to nature, discovery, and stewardship (Walker, 2012). Teachers and parents as facilitators of learning can also take lessons back home and reinforce concepts at school.

The impact of GSMIT on students and teachers has been examined (Stern et al., 2008), alignment of the GSMIT curriculum and teaching model has been studied (Walker, 2012), GSMIT staff leaders and naturalists have also been studied for perceptions of themselves as scientists (Jenkins et al., 2013), but little was known about the impact of the SYSL internship on the lives of young adult participants. Although there was a plethora of anecdotal evidence that supported the benefits of citizen science and applied ecology experiences with young adults (Bonney et al., 2009; Brossard, Lowenstein, & Bonney, 2005; Trumbell, Bonney, Bascall, & Cabral, 2000), there was little substantive data in the literature at the time of this study about citizen science internship experiences. This study contributed to the literature related to the impact of summer citizen science experiences on the lives of young adults. Also, the GSMIT intern program was dependent upon funding from various external sources, and an analysis of the SYSL internship could provide important data to continue or expand the program. With support from GSMIT and Middle Tennessee State University, the SYSL internship was examined from the year it was first initiated in 2001 to 2009. The internship was created to assist local youth and young adults decide future careers and encourage teenagers or young adults to consider careers in science (personal communication with GSMIT director, 2009). One to three interns were hired each summer based upon their interest in learning about the Great Smoky Mountain National Park's resources by working with park and university researchers on scientific projects during the summer months. In addition to working on citizen science projects, interns assist with citizen science projects that are components of ecology camp programs, and write weekly reports about these experiences in the *Friday Science Report* for the GSMIT staff and public.

Research objectives developed to guide this study focused on the over-arching goals of GSMIT. These goals are that all who visit the institute will develop a sense of place, develop understanding about ecosystem diversity, and engage in stewardship. College major, career aspirations, and employment were also considered important outcomes related to the SYSL experience.

The following research objectives guide this study:

1. To focus on if the participants of the SYSL Intern program have an extensive understanding of the natural history of the Great Smoky Mountains National Park as a result of participating in citizen science biological research.
2. To focus on if the participants of the SYSL Intern program have an extensive understanding of science process skills as a result of participating in citizen science biological research.
3. To focus on if the participants of the SYSL Intern program have an extensive understanding of environmental stewardship and are sharing that understanding with others.
4. To focus on whether the participants of the SYSL Intern program pursue careers in EE, biology and/or science research after leaving GSMIT.

CHAPTER TWO: METHODS

Research Setting

The setting for this study is the Great Smoky Mountains Institute at Tremont (GSMIT) near Townsend, Tennessee and is located with the boundaries of the Great Smoky Mountains National Park (GSMNP). The Great Smoky Mountains Institute at Tremont is located within the Little River watershed which includes 20,000 acres and 20 miles of hiking trails. There is great variation in habitat in the Great Smoky Mountains ranging from five forest types, meadows, bogs, balds, caves, rivers, and streams; the species diversity is thought to be the highest in North America (Linzey, 2008). Built in the sixties as a Job Corps facility and used for several purposes through the years by different organizations, the institute has been under the guidance of the Great Smoky Mountain Association and direction of Ken Voorhis since 1984 (Linzey, 2008). The GSMIT campus encompasses a dormitory, science lab, activity center, dining hall, administrative offices, and gift shop. Working closely under the supervision of the Citizen Science Coordinator, Summer Youth Science Leadership (SYSL) interns are given permission by the National Park Service to access to all GSMNP lands for research projects. The responsibility of the Citizen Science Coordinator is to find research projects that met the educational objectives for GSMIT curriculum and were interesting for participants. The success of following these guidelines is seen in two of the longest-running citizen science projects initiated by the first coordinator, the moth monitoring and aquatic salamander monitoring projects (Jenkens et al., 2013). Depending upon the need and available resources for that particular summer, the SYSL interns are assigned individual research projects or assigned to oversee data collection by student campers on selected projects within the GSMNP.

Research Design

The study's research approach consisted of data collected through narrative interviews and analyzed primarily by constant comparison technique. In this type of data collection, interviewee responses were collected based on answers to open-ended interview questions; questions that encouraged the participants to expand on their answers with more than one word responses such as "yes" or "no." Constant comparison analysis takes these participant responses and categorizes them in an attempt to identify trends that address the research questions.

Often, constant comparison analysis is chosen by qualitative researchers because there is little information in the literature about a subject and the data have a high internal validity. At the initiation of this study there was no information in the literature about citizen science internships at an environmental education (EE) center; therefore, a framework and interview format were designed to inform this research. An interview script was developed (see Appendix B) and for ease of analysis after the interview, questions were grouped according to the research objectives for the study (see Table 1). For example, questions were asked in a sequential, logical order (as indicated by question number on Table 1) to put the interviewee at ease, provide demographic or background information to the researcher, and refresh interviewee memory, since it had been years since some of the participants had been involved in their internship. Some overlap of the interview questions was expected and is indicated in Table 1 where most applicable.

The objectives for this study were:

1. To focus on if participants of the SYSL Intern program had an extensive understanding of the natural history of the Great Smoky Mountains National Park as a result of participating in citizen science biological research.

2. To focus on if participants of the SYSL Intern program had an extensive understanding of science process skills as a result of participating in citizen science biological research.

3. To focus on if participants of the SYSL Intern program had an extensive understanding of environmental stewardship and may be sharing that understanding with other.

4. To focus on if participants of the SYSL Intern program pursued careers in EE, and/or biology or other science areas after leaving GSMIT.

Table 1

Interview Questions Grouped by Study Research Objective

Objective	Question Number and Interview Question
O_1: Natural History	26. What were your weekly projects and duties? Describe them.
	27. What is your opinion of the weekly projects? Explain.
	54. What would you like to add about your intern experience?
O_2: Scientific Processes	16. Describe the research projects.
	17. Did you have an individual project? Explain.
	18. Give an overview of your research projects or of those you worked.
	19. Did you meet or interact with visiting scientists? Explain.
	26. What were your weekly projects? Describe them.
	28. Briefly describe your final project.
	29. How were your projects presented?
	30. What equipment or technology did you learn to use during the internship?
	38. Did you keep a log/diary of your daily activities? Explain.
	49. Did you participate in scientific research before and after the internship? Explain why or why not.
	55. Scientific Scenario: The following is a field biology scenario that I'd like you to consider. You are visiting a new park and bring with you field guides to learn about the animals and plants along the trail. You see a butterfly and look in the field guides to identify the genus/species. You don't see a picture/description of your unknown butterfly but you find pictures/descriptions of two butterflies that each have similar characteristics of your butterfly. What is your hypothesis about your unknown butterfly? How would you design an experiment to answer your question if you had time, money and resources?
	54. What would you like to add about your intern experience?

Table 1

Interview Questions Grouped by Study Research Objective

Objective	Question Number and Interview Question
O_3: Environmental Stewardship	48. How did your internship affect your thoughts/feelings about environmental education?
	52. What steps have you taken to make the world a more environmentally friendly place?
	53. Did your internship teach you how to make the world more environmentally friendly? Explain.
	54. What would you like to add about your internship experience?
O_4: Career Path	43. Did you do multiple internships? Explain.
	44. Did you benefit from the internship? Explain why or why not.
	46. How did you use the experience of your internship in future job searches?
	48. How did your internship impact your feelings about future projects?
	49. Did you participate in scientific research before or after the internship? Explain.
	50. Describe your current interests in scientific research and/or environmental education.
	51. Where have you worked since the internship?
	54. What would you like to add about your intern experience?

Participants

The SYSL internship program has been underway at GSMIT since 2001 and according to GSMIT records, 19 interns had participated at the conclusion of data collection in 2009. Interns were paid an average of $6 an hour and agreed to work 300 hours from June to August; the hours they worked varied from week to week based on the schedule of visiting scientists and GSMIT programs. The number of interns varied each summer from one to three, depending upon funding availability. Applications were only accepted from local high school and college age students for two reasons. First, the purpose of the SYSL internship is to promote an interest in science, biodiversity of the region, and stewardship in local youth, and second, although GSMIT is a residential facility, boarding was not provided which means applicants need to live within daily commuting distance. More than two-thirds (n=13) of former interns were available and agreed to participate in this study (see Table 2). The range in age of the interns was 15 – 26 years with a mean age of 18. All study participants were Caucasian; there were 4 males and 9 females. The majority of interns worked at GSMIT for only one summer; however, three of the interns worked two summers.

Attempts were made to contact all 19 participants with 13 responding (68.4%). Interviews were conducted via phone (7 participants), e-mail (1 participant), and in-person (5 participants). Longitudinal research that strives to survey the ideas of many individuals always struggles with the issue of response rate and non-response rate. Response rate for this study was less important because its purpose was to gain insight into the experiences of the GSMIT interns through rich, descriptive data. Goyder (1987) stated that researchers conducting phone surveys, in general, have an average response rate of 65%. Babbie (2007) determined that for most surveys, a response rate of 60% is good. Dillman et.al (2009) found in their research that mixed methods of surveying (in-person, phone, paper survey) increased response rates. This study with a 68% response rate exceeded the average response rate for phone surveys and employed mixed methods in data collection to obtain the highest quality data possible.

Since the number of participants was small and a purely quantitative research design not ideal, the researcher in this study was concerned with data saturation. Creswell (2007) defines saturation as not being able to ascertain new knowledge from the data. During interviews very similar accounts and answers to questions after the 11th person interviewed were given, indicating that saturation was reached in regard to data collection. This meant appropriate numbers of interviews had been conducted, providing rich and variable data for analysis.

Table 2

Participant Demographics for Interviewees of the SYSL Internship(2001-2009), n=13

Category	Sub-category	% Interns Interviewed
Gender	Males	30.8%
	Females	69.2%
Race	Caucasian	100%
	Other	0%
Education	High School	69.2%
	Undergraduate	23.1%
	Education Unknown	7.7%
Summer Participation in SYSL Internship	One summer	77.0%
	Two summers	23.0%
Age Range	15–17	46.2%
	18–20	38.5%
	21–23	0%
	24–26	7.7%
	Age Unknown	7.7%

Ethics and Validity

Consent for this study was granted in 2008 through the Middle Tennessee State University Institutional Review Board certification approval # 08-083 (see Appendix C). Participants gave oral consent if 18 years or older. For those under the age of 18, a written consent form was completed and signed by the participant's legal guardian and an assent form was signed by the participant. Identity of the interns was to be kept confidential as a condition of their participation.

Validation in a qualitative study refers to employing methods for the interviewer to give a correct account of what the interviewees said. Validity was increased by triangulating the data with other artifacts from the intern experience and exposing any potential bias in the researcher. These tools were utilized because they were most appropriate for addressing the research objectives and analyzing unique individual responses and experiences (Creswell 2007).

Triangulation involves finding different sources to support a particular theme (Creswell 2007). It also allows verification of the data from a different perspective other than the interviews. In addition to analysis of interviews, there was documentation analysis of 17 *Friday Science Reports* (2003-2007) provided by the citizen science coordinator for this research. The reports were written by interns and presented to GSMIT staff via the GSMIT website about their activities in the field, natural history information, and scientific research being conducted in the park. The bi-weekly reports were 4 – 8 pages in length. For part of a week in summer 2008 and 2009, observations and notes were made on site regarding the SYSL responsibilities, leadership ability, and scientific explanations while they worked on identification of wildlife or scientific experiments.

Bias is defined as past experiences of the researcher that have influenced the approach to the study. In an effort to tell the story from the interns' perspective and not the researcher's, the researcher must be honest about who she is (Creswell 2007). This researcher has worked for approximately ten years in various informal EE settings. For one year, she worked at a residential group camp as an apprentice at Brandon Spring Group Camp owned by the U.S. Forest Service at Land Between the Lakes in Golden Pond, Kentucky. For 5 ½ of those years, she worked as an interpretive naturalist at the Martha Lafite Thompson Nature Sanctuary (a non-profit 501(c)3 nature center) in Liberty, Missouri. She also worked as a biology graduate teaching assistant at Middle Tennessee State University for 2 years. Her experiences in the work place facilitated conversations with interns on such topics as strategies for catching wildlife, issues in EE, and current trends in biology. The researcher reflected as accurately as possible about what the interns were saying by taping and transcribing their conversation verbatim.

Instrument and Data Collection

The interview question guide was developed from the research objectives by a panel of science/EE experts, the researcher, and from a GSMIT exit survey. The questions were generated in an attempt to address the research objectives and to appropriately orient the interviewee during the conversation about their SYSL internship experience.

The researcher made several visits to GSMIT in 2008 and 2009 to conduct in-person interviews with five participants, in addition to on-site observations about daily events. Semi-structured audio recorded interviews lasted between 25-60 minutes depending on the length of the responses. After review of responses from the first four interviews, small revisions in the interview protocol were made to clarify and expand the participants' responses. Once the revised interview protocol was implemented, from further analysis of the four early interviews, data showed sufficient information and it was decided that an additional interview with these four interns was not needed. At the completion of each interview, the participant was given a scenario to analyze his/her ability to comprehend and explain scientific processes. The participants had a choice of e-mailing their response to the scenario or answering during the interview.

Data from interviews was collected by digital recorder and transferred to the computer using *Audacity*, a computer program that helped compress the large amount of voice data. There was full transcription of the interviews which translates to several hundred hours invested in accurate transcription. The data were stored electronically by CD-ROM and USB flash drive in a location that could only be accessed by the researcher and thesis advisor. Data will be securely stored indefinitely by the thesis advisor. Intern names were removed from the data and each was assigned a random alpha code to protect identity per IRB consent stipulations.

Data Analysis

The process of coding (looking for themes) from the responses of participants was based on Arksey and Knight (2007) and Creswell (2007). The process of coding is cyclic rather than a linear process. The researcher may return to each step of the coding process during data analysis. The responses were first analyzed by constant comparison technique which involved comparing data until common themes were found in participant responses. Responses from interviews were coded based on common themes, and the frequency of responses tabulated. This initial step in data analysis is known as open coding. For example, when the interns were asked, “What is your opinion of weekly projects?” the interns’ responses included one of three open codes: (a) learning about science, (b) tedious but important work, and (c) liked learning about wildlife.

The second step after open coding is axial coding, where categories of information related to a theme emerged from the responses. In this study, the theme was related back to the research objectives. For instance, the above open code responses could fit in the following objectives: (a) learning about science, and (b) tedious but important work fits with O_2 - Scientific Processes and

(c) liked learning about wildlife situates with O_1 - Natural History. Selective coding is the last step in data analysis in which a central category was related to the previous categories. In this study, the central categories were Intrapersonal, Interpersonal, and Other experiences. The initial objectives of Natural History, Science Process Skills, Environmental Stewardship, and Career Pursuits were designated to the above central categories of intrapersonal and interpersonal experiences. New responses that were not in the original objectives were designated to the central category of other experiences. Another step in data analysis is to develop assertions from the data; this can occur at any level. Assertions are written statements that summarize what the researcher found that emerged from the data. After data organization, a model (see Appendix D) can sometimes be developed to summarize the findings. See Figure 1 to demonstrate an example of the constant comparison design process. It is important to note this process is not original to this research but the schematic was developed to clarify the analysis strategy for the reader.

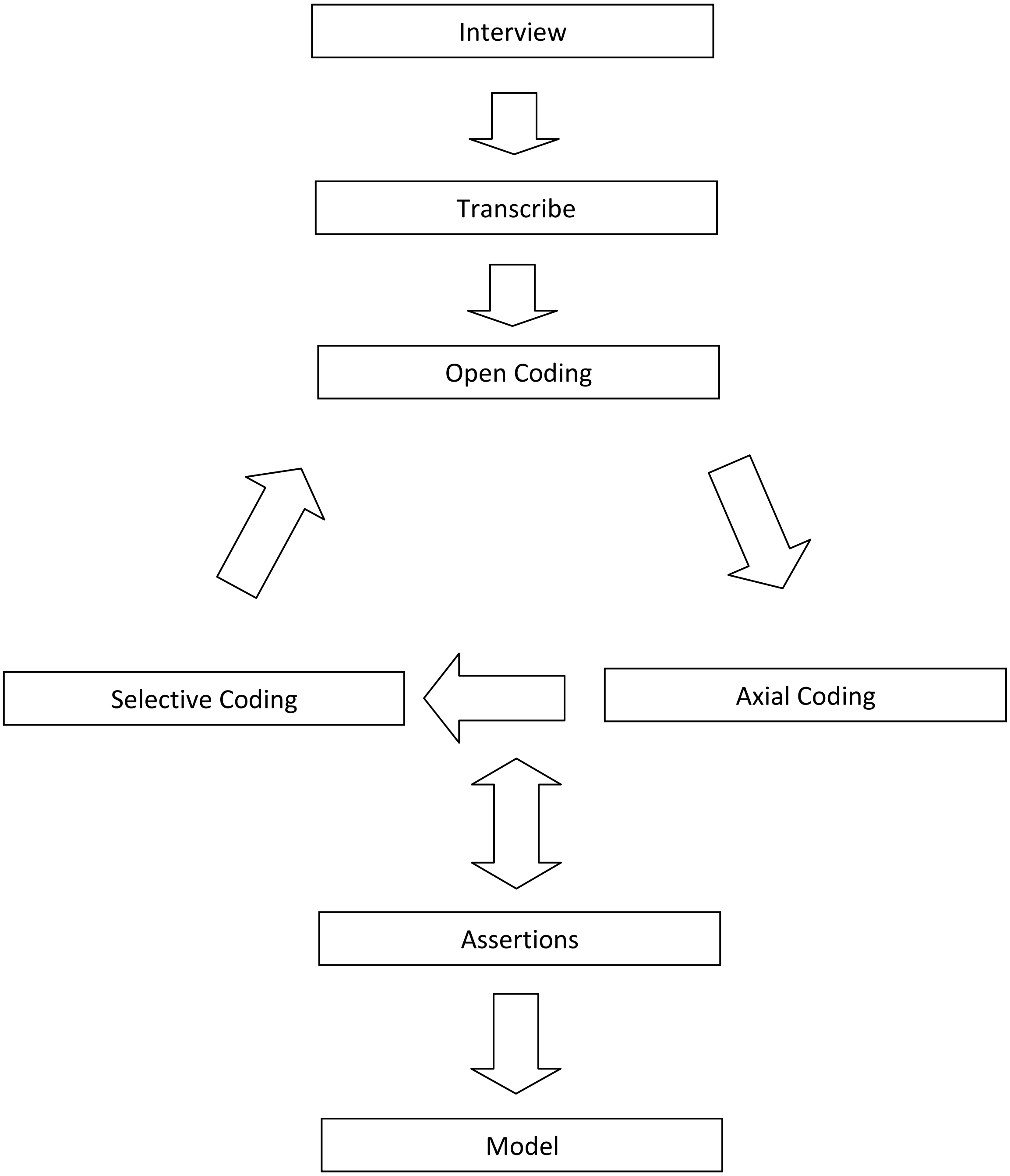

Figure 1. Schematic of Constant Comparison Design Analysis Process.

CHAPTER THREE: RESULTS

Participant Overview

Permission was obtained to interview 13 of 19 (68.4%) interns who worked at the Great Smoky Mountains Institute at Tremont (GSMIT) from 2001 until 2009. Participant demographic data is provided in Table 2, with 4 males and 9 females participating, all Caucasian, with an average age of eighteen. Participants learned about the internship in a variety of ways with over sixty percent of interns reporting that they found out about the internship by word-of-mouth through family, friends, teachers or classmates in high school or college. Nearly one-fourth (23.1%) had been at GSMIT prior to the internship, in that they reported attending a high school Field Ecology camp at GSMIT previous to the Summer Youth Science Leadership (SYSL) program. Only fifteen percent (15.4%) of interns searched and found the position advertised on the internet which shows local advertising has been effectively attracting local youth to the SYSL program.

To determine the uniqueness of the internship and understand what participants would have done with their summer if they did not get the internship, almost one-half (46.2%) of interns mentioned working at non-science or non-technical related jobs if they had not participated in the internship. Some of the jobs mentioned were typical summer employment for young adults such as construction, retail, restaurant, or working in a plant nursery. Two (15.4%) interns mentioned volunteering at different organizations as an option. Only two (15.2%) would have applied for another internship elsewhere, not within the region.

In regard to what motivated participants to apply for the position and what were the responsibilities for the summer, over one-half (53.4%) recalled being told they would be working

300 hours and earn approximately $2000. There was flexibility in the schedule based upon research scientist's visits and the GSMIT program calendar. Intern A explained their schedule:

> *We actually got to pick our hours. Most of the time, they were 8 in the morning to 4 in the afternoon. They really varied your hours depending on if something was not going on that day. They might let you have fewer hours. You might only be working four hours a day. Sometimes it was up to 12 or 13 a day when we went to Purchase Knob when we were doing the Ecology Camp …*

Interns experienced a schedule similar to a researcher that was flexible to some extent focused on completing specific tasks and not simply "punching a clock" to get work time completed.

Data Analysis Overview

Three central categories emerged after open, axial, and selective coding of interviews was analyzed. The categories were labeled: Central Category 1, Intrapersonal Intern Experiences; Central Category 2, Interpersonal Intern Experiences; and, Central Category 3, Other Intern Experiences. Intrapersonal Intern Experiences were experiences in which the interns described their thoughts and feelings about the SYSL internship that related to the study's objective components of natural history, science process skills, stewardship, and career goals. Interpersonal Intern Experiences were external contributions they perceived they made to biology research and environmental education as a result of participating in the SYSL internship. Other Intern Experiences were experiences about the internship that emerged from interviews that were not associated with the study's objectives. Assertions have been provided from data interpretation from each objective; this allowed the researcher to generate inferences from the data. Frequency tables (see Tables 3 – 22) were developed to evaluate and track intern responses categorically; these data provide the reader a snapshot of responses but do not represent a complete set of analyses. Frequency table data were sorted by topic and interns were represented by alpha code; an asterisk indicated a response. Missing asterisks indicate a response was not received or able to be documented with the collection tools used for this study.

Objective One: Natural History Perceptions

The first objective focused on SYSL interns' understanding of the natural history of the Great Smoky Mountains National Park (GSMNP) as a result of participating in citizen science biological research. The term natural history refers to " … telling the story of our living earth. It describes the systematic observation, classification, interpretation, and description of the biosphere and its inhabitants" ("Natural History Network: About," 2013). Because observation and classification are also science process skills, some natural history topics were subsumed in the category of science process skills (Objective 2). To clarify, intern responses that detailed natural history interpretation and descriptions were associated with the category of Natural History while narratives about natural history that included specific details about observation and classification were associated with the category for Science Process Skills. In an effort to further interpret intern responses to interview questions and *Friday Science Report* narratives, Tables 3, 4, and 5 were generated to include questions, themes or responses, and frequency of responses from some of the interview questions related to natural history.

When asked about duties associated with citizen science projects, interns said science research projects were weekly or bi-weekly and usually in cycles. Reported natural history topics in the *Friday Science Report* narratives for science projects included plants, insects, salamanders, snakes, birds, and tardigrades (see Table 3). Weekly projects mentioned more frequently in interviews were studying the phenology of seasonal changes, plant ozone monitoring, trapping insects, bird mist net repair, assisting with the moth collection, and natural history article development for the newsletter were (see Table 4). Interns reported enjoying the majority of research projects because they were learning something about science or wildlife while working outside. Thirty-three percent (33.3%) of interns talked about assisting with the moth collection or bird mist net repairing as being tedious but important work. They recognized the fact that these were essential components to scientific research, even though these tasks may not have been as engaging (see Table 5).

Table 3

Natural History: Frequency of Topics in the Friday Science Reports

Themes and Responses	Total Responses	Frequency of Responses
Insects or Other Invertebrates	6	46.2%
Plants	3	23.1%
Salamanders and Snakes	2	15.4%
Birds	1	7.7%
Tardigrades	1	7.7%
Total	**13**	**100.0%**

Table 4

Natural History: What Were Your Weekly Projects?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Projects with live animals and plants	*	*	*				*	*	*		*	*	*	9	52.9%
Developing natural history articles for the newsletter		*				*								2	11.8%
Assisting with moth collection		*					*							2	11.8%
Other	*							*			*		*	4	23.5%
Total	**2**	**3**	**1**	**0**	**0**	**1**	**2**	**2**	**1**	**0**	**2**	**1**	**2**	**17**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Table 5

Natural History: What Is Your Opinion Of The Weekly Projects?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Liked learning about science while working outdoors							*	*				*		3	33.3%
Tedious but important projects		*						*			*			3	33.3%
Liked learning about wildlife	*					*	*							3	33.3%
Total	**1**	**1**	**0**	**0**	**0**	**1**	**2**	**2**	**0**	**0**	**1**	**1**	**0**	**9**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Objective Two: Science Process Skills

The second objective focused on if participants of the SYSL internship had an extensive knowledge of science process skills as a result of participating in citizen science biological research. According to the American Association for the Advancement of Science (AAAS), science process skills are more than a “rigid sequence of steps” (AAAS, 1993, p.9). Basic process skills identified by AAAS that assist scientists in investigations are:

1. **Examine** the event or thing using senses and write a description;

2. **Categorize** the things examined by assembling them according to likenesses or variation in assets. Lists, tables or charts are made; and,

3. **Quantify** things to help with categorizing. Quantifying is done by contrasting an unknown quantity (such as length, area, or volume) with a known quantity and using devices such as rulers or other metrics to assist with quantifying. Charts, graphs, or tables can be generated.

Scientists also apply the skills of examination, categorization, and quantification to;

4. **Make predictions** about things based on their examinations. In addition to making predictions based on information gathered, they attempt to disseminate findings and;

5. **Commnicate** discoveries and predictions by using written or spoken words in presentations with the modes listed in the above steps (AAAS, 1993).

To further analyze interns’ responses to interview questions and *Friday Science Report* narratives about science research projects and science process skills, Tables 6 – 14 were generated to summarize questions, responses or main themes, and frequency of responses for each of the interview questions. Proceeding frequency table data are assertions that summarize qualitative data into statements.

Interns described a variety of research projects either in responses to interview questions or in *Friday Science Report* narratives. Projects they discussed were diverse and included salamander or snake monitoring, identifying or trapping and collecting insects, bird banding, plant monitoring, ozone monitoring, and stream monitoring (see Table 6). Five interns had individual research projects but those that did not have their own project assisted with research projects during the two week high school Field Ecology camps. Interns assisting high school students gained leadership experiences; Intern L provides insight as they explain the reason they did not have an individual project:

> *No, we did not do individual research projects this year because there were so many kids that there wasn't enough time if that makes sense. We were too busy helping the various groups with their projects along the way.*

Individual citizen science projects described at GSMIT represented several areas of field research and ranged from studying phenology of seasonal changes, seeking a salamander virus, testing for the presence of tardigrades on bird or dragonfly legs, and drawing scientific illustrations of wildlife at GSMIT (see Table 7). Some interns were able to maximize the SYSL research experience and apply their research toward their undergraduate program. Two interns with individual projects said their research projects were also thesis projects for an undergraduate degree program (see Table 8).

In the field, more than one-fourth of interns learned how to use GPS and data logger equipment, in addition to digital cameras, bird banding tools, and hydrology equipment. In the lab, interns gained knowledge about Apple computers and Excel software for data entry, analysis, and graphing, and also learned to use microscopes and equipment for preserving or pinning and labeling insects (see Table 10). Intern H explained how field research equipment did not necessarily need to be sophisticated or high tech but that basic skills were really what one needed for projects; *" ... For many of the projects, you just needed basic manipulative skills with measuring devices ... "*

All research interns that responded to the question about interacting with a scientist agreed they enjoyed working with visiting scientists during their intern experience (see Table 11). Interns had an opportunity to see field biologists at work and also be part of the experience as they collected data for scientists' project. Research scientists mentioned were specialists on fungi, worms, tardigrades, millipedes, fireflies, beetles, moths, butterflies, hellbenders, and bats. Approximately eighteen percent (18.2%) of interns included the staff in the same category as scientists when asked this question. Although some GSMIT staff members did not see themselves in this role, it demonstrates the respect interns have for GSMIT staff and how proficient they are in over-seeing citizen science research.

To understand more about research experiences that may have occurred before or after the internship and how that may have impacted the SYSL experience, interns were asked to elaborate on research experiences before and after their summer at GSMIT (see Table 12). Only one reported previous research experience; Intern L investigated two research topics, one in math and one in biology before the internship. Several reported continuing to participate in research through a graduate program or additional internships but none of their projects were directly related to field ecology. One of the post SYSL research experiences directly related to the mission of GSMIT in that Intern G completed a Master's Degree in Environmental Education after the internship. However, two interns participated in physics-related internships; Intern M's research area after his SYSL internship was in nuclear engineering. Intern C participated in a material science internship at Oak Ridge National Laboratory in Tennessee and a physics internship at the National Institute of Standards and Technology in Colorado after the internship.

Interns M and C redirected their interest in science to physics but they may also have benefited from authentic field ecology research.

To determine scientific thinking within the context of understanding the process of science, interns were asked to explain their thinking, beginning with formulating a hypothesis about a scenario regarding finding a butterfly species very similar in morphology to two other species, but not identical. This was the last interview question of an hour-long interview session and often, interviewee fatigue or lack of time necessitated a follow-up response. Most interns did not respond to repeatedly sent follow-up e-mail requests or phone messages; however, three interns responded to the scenario question (see Table 13). All interns responding demonstrated an extensive knowledge of science process skills by generating suitable hypotheses, evaluating evidence (making comparisons to voucher specimens and/or using molecular tools to determine phylogeny), and basing their conclusions on evidence.

Graphically representing data is an important science process skill and research interns developed tables, pie charts, and graphs to report data collected for many wildlife species in the *Friday Science Report* (see Table 14). They sometimes described in detail the procedures used to collect data including some procedures invented by research interns themselves. There were photographs taken by interns of wildlife and the data collection process. Some interns had questions of their own about data collected and wildlife they found. In summary, interns utilized science process skills described by *Benchmarks of Science Literacy* (AAAS, 1993) to assist scientists in investigations.

Table 6

Science Process Skills: What Were Your Weekly Projects?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Reptile/amphibian monitoring	*	*	*		*	*	*	*	*			*	*	10	31.3
Insect: trapping, collect, or identifying	*	*	*		*	*	*	*	*			*		9	28.1
Bird banding		*	*		*	*		*						5	15.6
Plant monitoring		*			*	*							*	4	12.5
Ozone monitoring			*										*	2	6.3
Stream monitoring			*									*		2	6.3
Totals	**2**	**4**	**5**	**0**	**4**	**4**	**2**	**3**	**2**	**0**	**0**	**3**	**4**	**32**	**100.0**

Note. Reasons for missing responses varied. See page 79 (“RESULTS: Missing Responses”) for further explanation.

Table 7

Science Process Skills: Did you have an individual project?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Presence of Tardigrades								*			*			2	40%
Salamander virus		*												1	20%
Phenology	*													1	20%
Drawing Scientific Illustrations										*				1	20%
Total	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**5**	**100%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Table 8

Science Process Skills: Give An Overview Of Your Project.

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Wrote a report	*	*						*		*	*			5	71.4%
Wrote a thesis	*	*												2	28.6%
Total	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**7**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Table 9

Science Process Skills: What Was the Presentation Method for Your Project?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Poster	*	*									*			3	75.0%
Newsletter							*							1	25.0%
Total	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**4**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Table 10

Science Process Skills: What Equipment Or Technology Did You Learn To Use During the Internship?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
GPS & Data logger	*	*					*				*			4	26.7%
Apple computers-Excel software	*	*						*						3	20.0%
Hydrology								*				*		2	13.3%
Microscopes							*				*			2	13.3%
Preserving, pinning, labeling insects							*				*			1	13.3%
Bird banding								*						1	6.7%
Digital cameras	*													1	6.7%
Total	**3**	**2**	**0**	**0**	**0**	**0**	**3**	**3**	**0**	**0**	**3**	**1**	**0**	**14**	**100.0%**

Note. Reasons for missing responses varied. See page 79 (“RESULTS: Missing Responses”) for further explanation.

Table 11

Science Process Skills: Did You Meet Or Interact With Visiting Scientists?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Visiting experts in biology fields	*	*	*	*		*	*	*			*	*		9	81.8%
GSMIT staff	*										*			2	18.2%
Total	**2**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**0**	**0**	**2**	**1**	**0**	**11**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Table 12

Science Process Skills: Did You Participate in Scientific Research Before or After the Internship?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Environ-mental education							*							1	20%
Math / Biology												*		1	20%
Nuclear engineering													*	1	20%
Material science			*											1	20%
Physics			*											1	20%
Total	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**5**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Table 13

Science Process Skills: Reponses to a Scientific Scenario.

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
DNA Analysis		*								*				2	66.7%
Genetic experiment	*													1	33.3%
Total	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**100.0%**

Note. Reasons for missing responses varied. See page 79 (“RESULTS: Missing Responses”) for further explanation.

Table 14

Science Process Skills: Project Topics in the Friday Science Report

Themes and Responses	Total Responses	Frequency of Responses
Salamander Monitoring	6	33.3%
Insect Monitoring	4	22.2%
Bird Banding	3	16.7%
Snake Monitoring	2	11.1%
Bear Monitoring	2	11.1%
Field Ecology Camp	1	5.6%
Total Responses	**18**	**100.0%**

Assertion 1. The SYSL interns have an extensive understanding of science process skills and natural history knowledge related to their citizen science experience.

Science Process Skills Topics

This section provides discussion of topics for Central Category 1, Intrapersonal Experiences using science process skills which include: examining wildlife using the senses and observation tools, categorizing and quantifying wildlife with basic and advanced technology, making predictions about wildlife, and communicating about wildlife through verbal and written media. Examples of topics for Central Category 2, Interpersonal Experiences with science process skills are the contributions interns perceived they were making to biology research and the field of environmental education (EE). Included with science process skills is natural history knowledge. Making natural history connections to something familiar or informing through a story is known as interpretation. Interpretation is a “communication process that forges emotional and intellectual connections between the interests of the audience and the inherent meanings in the resource (“National Association for Interpretation: Resource: Definition workshop,” 2013).” Effectively communicating natural history knowledge about a life science concept or an organism’s life history to a lay audience is a useful skill for a biologist. Interns had experiences with biologists, GSMIT staff, high school students in the Field Ecology camp, and the public that gave them opportunities to share natural history knowledge in an interpretive manner. Documentation for intern understanding science process skills and natural history knowledge was supported with written and published accounts in *Friday Science Report* narratives, constant comparison analysis of semi-structured interviews, and citizen science research projects presented through research posters to GMSIT staff and/or through an undergraduate thesis to the scientific community.

Examining and categorizing.

Examining and categorizing the animal or plant under study for citizen science projects was an important part of learning science skills for many interns. They also examined an event or thing using their senses; observations were recorded. Interns categorized things they examined by assembling objects or events according to likeness or variation in characteristics. Natural history topics were grouped according to biology subjects such as botany, entomology, ornithology, and zoology.

There were fewer natural history topics described about botany than other topics discussed in interviews and *Friday Science Report* narratives, due to the fact there were fewer research projects about plants. Some interns learned about characteristics and identification of plants for projects while others took an interest in plants while working outside on other research projects. Since natural history includes “interpretation and description of the biosphere and its inhabitants” (“Natural History Network: About,” 2013), evidence for Assertion 1 was found in the following articles about plants. In the July 23, 2004 issue of the *Friday Science Report*, “Another Fascinating Find: Indian Pipe: a Chlorophyll-Less Plant,” the research intern took an interest in the characteristics of Indian Pipe plant and saprophytes while working on a project with salamanders. The intern described the features of this unusual plant they examined in the field:

> *Indian Pipe, Monotropa uniflora, is a vascular plant, but it contains no chlorophyll- it is saprophytic. Saprophytic plants are plants that lack green color and depend on decaying organic matter for nutrients …*

The ozone garden was written by a research intern in the June 18, 2004 issue of *Friday Science Report*. The intern, using appropriate scientific terminology with prefaces for the uniformed reader to understand, also described characteristics of several types of plants affected by ozone depletion:

> *We have begun work on preparing the Ozone Garden for monitoring and research again this summer. We will be looking for several different signs of damage known to be caused by ozone on three species known to be sensitive. Milkweed, Coneflower, and Crown beard will be studied for signs of stippling (also called purpling), chlorosis, and necropsy …*

In the July 2, 2004 *Friday Science Report* article, “In Bloom or Not in Bloom: That is the Question,” interns continued work on a research study that began in 1999 known as the Rhododendron Bloom Density Survey. The research intern not only described the natural history and life cycle of the Rhododendron plant but made connections to the importance of this research and the usefulness of this knowledge for interpretation with visitors to GSMNP:

> *Only Rosebay is studied in Tremont, as Catawba does not normally grow below 3000 feet elevation … Rhododendrons bloom in June and July and retain their seed pods for 1 ½ to 3 years, and they set next year’s flower buds by fall. Because of this it is possible to determine in the autumn how many blooms it had the previous spring and how many it will have next spring. This makes it possible to look at the effects of weather and climatic change on blooming and answer questions asked at Park Visitor Centers.*

There were many topics mentioned in the *Friday Science Report* about entomology as a result of numerous citizen science research projects related to insects. Assertion 1 evidence was noted in the article where dragonflies were categorized according to likenesses or variations in structures. In the June 12 – July 6, 2007 issue of the *Friday Science Report*, the research intern wrote in her article titled, “Swing, Dragonfly Catcher, Swing!” about the characteristics of dragonflies and damselflies caught by net for the All

Taxa Biodiversity Inventory (ATBI). She describes morphological features of Odonates used to categorize this order of insect and the identification guide used to identify different species in the order:

> *Odonates are the order of insects including Damselflies and Dragonflies. They are known for their tiny antennae, large compound eyes, and four veined wings of similar length, and a long ten-segmented abdomen … After catching what we could, we then turned to our identification guides, Dragonflies through Binoculars and Damselflies of the Northeast, to identify each species we caught …*

More confirmation for Assertion 1 was noted in an intern's article, "Research Assistants Suck Back" in the July 5 – 14, 2006 issue of the *Friday Science Report.* This narrative about mosquitoes demonstrates extensive understanding because multiple species are discussed, developmental stages are appropriately described, and multiple collection techniques shared. They acknowledge how common mosquitoes are but point out gaps in the literature and the need for research:

> *We are all too familiar with these insects and their blood-sucking tendencies. And yet, we know very little about the mosquitoes that live here … There has been no in-depth research about the diversity and distribution of mosquitoes in the Smokies …*
>
> *Most mosquitoes lay their eggs in standing water, and the eggs hatch within three days. However, some species lay eggs in moist areas … After hatching, the free-swimming larval mosquitoes will feed on small organic debris. As they do so, they progress through four smaller stages called instars … each of which ends with the shedding of the skin …Using three different collection methods, this study aims to survey mosquitoes at each stage in their life cycle …*

Great Smoky Mountains Institute at Tremont has an on-going project of trapping, identifying, and collecting moths. There were several articles through the years in the *Friday Science Report* about moths because this was one of the first citizen science projects initiated at GSMIT. An intern demonstrated evidence of Assertion 1 when she described and used interpretation skills when discussing her favorite moth in the June 20, 2003 *Friday Science Report* in the article "Species Spotlight: Dot-lined White." She compares moth features to something familiar to most people (an owl) but continues to provide scientific information about the animal:

> *The Artac cribraia, commonly known as the Dot-lined White, is the research assistants' favorite moth. We love this moth because his fat little furry body and white color resembles a tiny owl. The Dot-lined White is a member of the family Lasiocampidae …*

There are often events held in GSMNP called Bio-Quests in which scientists and novices gather information in a short timespan about species within the GSMNP. An article in the July 23, 2004 *Friday Science Report* called "*Research* Smurfs Visit Professional 'Lep'-ers*"* described and interpreted for an outsider (including humor about "some lucky moths") what happens behind the scenes during a Lepidopteran Bio-Quest. They note our science can be a community effort and also revealed much about the roles interns had in pinning the moths for classification:

> *Scientific names and classifications flew across the room, along with a few lucky moths. 'Hey Dale, do you think this moth looks more like a Herpetogramma abdominalis or a pertexalis'*
>
> *Our role in the research was important, too. The three of us combined must have pinned somewhere around a thousand moths. Pinning is one of the most time consuming processes …*
>
> *On Wednesday, we did moths with the Field Ecology campers and sent our data over to Sugarlands to help the Lepidopterists collect even more data.*
>
> *After pinning some moths, learning some names, and otherwise generally observing an amazing scientific spectacle, we headed home, moths in our clothes, eyes, ears, and brains.*

The challenges of field biology research are evident in the article "Monarchs Hard to Find in Cades Cove Area" of the June 18, 2004 issue when an intern described how to find minute eggs and young Monarchs in the field; also included are notes about population distribution:

> *Despite searching 250 milkweed plants spread over two locations in Cades Cove this Thursday, no signs of Monarchs were found. The signs that we are looking for consists of eggs and the five instars (or stages) of monarch development. Although crescent-shaped eating patterns left by the monarch caterpillars have been seen; the actual presence of the monarchs were not confirmed.*
>
> *Last week, on Tuesday, even more plants were searched, and three eggs were found. The small monarch eggs are clear in color and have vertical lines. They are a little larger than a pin head. As you can imagine, searching hundreds of plants for a pin-head sized object is rather difficult. We are hoping for greater success later in the summer.*
>
> *One of the patterns of monarch populations in this region shows a greater number of monarchs very early and much later in the summer. As there have been very few signs found, this pattern is the same as we have experienced here.*

Bird banding for MAPS (Monitoring Avian Productivity and Survivorship) project had been on-going at GSMIT for many years. Most *Friday Science Report* articles were primarily descriptions about numbers and types of bird species caught and released. In support of Assertion 1, it was noted a research intern expanded an article to describe the complexities of sex-linked characteristics in the Black-throated Green Warbler in the July 5 – 16, 2006 issue:

> *The second banding day, June 6, was much more active. We captured 16 birds representing 5 species … One bird of particular interest was a Black-throated Green Warbler. Although it had the coloration of a male, the bird also had a brood patch, which only occurs in breeding females of this species. The reason for this bird's bright plumage is that the older females of some species will actually develop coloration similar to that of males …*

Herpetology was a popular topic among scientist researchers and there were many research projects involving amphibians and reptiles. Species identification is an important field biology skill, particularly as it relates to venomous species. Evidence for moderate natural history knowledge was observed when Intern A explained in an interview about a research project studying parasites that involved identifying and collecting feces from snakes:

> *We did the snake monitoring. We went underneath the tins to see about what different species we could find and how often we found them. If we could find the snake, we collected the snake poop because there was a project going on where we looked if there were any parasites or whatever or anything in there dealing with their digestive tract … Because of liability issues, if we found a copperhead or we found a , I can't think of the name of the other one that is poisonous around here, but if we found either one of those two then we were not allowed to touch them at all.*

Additional support for extensive knowledge about natural history about water snakes was noted in the July 2006 issue of the *Friday Science Report*, where an intern described the behavior and temperament of Northern Water snakes from first-hand experience:

> *This week's snake of the week is the Northern Water Snake … "Sam and Phil" made a really neat discovery last week when they were cleaning up behind the staff apartments … In total there were eight Northern Water Snakes under the staff apartments that were seen …*
>
> *The Northern Water Snake is one of or our most common species. They have different color variations and are covered with mud most of the time, so they are often confused with other species … During the day they will cruise the water's edge looking for small fish, frogs, young birds, and salamanders. At night they will concentrate on hunting minnows and other small fish sleeping in shallow water. When cornered these snakes will become very aggressive and are widely known for their bad temper. If handled these snakes bite, and believe me it hurts …*

Two interns mentioned individual projects working with relatively unknown animals in the phylum Tardigrada. Evidence for Assertion 1 was apparent when Intern I described the characteristics and life cycle of tardigrades and their ability to survive in a dehydrated state. The intern makes an inference about survivorship capacity and then qualifies the statement with an important note about their own uncertainty because they had not read anything factual to support the statement:

> *They're microscopic animals. They're segmented. They have eight legs. They're kind of cute… One of the neatest things about them is that they can dry up. They live on lichens and moss generally. You can find them in water or on beaches. If water is scarce or other resources, then they dehydrate themselves into these tuns…. Some people think years. Some people think months. I think it depends on the tardigrade…. I think they tried temperatures quite close to absolute zero and the poor tardigrade subjected to this ended up surviving. Somebody told me they could survive a nuclear blast. I'm not sure I've found anything that could back that up. They are very sweet little creatures. There are several species.*

Quantifying.

Interns quantified wildlife to assist with organism classification and population density research studies. Sometimes special techniques were used to try and catch animals under examination for quantification. Intern H discussed the process of gathering data by quantifying wildlife during aquatic salamander monitoring and bird banding at GSMIT:

> *We have set up salamander bags which are bags made of chicken wire not tied at one end and filled with leaf litter and kind of left in the stream. The salamanders are attracted to the wet, moist, kind of nasty environment created by the decaying leaves. We come once a month. We empty the leaves and strain them and basically extract all of the salamanders. Put them in bags and weigh them and measure them ...*
>
> *Once a week during the peak of the summer, we set up bird mist nets …We identify the birds, take various wing measurements and such, maybe [sic] collect mites off of their wings depending on what species they are. Monitoring the populations as well …*

In the article, "Amber: Hellbender Goddess" of the July 11, 2003 issue of the *Friday Science Report*, an intern described quantifying and documenting salamanders known as hellbenders. This is an example of a citizen science project that involved an intern and a graduate student researcher that required sampling salamanders in the GSMNP:

> *When she finds one, the hellbender is measured, weighed, and injected with nontoxic acrylic paint. The acrylic paint serves as a "tattoo" that will let future researchers know that the individual has been previously caught and documented.*

In the July 5 – 14, 2006 issue; an intern wrote about quantifying the canopy and why it was important for a terrestrial salamander monitoring project in the article, "Distinguishing the Trees from the Forest":

> *All of which leads to this week's endeavor- measuring canopy coverage. At each site, we extended a measuring tape along each transect, a row consisting of eight cover boards. Then we estimated where tree canopy intersected the tape … In this manner, we calculated the amount of canopy that covered each transect and the percentage of canopy resulting from each particular species of tree. Hopefully, these calculations will help provide insight in determining how salamander activity is influenced by tree canopy cover and composition.*
>
> *One species of special interest is the Eastern Hemlock, since it is currently waging- and losing- a battle with the Hemlock Wooly Adelgid. Our sites were deliberately selected based on the percentage of hemlocks in the area … If the decline in hemlocks does affect terrestrial salamander activity, then these sites will provide us with a comparison. The information gained from this project should make it an excellent addition to Tremont's long list of scientific studies.*

In the July 5 – 16, 2006 and the June 12 – July 6, 2007 issues of *Friday Science Report* an intern described the research project quantifying snakes and also explained how he invented a device to catch them; he also shared that he had extensive experience with snakes:

> *If the snake is non-venomous, we pick it up carefully without getting bit if possible and measure it first, taking a snout-vent length and a full length. We also record what time of day it was, the air temperature, and the temperature under the tin. We do this to see when the most prime time would be to see the most number and the biggest variety of snakes that are under the tins. If the snake is venomous then we just say "Oh, we saw a copperhead under tin two of the ozone garden."*

> *I had learned that before this year the research assistants didn't handle the snakes under the tin- they just recorded the data for it. I wanted that to change if possible because I have been catching snakes since I was five years old. I had figured up a cheap way to make a snake hook. Here's how: you go to Wal-Mart and buy a two-dollar garden hoe that is welded, break the welded piece off, and you have a very efficient snake hook …*

Support for Assertion 1 in the article, "Research Assistants Suck Back" in the July 5-14, 2006 issue of the life cycle was presented when the intern described improvising research techniques to collect adult mosquitoes:

> *In order to collect adult mosquitoes, we have set out four battery-powered light traps. These traps are hung between five and six feet from the ground, which made plugging them in to the batteries a challenge. Research assistants improvised several methods to solve this problem, including supporting batteries with stick pyramids and hanging them from trees. Once the batteries are within reach and plugged in, a light attracts the adult mosquitoes during the night. Beneath the light is a small fan, which sucks the mosquitoes downward into a collection jar. The next morning, we remove the collection jars and freeze the mosquitoes before sending them off for identification …*

Intern K described the methods and technology she used for catching and observing tardigrades on the legs of dragonflies:

> *I would go out and catch them (dragonflies) with an aerial net which could take a while. I could chase them for a long time and not find them because they're really fast …. Then once I finally caught one, I'd hold it between my fingers by the wing and then I would rinse its legs for 30 seconds with a squirt bottle while I was rubbing its legs with my fingers … I would just transfer it in the Petri dishes, but it would spill a lot …so I transferred it in vials …. I'd come back here and look at it under at first I used a dissecting microscope … On the last time, yesterday, I started using a compound microscope …*

Making predictions.

Most research projects involved only collecting data for other researchers, and did not include making predictions. However, one way interns demonstrated these skills was through the scenario question about how they would determine that a butterfly is a new species. They were asking questions and generating predictions based on information gathered. They were also demonstrating an extensive understanding of science process skills.

When given the scenario question, Intern A said in her e-mail response she would do a genetic experiment on the unknown butterfly. She also talks about other important concepts related to genetics such as co-dominance:

> *If a butterfly was found and it did not match to one specific species and was close to several, one question to ask would be if the butterfly found was a hybrid from the two others. A hypothesis would be that if you crossed the two butterflies that the one seemed to portray that the crossing would result in the butterfly that was found in the park.*
>
> *If money, time, and resources were no option, I would love to work on crossing the two butterflies to indeed see if the unknown butterfly would be the result or if it is a new species. That would help to determine the co-dominance of the other two butterflies' genes or if one had dominance over the other. Just because the unknown butterfly shares characteristics with two others does not necessarily mean that it is a cross of the two. The experiment would determine crossing genes to find co-dominance or a new species that looks like a cross between the two.*

Intern B compared this scenario to research currently occurring in the park. He responded at the end of the interview that he would do genetic analysis and related this to research that he conducted at GSMIT:

> *So a genetic analysis if you did have money, you could send them a clip of the butterfly leg to analyze its genetic sequence and then you could collect clips … from the two species of butterflies in the field guide that you could see and compare those. One of the projects I didn't mention, there's a researcher who's interested in a butterfly called the Diana Fritillary and their interested in the population genetics which is the same species that have different traits in different areas. We've done just that with that butterfly. If we catch it we take a little clip off its leg and send it to that researcher who does the genetic analysis to compare the genetic sequences of the butterflies in different places to see if their different because they live in different areas of the country …*

An intern wrote about Stream Salamander Monitoring and drought in the May 29 – June 8, 2007 article "Running for the Water" of the *Friday Science Report*. After discussing the process of catching and classifying aquatic salamanders, he made predictions about the occurrence of some terrestrial species:

> *Though not rare in small streams throughout the park, the Blue Ridge Two-Lined are more terrestrial during the summer months. This shift into the streambeds is largely impacted by the lack of rain that we are experiencing. What will the summer continue to hold? Lack of rain or temperatures so dry that will have all the salamanders running for water?*

Communicate.

It is important for scientists to share their findings with other scientists so they learn about others' results and gain new knowledge. Interns conveyed their findings and observations with scientists, their peers, other staff, GSMIT sponsors, and collegiate organizations. Intern A learned about and became interested in phenology for her undergraduate thesis project while working at GSMIT. She explained how she used the data for her project from past employees at GSMIT, and developed a graph to convey her findings:

> *When I first heard about it, I really didn't know anything what [sic] phenology was so even just looking it up it deals with climate patterns and when things appear … It started out as a friendly competition between some of the teacher/ naturalists. Who can figure out what were the first things blooming? What were the first birds heard of the season? … They wrote it down at first. They realized they really had something. They started looking at this data trying to compile it all together … It brought about 102 species on the data sheets together. It's from 1985-2008. For my project, "Jim" (the citizen science director) and I went through and narrowed that down to 36 species that we had the most conclusive data. Then we started looking at that based on the 365, unless it's leap year-366, date calendar if you label January 1st as O and then December 31st as either 365 or 366. We took all the dates … and graphed them to see if overall could you see patterns like global warming or global changes? … If you had a heat wave … or El Nino events, does that influence when the species would appear for that*

> *spring? ... I did find there were patterns to it. Overall, from 1985 – now, species are starting to emerge about two weeks earlier than what they used to.*

Some interns presented posters of their research projects. Intern A said the poster was about everything they had done that summer. It was set up in PowerPoint and printed from a poster printer. Intern B recalled making a poster about one of the research projects, *" ... two summers ago each of the interns would choose one of the projects at Tremont and prepare a poster about the project ... I talked about the bird banding program ... "* He continued to explain his most recent poster was about an individual project that he developed and was presented along with high school campers at the Field Ecology camp to sponsors of the intern program:

> *This summer we're hoping to have kind of a mini-symposium in July ... the high schoolers will get together and accomplish an individual group project ... They'll make a poster about their project, print it and do a little presentation on that ... then have the research assistants prepare a poster on some Tremont project ... In my case, I'd prepare a poster about how my research is going, even though I don't have all my results yet ...*

Intern M described how his poster was evaluated:

> *We just hung up our posters by the science room. The program director gave a final evaluation before we printed them off. It wasn't like he was giving us a grade. He would make sure that we would put factual information on there and that it was well-written ...*

Four interns recalled keeping a log/diary of the daily activities as requested by the citizen science coordinator. Many were provided with field biology notebooks to assist interns with data collection or descriptions of wildlife. Intern A not only kept a log/diary of her daily activities but also made a scrapbook. She explained about both in the following paragraph:

> *We wrote in a little notebook. We could go back through when we wrote up the Friday Report so we didn't forget or have to go back and think about it. It wasn't*

> *really a journal like all my feelings and everything, but I did keep a chart of what I needed to focus on ... I did make a full scrapbook of everything that we did at the internship. That helped me to be able to organize some of the stuff ...*

Intern B described how a log/diary helped record information about a species that was then entered into the ATBI database:

> *If we find a moth for example, we write down where we found it, get the GPS coordinates and the location ... If we find an interesting species or a species that is known to be in the park but in a different place but haven't been found before, we have field notebooks to write that down ... we take a certain set of data that we can enter into the database later.*

Objective Three: Environmental Stewardship/Education Perceptions

The third objective focused on if participants of the SYSL internship gained new knowledge of environmental stewardship and might share their ideas with others once they leave GSMIT. Great Smoky Mountains Institute at Tremont defines stewardship in its mission statement as "responsibility for preserving and caring for the Great Smoky Mountains and places like it, learning about its problems and working to help, lifestyle and daily habits can be adjusted to have minimal impact upon the environment, and living in an earth-friendly way can be transferred to our lives at home ("Great Smoky Mountains Institute at Tremont: Our mission," 2013)." To display most of the interns' responses to interview questions about stewardship, Tables 15 – 17 display the questions, responses or main themes, and frequency of the responses for each interview question.

All interns learned about topics in environmental stewardship during the internship or said they were made more aware of them. Nearly fifty-five percent (54.5%) responded they learned it was important to share knowledge with others. Most of the interns (Table 15) responded that they took steps to make the world a more environmentally friendly place. Table 16 shows that over thirty-eight percent (38.5%) said recycling was a major part of what they do at home or school to make the world a more environmentally friendly place . Three of the interns (Table 17) discussed the importance of sustainability. Making purchases related to environmental consumption was evident with Intern A in that she mentioned buying a hybrid car and putting solar panels in her house. Over 30 percent (30.8%) responded they were involved with environmental programs at their school or work. The National Environmental Education and Training Foundation report titled *Environmental Literacy in America* (2005), noted that sixty-percent of Americans recycle items in their day-to-day life but only about ten-percent of the public is likely to be active about issues about the environment in daily life. Even though the number of interns reporting they recycled was less than the average percent of people that recycle, more SYSL interns may recycle than mentioned in the interview because direct questions about recycling were not asked. In support of the SYSL experience, interns are more active in environmentally-related activities than the average number of Americans because of their continued involvement in environmental programs beyond GSMIT.

Table 15

Environmental Stewardship: How Did Your Internship Affect Your Thoughts/Feelings about Environmental Education?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Sharing with others		*		*	*			*	*				*	6	54.5%
Learning about topics	*					*	*			*				4	36.4%
Pessimism			*											1	9.1%
Total	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**11**	**100.0%**

Note. Reasons for missing responses varied. See page 79 (“RESULTS: Missing Responses”) for further explanation.

Table 16

Environmental Stewardship: What steps Have You Taken to Make the World a More Environmentally Friendly Place?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Recycling	*	*				*				*			*	5	38.5%
Involvement in environmental groups or programs		*					*	*				*		4	30.8%
Building improvements	*	*												2	15.4%
Transportation	*				*									2	15.4%
Total	**3**	**3**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**1**	**13**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Table 17

Environmental Stewardship: What Did Your Internship Teach You about Environmental Stewardship?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Effects of people and wildlife on environment	*			*	*	*	*	*	*					7	70.0%
Importance of sustainability	*	*										*		3	30.0%
Total	**2**	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**10**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Assertion 2. The interns have a moderate and extensive understanding of environmental stewardship.

Environmental Stewardship Topics

Examples of Central Category 1, Intrapersonal Experiences with environmental stewardship topics such as the effects of people's activities on wildlife and sustainable lifestyle choices will be discussed in the following examples. Examples of Central Category 2, Interpersonal Experiences with environmental stewardship topics in contributions to environmental education and biology are also found in some of the following examples. Many of the interns started environmental education programs at their school as a result of what they learned from their experiences as SYSL interns.

Falk & Adelman (2003) define a minimal, moderate, and extensive knowledge of environmental stewardship. A minimal knowledge of environmental stewardship refers to "general references to threats to the environment, what is being threatened, and sources of protection (Falk & Adelman, 2003 p.173)." Moderate knowledge of environmental stewardship refers to "emphasis on respect/awareness and responsibility toward the environment, supported by more detailed elaboration (Falk & Adelman, 2003 p.173)." Extensive knowledge of environmental stewardship is an "emphasis on the interconnectedness and need to maintain balance between humans and environment; supported by elaboration; sometimes focus on root causes of issues (Falk & Adelman, 2003 p.173)."

Dutcher, Finley, Luloff, and Johnson (2007) listed changing behavior because of a concern for the environment as a measure of environmental values. The interns mentioned how the internship effected changes in their behavior many times in the following examples. A discussion for support of Assertion 2 is seen in the following examples.

People and wildlife in the environment.

Intern M stated that knowledge gained from the internship helped him become more aware of the helpful and harmful effects some introduced insects have on the environment. He had moderate knowledge of environmental stewardship issues because he described awareness about problems in the environment with some elaboration (Falk & Adelman, 2003). Intern D talked about what he learned from a visiting scientist about the effect of exotic worms on the environment. He had extensive knowledge of environmental stewardship because he described problems between humans and the environment (Falk & Adelman, 2003):

> *Realizing, that even the fishing that goes on, this going back to what "John" does studying the worms and millipedes, that goes up at that lake. The fact that some people decided to dump out worms that they didn't use … thinking that it would be good for the nature site. I would have avoided it. There are actually exotic worms that are harming the area there … That's something that I know I never would have realized before. I don't think anyone would have either.*

Intern C added about what he learned about salamanders as environmental indicators for the environment. He had extensive knowledge of environmental stewardship because he described the relationship interconnectedness between humans and the environment (Falk & Adelman, 2003):

> *My internship taught me that our own actions have consequences far beyond what we can see. For example, salamanders are extremely valuable as environmental indicators, because their skin is permeable to water and toxins. Increased pollution by humans directly hurts every aspect of the environment.*

Sustainable lifestyle choices.

Intern A said the internship taught her to act in a more sustainable fashion in several ways. She demonstrated moderate knowledge of environmental stewardship because she described solving some problems in the environment with some elaboration:

> *My family had always recycled the cans ... I didn't realize that there is so much that could be recycled. You can pull the different kinds of glass bottles out. You can pull the mixed paper versus the newspaper. Not just soda cans, but all of the cans for fruits and vegetables. There are a lot of the food products that we take for granted. I eat leftovers more instead of thinking the first time is the charm and then you can just throw them away.*

Sharing with others about environmental stewardship.

The following interns demonstrated moderate knowledge of environmental stewardship. Intern L talked about how effective the GSMIT staff was in teaching about environmental stewardship to visitors: *" ... You can see the changes in the people as they come through the Tremont system to make them more interested in what's going on around them and things like that."* Intern C did not feel as positive about the availability of environmental education to the general public. He commented:

> *Environmental education is important, and Tremont does a great thing, though I'm a pessimist, and believe that ultimately, environmental education is not widespread or common enough to have a large effect on the general populace.*

Intern B said GSMIT inspired him to share knowledge about the environment with others:

> *That is something at my college right now that I'm heavily involved in environmental issues and making people aware how to better protect the environment and live sustainable. That is something that Tremont (GSMIT) nurtured in me.*

Intern D said he learned the importance of sharing knowledge about the environment with others during his internship:

> *Before [the internship] I thought it was important, but it wasn't really directly, okay this has to happen. But afterwards, I had a much different feeling about it. I want people to know more about what's going on around them. It means more to me to say that people need to learn. It's not simply just a statement. It is something I understand about now and I would love to share with others.*

Intern E learned a better way to educate the public about environmental issues without using scientific terms from GSMIT:

> *While I was at Tremont, I kind of learned about one way of doing it to make it more available and understandable to someone who's never taken science before … I am having issues with people who are science people trying to explain to non-science people but using science terms. It's very difficult to see because I know there's got to be a better way to do it.*

Intern B not only assumed a leadership position but also identified several things that he has helped accomplish at his college related to sharing knowledge about environmental stewardship:

> *My student group, I am the president of that group … we look at every aspect of campus life that we can to see if there are ways that it can be made more environmentally friendly or sustainable. We coordinate the recycling program. We're the ones who collect it and take it to the recycling center .... We work with the college administration. We've advocated when they construct new buildings, incorporating sustainable features into those. We've been pushing for something called Leed Certification .... It's a certification that says that this building has sustainable measures in place. Also part of the residential life on campus, we put out signs saying, "Turn off the light when you're not using them.*

Intern H started an outdoor activity environmental club at his high school which adopted a stream at GSMIT that used salamander monitoring. Intern L met with the principal at the school where she worked to help implement a program called "Zero Food Waste" similar to GSMIT's policy of saving leftovers and using a compost pile. Intern G worked in a job educating people about not spreading invasive species on lakes. She demonstrated extensive knowledge of environmental stewardship because she knew about the root causes of issues between humans and the environment (Falk & Adelman, 2003).

Objective Four: Career Pursuits

The fourth objective was focused on the types of careers pursued by the SYSL interns. To view intern responses provided to the interview questions below, Tables 18 – 22 display questions or categories, intern responses or main themes, and frequency of the responses for each of the interview questions. Five individuals participated at GSMIT as SYSL interns for one summer. Of those that had multiple internships, fifty percent were SYSL interns at GSMIT more than once, and fifty percent had internships in other programs besides GSMIT (see Table 18).

All interns agreed that they benefited from the internship program. Twenty-three percent (23.1%) of interns responded that they felt the internship helped them decide a major in college, and twenty-three percent (23.1%) said the internship helped them with their college research. As a result of their SYSL experience, Intern B and Intern E became biology majors.

Intern G became an environmental education major in graduate school. Intern I said her internship helped her get a Fulbright archaeological research scholarship. Fifty percent of intern responses described that the experience benefited them in job skills or as a job reference (see Table 19).

All interns were interested in doing research in the future with more than seventy-percent (71.4 %) of interns responding they were most interested in research in basic and applied scientific fields (see Table 20). However, Intern F chose a different career path from basic and applied scientific research, and was pursuing a Master's degree in Social Work. At the time of this study, more than one-fourth (27.2%) of interns had entered schools as undergraduate or graduate students and/or taken additional jobs within the school they attend. Thirty-six percent (36.4%) were between jobs, and thirty-six percent (36.4%) have professional careers or are participating in other internships (see Table 21). Contradictory to intern responses to a similar question (see Table 12), three of the interns responded they participated in scientific research before the internship. Sixty-seven percent (66.7%) participated in scientific research after the internship (see Table 22).

The majority of interns had not used their internship in future job searches because they were still in school, but many felt their internship experience would help them get jobs or fellowships. Two former interns, C and M, had also not used their internship experience in future job searches. Intern C said, *"Because my future jobs were not in the field of science or environmental education."* Two interns, G and I, used their internship experience to assist in finding jobs. Intern G stated: *"Obviously, it's on my resume. It's a big part of going in for interviews and making my portfolio because when you're in education positions you need that. The things I did at Tremont are a huge part of that."* Intern F felt it taught her the role of being a good supervisor because of the great citizen science coordinator that year. Interns G, H, I, and L stated they were more confident about future projects and doing fieldwork.

Table 18

Career Path: Did You Do Multiple Internships?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Tremont		*			*	*		*						4	50%
Other		*	*				*					*		4	50%
Total	**0**	**2**	**1**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**8**	**100.0%**

Note. Reasons for missing responses varied. See page 79 (“RESULTS: Missing Responses”) for further explanation.

Table 19

Career Path: How Did You Benefit from the Internship?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Experience			*	*	*		*	*				*	*	7	50.0%
Major in college		*				*	*							3	23.1%
Research in college	*	*							*					3	23.1%
Total	**1**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**13**	**100.0%**

Note. Reasons for missing responses varied. See page 79 (“RESULTS: Missing Responses”) for further explanation.

Table 20

Career Path: Describe Your Current Research Interests.

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Basic and applied science	*	*	*	*	*			*	*	*		*	*	10	71.4%
Environ-mental education		*					*							2	14.3%
Art										*				1	7.1%
Social work						*								1	7.1%
Total	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**0**	**1**	**1**	**14**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Table 21

Career Path: Where Have You Worked Since the Internship?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
Between jobs or non-career jobs	*			*				*		*				4	36.4%
Professional jobs/ internships		*	*			*	*							4	36.4%
Students or student job					*							*	*	3	27.2%
Total	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**1**	**11**	**100.0%**

Note. Reasons for missing responses varied. See page 79 (“RESULTS: Missing Responses”) for further explanation.

Table 22

Career Path: Have You Participated in Scientific Research Besides the Internship?

Themes and Responses	Intern Labels													Total Responses	Frequency of Responses
	A	B	C	D	E	F	G	H	I	J	K	L	M		
After the internship		*	*				*		*			*	*	6	66.7%
Before the internship	*	*										*		3	33.3%
Total	**1**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**2**	**1**	**9**	**100.0%**

Note. Reasons for missing responses varied. See page 79 ("RESULTS: Missing Responses") for further explanation.

Assertion 3. The internship had a positive impact on the SYSl interns pursuing careers in environmental education and/or biology or other science field.

Career Topics

Examples of Central Category 1, Intrapersonal Experiences with career topics, such as deciding career choice and thesis research, are discussed in the following examples. Examples of Central Category 2, Interpersonal Experiences with career topics in contributions to biology and environmental education were also found in some of the following examples.

Interns were pursuing careers in the basic and applied science fields as shown in Table 20. Of those seeking careers in the basic and applied science fields, (30%) were in the field of biology. Support for Assertion 3 was observed in the following interview examples.

Career choice.

Intern A was considering a career teaching science. She thought the internship would help her be a better graduate teaching assistant and a better science teacher:

> *I think it's going to help a lot, going into grad school, into teaching. I think it shows especially being a science teacher that the more knowledge that you can get, the more that you enjoy what you are doing. It really rubs off on your students and the people that you work with and that's going to make it easier for them to want to learn.*

Intern G entered into the field of Environmental Education as a career. She explained how her citizen science internship and subsequently her job as a teacher/naturalist at GSMIT helped her to communicate with people in her current job of protecting lakes in Wisconsin:

> *My primary job is working with citizens who live on lakes and trying to help them learn about how they can keep from spreading different invasive species from*

> *their lakes and other lakes … Tremont was a huge help in helping me learn how to communicate with people in general … I'm always looking for more ways of how to motivate volunteers and motivate citizens to get actually active on their lakes and to take pride in their lakes and do certain things …*

Not all interns were interested in a science career. Intern J voiced her concern about being a scientific researcher as it related to income, she said: *"I always definitely considered it. Right now my only problem with it is I know it's not a very high paying job … "*

Science research.

SYSL Interns A and B chose their undergraduate thesis research topics because of their internship at GSMIT. Intern B talked about how he took samples for his thesis topic about a virus affecting salamanders while assisting with the research projects during his internship:

> *Tremont's been a particularly good way to go about that project. We have a stream salamander monitoring project so I can get the aquatic variety. Now we have the terrestrial project so I can get different species. … It will give me a good opportunity to sample throughout the park.*

Intern A worked with the citizen science coordinator at GSMIT with the phenology project for her undergraduate thesis topic about phenology: *"Sam" [citizen science coordinator] and I worked closely the whole time I was doing my thesis and kept the phenology project going as far as entering the data, getting everything done, doing the data analysis to what the park's got so far."* Intern A also explained how other scientists were interested in her research.

There were new assertions that emerged from the data that did not exactly coincide with the initial four objectives. They were separated into Central Category 3. The emergent new category was related to the broad topic of science as a career choice.

Evidence of an interpersonal opinion was seen in Assertion 5 in which the interns discuss whether or not they would have preferred to teach more as SYSL interns. Evidence of intrapersonal opinion was seen in Assertion 6 and Assertion 7 about an interest in biology field research and confidence in research.

Assertion 4. Having an interest in science can, but not necessarily mean an interest in teaching science.

When interns were asked what percentage of their time was spent on research and what percentage was spent on teaching, those that responded said most of the time was spent on research. Three of the interns stated that 75% of their time was spent on research and 25% was spent on teaching. They were then asked if this was an appropriate percentage. Almost everyone felt this was an appropriate percentage because being a research intern was what they were hired to do. Intern D (physics and math major) stated that he would have preferred to do more research. Evidence of Assertion 5 can be found in a quote from Intern B (Biology major). He stated that he felt the percentage was appropriate but that he had opportunities to teach and enjoyed them:

> *Some of the other interns haven't taught as much as I have because they'll come here for a summer and it is all new to them. Most of the teaching that I do are additional opportunities that "John" and "Sally" presented me. They know that I know stuff and I can teach others. They'll offer those opportunities available to me if I am comfortable. I like that. I'm glad they do that for me.*

At the time of this study, there were no other studies about the benefits for interns teaching in an informal education setting, but there is research on students that taught at universities. Students who taught science topics in university settings gained more knowledge about those topics and more experience for their resume′s(Romm, Gordon-Messer, & Kosinski-Collins, 2010).

Assertion 5. Having an interest in science does not necessarily mean an interest in biology field research.

When interns were asked about how they would use their experience from the internship in future job searches, two interns (physics majors) that said they would not be using their internship for future job searches other than for experience on their resume. One intern suggested the possibility of combining biology field research and his science major, nuclear engineering. When asked if he was using his internship experience for a job search, he stated:

> *I haven't really. I had already decided to go into nuclear engineering. It's in the back of my mind to maybe try and combine my future career with this experience possibly research into the effect of power plants on local ecosystems which there is a lot of that research going on.*

Although this intern had decided prior to the internship to pursue another field, it is noteworthy he expressed a possible research study related to power plants and the environment.

The researcher did not find existing studies about the interest of interns in field research after working in an informal education setting, but did find a study of college freshman in an introductory biology course that showed an increase in biology interest after students read true historical short stories about biology and biologists. After students read the stories, there was an increase in interest in biology science careers (Kruse, 2010). In another study, college students were interviewed about their interest in staying in a major in science. This study found college students chose to be science majors in college due to their interest in high school science content and their high school science teacher's personality. Once they were in college, content had the greatest effect on their interest in being a science major (Fredrick, 2010).

Assertion 6. For many interns, the internship gave them more confidence in their ability to participate in scientific endeavors.

Confidence was a theme mentioned several times by the interns. Evidence for Assertion 6 was revealed when an intern was asked, "Did you participate in scientific research before and after the internship?" she responded with the following:

> *I was familiar with it. I had taken biology with my friends in school. I had never applied it before in a real scientific project. It made me feel really confident and felt like I had a bit of an edge when I went to do research of my own because I had done it before. I think confidence is something that is fundamental to research.*

There were limited studies about increased confidence from an internship experience in a formal education setting. Interns in a university lab were more confident in their ability to perform skills needed in a research lab after their internship; faculty mentors also agreed that the interns' skills had improved (Kardash 2000).

Missing Responses

As can be expected in a study involving conversations with many subjects, there were missing or incomplete answers to interview questions. Some questions were not provided to four of the initial participants due to changes made to the interview protocol after their interviews. Other reasons for missing responses included interviewer question error such as phrasing the question in a manner that garners a single word response instead of as an open-ended question, participant misunderstanding of the question, recording to verbal transcription, technical difficulties, and participant e-mail non-responsiveness. However, after analysis of an abundance of data in written and verbal narratives, responses given sufficiently address the four objectives and provide rich, descriptive data for analysis.

CHAPTER FOUR: DISCUSSION

Summary of Study

This study focused on a citizen science internship program at Great Smoky Mountains Institute at Tremont (GSMIT), a private non-profit environmental education center. This longitudinal, qualitative study followed Summer Youth Science Leadership (SYSL) interns at GSMIT from 2001 until 2009. In an attempt to answer questions related to GSMIT program vision, environmental stewardship, and science careers, data analysis of semi-structured interviews were conducted with 13 interns. Also included was analysis of documents called *Friday* S*cience* R*eports* written by interns to provide updates to GSMIT staff and interested parties about research findings and other natural history events within the Great Smoky Mountains National Park (GSMNP).

Four objectives guided the study:

$O_{1:}$ To focus on if participants of the SYSL internship had an extensive understanding of the natural history of the Great Smoky Mountains National Park as a result of participating in citizen science biological research.

$O_{2:}$ To focus on if participants of the SYSL internship had an extensive understanding of science process skills as a result of participating in citizen science biological research.

$O_{3:}$ To focus on if participants of the SYSL internship had an extensive understanding of environmental stewardship and may share that understanding with others as a result of participating in citizen science biological research.

O_4: To focus on if participants of the SYSL internship pursued careers in environmental education, biology and/or other science fields after leaving GSMIT.

The researcher used constant comparison technique to find major themes from interview responses and science reports. Interview questions were designed to solicit more than single word responses which provided the researcher with multiple data points for analysis. After linking major themes from the interview instrument to the four objectives, the researcher was able to determine if results supported the study objectives. A frequency table of responses for each of the interview question sets nested within the objectives was developed to assist with data analysis. New results also emerged from the data not based on the study objectives.

Discussion of Results

Objective one: natural history.

The results supported objective one, suggesting that all of the interns learned more about natural history from the internship. Based on responses from Table 5, one could infer that most interns gained more knowledge about natural history because of the variety of species examined while working on their weekly projects within the Great Smoky Mountains National Park. They described and shared life history information with one another and with a broader audience. More than half (52.9%) of responses were related to projects involving animals and plants in the field. More than one-third (33.3%) of responses from interns acknowledged they learned new facts about wildlife, which can be interpreted to mean they gained new knowledge about natural history.

A list of themes and responses related to research projects (see Table 6) include a variety of natural history topics. Although most of interns in their *Friday Science Report* articles did not explicitly state they increased their knowledge of natural history, one could infer they did learn about natural history topics based on the quantity and quality of information shared in articles with natural history topics. For example, in an article about a Bio-Quest, the research intern mentioned twice that they and other interns were "…*constantly learning and experiencing nature*…."

Another example of a *Friday Science Report* natural history topic was the following narrative about the life cycle of the dobsonfly found in many moth traps:

> *The Dobsonfly belongs to the Megaloptera order, which has only 2 families and 46 species in North America. Before this insect can fly, it begins as a Hellgrammite, which resides in spring seeps, streams, large rivers, swamps, and ponds…The larvae are beneficial to the environment because their activeness can improve diversity in the community…At times, the Dobson flies traumatize the research interns. Perhaps this is because there have been more than 10 of these beasts, as we like to refer to them, in the moth trap at one time…*

There were a number of studies about human connectedness to nature especially in the field of environmental psychology. Shroeder (2007) studied the human-nature relationship and how humans can feel "part of" and "apart from" nature. His findings showed how people's relationship to places gave them a sense of caring toward nature. Dutcher, et al. (2007) completed a mail survey of Pennsylvania landowners and found a positive relationship to a connection with nature with concern for the environment and positive behavior towards the environment. This study also connected Objective 1 with Objective 3 because it links having an understanding of natural history to having a stronger interest in environmental stewardship.

Objective two: science process skills.

Research findings supported the second objective that interns would have an understanding of science process skills based on the different scientific projects they participated (Table 5). Five of 13 interns reported completing an individual project which involved learning new techniques and skills. Over three-fourths (9 interns) mentioned having one-on-one training with visiting research scientists. These statements implied they experienced new knowledge and skills related to scientific processes.

Although less than one-fourth of interns responded to the scenario about scientifically determining the identity of an unknown butterfly (interview question #50), all responding interns were able to accurately describe scientific approaches to figure out species identity. Two-thirds of interns based their responses on knowledge about the topic of species identification gained during the internship. Not leaping to conclusions and systematically approaching species identification are important science process skills gained from citizen science projects (Trumbull et al., 2000). Here's what one intern said related to these skills when they shared what they learned at Tremont about finding new species:

> *First of all working at Tremont, we kind of see that situation sometimes where we have something, this happens a lot with the tiny little moths that we catch, it's similar to something but we're not real sure about it. Something I learned from Tremont, if you're not real sure about something, you want to double check as much as you can. You don't want to assume anything. If you're not sure, you don't want to just call it one species and be done with it. My hypothesis I guess would be either sometimes with butterflies it could be that it's just a variation.*
>
> *Often at Tremont, we see sometimes species can vary in how they look. It could be that it's one of those species that it's a color variation or something. We also don't want to ignore the possibility that it could actually be a new species. That's something at Tremont we get excited about sometimes. As part of the All Taxa Biodiversity Inventory, we're finding new records in the park all the time. It could be a new species. If you did have unlimited time and money, you could do a genetic analysis…*

Science process skills are not only used in scientific research, they are skills for life (Aktamis & Ergin, 2008). When the SYSL learned about how to use science process skills (examining, categorizing, quantifying, making predictions, and communicating) to study wildlife, they were also learning skills that can be used in everyday life. For example, in the previous example, the intern learned how valuable it was to examine something closely and "not assume anything." He learned to "double check" as much as he could. For example, when driving a car you should always check your side and review mirrors for oncoming cars.

Objective three: environmental stewardship.

The results supported the third objective, suggesting interns have an understanding of environmental stewardship and may share their knowledge with others. In Table 7, five interns specifically describe what the internship taught them about environmental stewardship. Three interns said they learned about the effect/impact of people and wildlife on the environment, while three learned new sustainable methods such as not wasting food by eating leftovers or composting scraps. Six interns discussed sharing that knowledge with others in their current situation. One intern described the "zero food waste" program they started at their institution based on the program at GSMIT:

> *Tremont uses a program-zero food waste. So I went to my principal at my school and said this is what they do and I think it's a good idea. So we've implemented that and the compost pile at our school at the 'Central School'.*

Another intern described learning about recycling more than just aluminum cans and the importance of eating left-overs from GSMIT:

> *My family had always recycled the cans... I didn't realize that there is so much that could be recycled. You can pull the different kinds of glass bottles out. You*

can pull the mixed paper versus the newspaper. Not just soda cans, but all of the cans for fruits and vegetables. There are a lot of the food products that we take for granted. I eat leftovers more instead of thinking the first time is the charm and then you can just throw them away.

There is much research about what influences environmental concern and environmental behavior. Allen and Ferrand (1999) found that psychological needs such as self-esteem and a sense of belonging influence pro-environmental behavior. Bamburg (2003) reported that environmental concern was an indirect measure of environmental behavior. Hallin (1995) determined that the reasons some people do not take part in pro-environmental behavior was due to lack of perceived time, money, or convenience. Dutcher et al. (2007) found an appreciation of nature (Objective 1) to be an influence for an interest in environmental stewardship.

Objective four: careers.

Data strongly supported the fourth objective, that interns would pursue careers in science. More than 70% (10) of interns were interested or participating in careers that involve basic and applied science (see Table 20). Six interns participated in scientific research after the internship. Two interns were interested or participating in a career in EE. The following intern chose EE as a result of working at GSMIT:

Working at Tremont, definitely helped me decide what I was interested in and that I wanted to go on for more schooling specifically in environmental education. It also helped me I think get into graduate school and be accepted in graduate school and then get a job afterwards. Obviously, it's not the only thing. It taught me a lot about talking with people and gathering information.

Like I said in moving to Wisconsin, I'm from Tennessee so I knew very little about a lot of the species up here. I work with aquatic and invasive species in lakes up here. While I didn't know a whole lot about them when I started my job, I thought well I didn't know a whole lot about stuff when I started at Tremont but that worked too. I can learn on the fly. It was really useful in a lot of ways. I learned a lot from it. It benefited me in a lot of different ways.

Another intern (biology major) said the following about what GSMIT helped him decide in regard to professional aspirations:

> *I know from working here that I'm really interested in field work. I know that is something I really enjoy because I have been doing it for a really long time. When I do look for a job that is something I am going to look for.*

The previous intern did not explicitly say that he was going into the field of environmental education but his other interests did include coordinating a recycling program at his school and the following statement showed an interest in protecting wild places (and the place where he lives):

> *It's also made me appreciate how fragile the ecosystems can be in the environment sometimes to see firsthand. For example, the hemlock boreal aphid, I think is a good example the insect that's killing the hemlock trees. I hear about that in college classes. But to be hiking around the park, and pretty much everywhere I go, I see this tree being infected by this insect. It's more personal that way. This park now is special to me too because I've been able to work here for so long. I go around and I see that. I realize even in a national park there are a wide variety of threats to it. It's really made me feel it's important to protect those types of things and also working on it from a scientific perspective.*

Environmental education careers occur in a variety of perspectives and fields. For example, environmental education careers in science can include ecology and biology or include social sciences. Other fields in environmental education besides being a scientist include urban planners, lawyers, and auditors. These fields also help communities with understanding environmental problems and how to change them.

New assertions that emerged from the data not based on the original objectives showed that there were subtle differences in science career interests (such as teaching and field research) and perceived confidence in the intern's ability to perform science process skills as citizen scientists. The following studies describe possible reasons for these findings. Many factors may play a role in post-secondary educational choice. Trusty, Robinson, Plata, & Ng (2000) found that socioeconomic status and reading scores were most likely to influence women's choice of post-secondary educational choices. While for men, interest in mathematics was most likely an indication. Another study (Dick & Rallis 2013) found that parents and teachers were most influential for students choosing a STEM career and not so influential for students not choosing a STEM career. Stake & Mares (2005) found that students that participated in extra science-enrichment programs during the summer off-site from their schools had more confidence in science classes seven months after completing the programs.

Study Limitations

The SYSL program is unique to GSMIT and this study's findings span nine years of the program from 2001 to 2009. The purpose of the SYSL experience is to provide local youth with the opportunity to work as citizen scientists in collaboration with research scientists, to increase interest in STEM fields. With financial support from local industries the SYSL opportunity is a mechanism for developing informed citizens that have an appreciation for and knowledge of the local environment. Although these data can be used to generalize to other settings with summer internship citizen science programs for local young adults, some of the limitations of this study include: (a) the study location was limited to GSMIT, sites that may have offered other types of internships were not included; (b) although numerous attempts were made to contact all participating interns from 2001 to 2009, several did not respond so all intern perspectives have not been included for this time period; (c) the difficulty of obtaining face-to-face interviews with participants that moved to other parts of the country or the world or had conflicting schedules with the researcher, necessitated phone interviews; (d) questions asked by the researcher did not always apply each year because of programmatic changes at GSMIT; (e) interns that participated in early years of the project were responding to events that occurred many years previously and may not have had as much recall as participants more recently involved; (f) perceptions of interns prior to the study were not known and 20% had previous experiences at GSMIT with high school ecology camps; and, (g) when it was determined intern understanding of science process skills was unclear an additional question was added and several interns did not follow-up the interview with e-mail responses to the scenario question even though they indicated they would.

Future Research

Several suggestions for further research can be made based upon this study's findings. There was a suggestion by the citizen science coordinator to compare the responses of interns in a more science-focused internship program located in another area of the GSMNP to the SYSL program. It should be noted this comparison was not done with this study because that site is a boarding facility that limits internships to college science majors. To understand more about the quality and usefulness of the SYLS data and interaction with research scientists, additional interviews with research scientists and how the SYLS program assisted them with their research questions would be helpful too. The SYLS interns not only conducted research but also interacted with visiting students and teachers which could provide additional information about intern interactions with public audiences.

Based upon intern comments, the following suggestions are listed for future consideration for the SYSL program at GSMIT:

(1) Individual scientific projects, with the help of the Citizen Science Coordinator, should be a required part of the program to help the interns contribute more to the program and to their understanding of the process on science.

(2) The intern program should consider housing for the interns to reach a wider variety of participants, not just local participants. This was a suggestion made by the interns themselves as an idea for improvement to the program. Campers come and stay for up to a week at GSMT but staff resides off site. A residential experience could increase time for more science learning and informal interactions. However, using local participants advances opportunities for them to experience science and could provide multiple entry points into the STEM pipeline.

(3) Exit interviews with each intern would provide meaningful feedback to GMSIT administration. A subset of interview questions used in this study would be useful and could serve as a basis for annual program evaluation.

This study was an important addition to the research base because it was about an intern program at an informal environmental education center. Two examples of qualitative studies found in the literature similar to this study included a study about master's degree counselors and their first year working in the field (Spriggs, 2009) and a study of volunteer beach naturalists working at a Seattle aquarium (Miller, 2010). More research is needed about intern experiences at informal environmental education programs to better understand how an intern program can help an informal environmental education organization achieve its long-term goals.

Conclusion

Great Smoky Mountain Institute at Tremont is accomplishing the goals of its mission through the SYSL program. Those goals include providing Citizen Science Experiences to local young adults so they can appreciate the diversity of species in the Great Smoky Mountains National Park (which is in their own backyards) and learn about stewardship of Park resources. This kind of place-based education is more concerned about connecting youth to their local community which is in contrast to the education system which encourages youth to leave their communities and find work elsewhere for higher wages. The positive influence of the SYLS experience has many layers as revealed by intern narratives about their perception about what they learned. This long-term study shows a glimpse of what citizen science and an internship program can do in guiding participants toward future career goals, learning meaningful things about natural history, practicing environmental stewardship, and developing life-long science process skills. Overwhelmingly, interns admitted they benefited from the experience and gained new knowledge and confidence as a result.

Programs such as GSMIT are providing local residents a sense of community and environmental behavior changes in its youth. However, one intern spoke words that were hauntingly familiar. He stated:

> *Environmental education is important, and Tremont (GSMIT) does a great thing, though I'm a pessimist, and believe that ultimately, environmental education is not widespread or common enough to have a large effect on the general populace.*

Programs such as GSMIT need more funding and support to expand outreach to other local communities. Programs such as GSMIT have accomplished a great deal, but there remains to be more work to be done to provide environmental education experiences to more communities. For example, this study provided important information about experiences and contributions made by interns at an informal environmental education center. Additional research about intern programs at other informal environmental education facilities may provide program planners more information about how to successfully start or improve an intern program at their facility.

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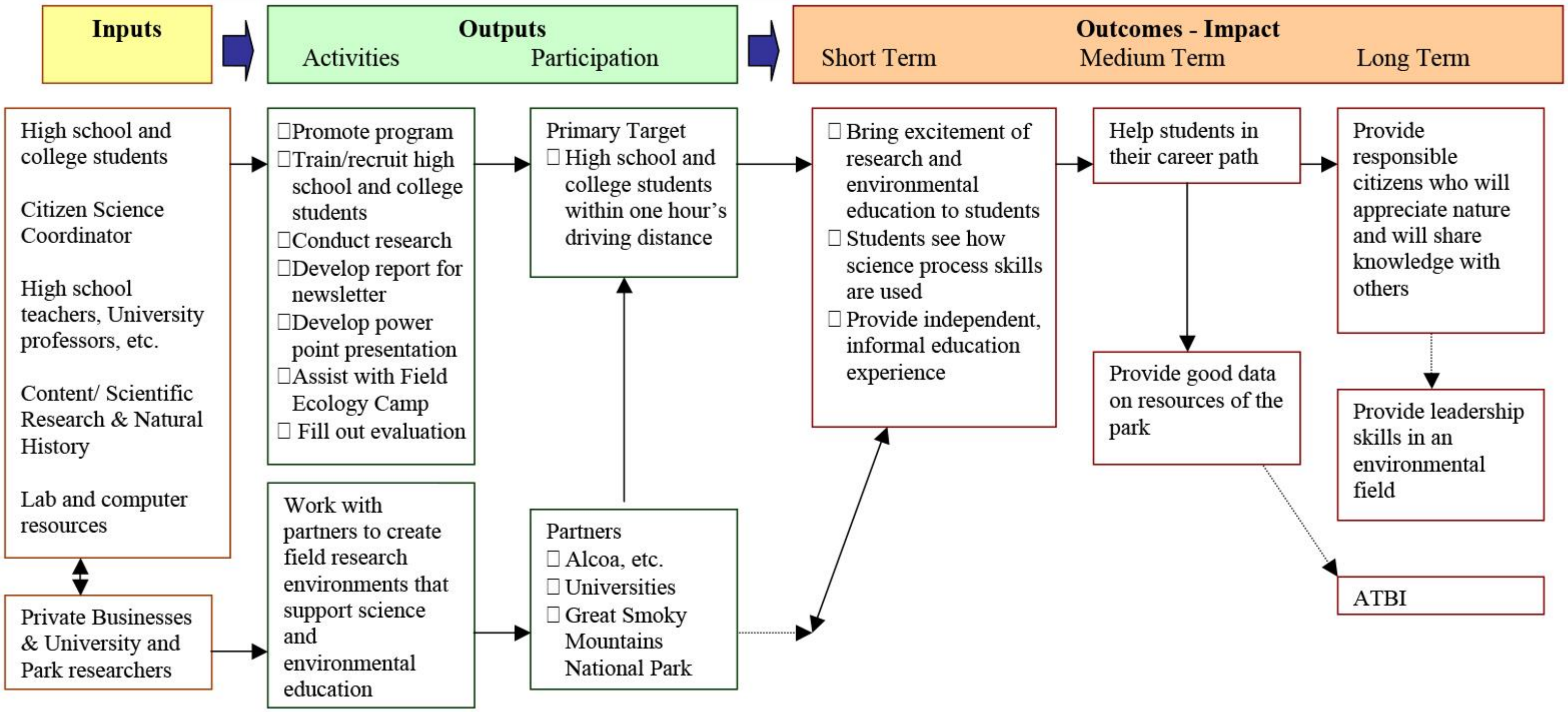
APPENDICES

Appendix A: Logic Model

SITUATION STATEMENT: The goal of the Great Smoky Mountains Institute at Tremont's Summer Youth Science Leadership Intern Program is to provide communities with new leaders in environmental fields and/or responsible citizens. The SYSL Intern Program focuses upon high school and college students with an interest in scientific research and natural history. Interns will work with the Citizen Science Coordinator on various field research projects including the All Taxa Biodiversity Inventory.



ASSUMPTIONS (What evidence supports this approach?):

1) List research that says the intern approach is effective in providing responsible citizens

EXTERNAL FACTORS (What may influence expected results?):

1) Personal interactions between students and Citizen Science Coordinator

Adapted from the UW-Extension Program Development Model

Appendix A (Continued). KEY EVALUATION QUESTIONS (What do we want to know?):

Were resources used adequately and in a timely fashion?	☐ Did students participate in all aspects of the program? ☐ Did students benefit from the summer research experience?	☐ Did students work with researchers in a meaningful way? ☐ Did they respond to evaluations with satisfactory responses?	☐ Did students leave intern program with more interest in environmental education programs and scientific research? ☐ Did students leave the program with a better understanding of the scientific method?	☐ Are students using their experiences of the internship in their future job searches and/or future jobs? ☐ Were records of taxa found during the internships used in park data?	☐Are students better prepared for future projects? ☐Has career interest in scientific research and/or environmental education increased among student participants? ☐Have university and community partners benefited from this collaboration?

INDICATORS (How will we measure it?):

Actual time/$ used vs. planned/ budgeted per activity Alcoa funding Universities Researcher's data request	☐ Attendance rosters from program ☐ Summer research evaluations	☐ # of interns ☐ Survey of responses	☐ Survey of responses from evaluation ☐ Phone calls and/or e-mail past participants	☐ Phone calls and /or e-mail past participants ☐ Check records of ATBI	☐ Phone calls and /or e-mail past participants ☐ Check records of ATBI ☐ Phone calls and/or e-mails to community partners

Appendix B: Interview Guide

Questions for Former Interns

Introduction

You have been contacted for an interview about your internship experience. Your responses will help the staff serve future interns and will help them evaluate the internship's impact on the career choices of the participants. Your responses will be kept confidential by changing your name in the documentation and by using a coding system for your responses.

Introduction questions

1. What is your name?
2. What is your ethnicity?
3. What is your level of education?
4. If in college, what is your major, or if you have already graduated from college, what was your college major?
5. What is your current profession?
6. What do you plan to be doing in five years?

Before the Internship

7. How did you hear about your internship?
8. What was your age and level of education at the time of the internship?

9. If you had not participated in your internship, what would you have done that summer? What were you told about the pay and number of hours for working in the internship?

During the Internship

10. Who was your supervisor?
11. How often did you see your supervisor?
12. What was his/her teaching style or method of giving instructions?
13. How much in advance were you told of upcoming projects and meetings?
14. Describe your integration with the rest of the staff.
15. How often did you attend staff meetings with the other staff?
16. Describe the research projects.
17. Did you have an individual research project?
18. Give an overview of your research project or of those you worked.
19. Did you meet or interact with visiting scientists?
20. With which scientists did you interact?
21. Did you observe the staff teaching visitors that attended the park?
22. Who was the staff you observed?
23. Describe their teaching style. (Example: How did they tell visitors about the plants and animals in the park? Did they describe them first or take them to see them first?)
24. Did you teach during the internship?
25. With whom did you teach?
26. What were your weekly projects/duties?

27. What is your opinion of them? (positive, somewhat positive, negative)
28. Briefly describe your final project(s).
29. How were your projects presented
30. What equipment or technology did you learn to use during your internship?
31. What did you expect to gain from your internship?
32. To what extent were your expectations met?
33. What do you consider to be the best part of your internship?
34. What part of your internship did you like the least? Explain why.
35. What percent of your time was spent on research and what percent on teaching others?
36. Do you consider the time spent appropriate? Why or why not?
37. How could your internship have been improved?
38. Did you keep a log/diary of your daily activities?
39. Briefly explain your method and the value of recording daily activities.
40. What skills did you bring to the internship that helped you feel prepared for the job?
41. What technology or equipment did you know how to use that helped you feel prepared?
42. Were there times when you did not feel prepared for your assignments? Explain.
43. Did you do multiple internships? Briefly list where they were and when.

After the Internship

44. Did you benefit from the internship? Why or why not?
45. What did you learn about yourself from the internship?

46. How did you use the experience of your internship in future job searches?
47. How did your internship impact your feelings about future projects?
48. How did your internship affect your feelings about environmental education?
49. Did you participate in scientific research after the internship? If so, explain. Had you participated in scientific research before the internship? If so, explain.
50. Describe your current interests in scientific research and environmental education.
51. Where have you worked since the internship?
52. What steps have you taken to make the world a more environmentally friendly place?
53. Did your internship teach you how to make the world more environmentally friendly? If so, how?
54. What would you like to add about your intern experience?

Scenario

55. The following is a field biology scenario that I'd like you to consider.

You are visiting a new park and bring with you field guides to learn about the animals and plants along the trail. You see a butterfly and look in the field guides to identify the genus/species. You don't see a picture/description of your unknown butterfly but you find pictures/descriptions of two butterflies that each have similar characteristics of your butterfly. What is your hypothesis about your unknown butterfly? How would you design an experiment to answer your question if you had the time, money and resources?

Appendix C: IRB Approval Letter

October 18, 2007

Zena Tenenbaum, Dr. Kim Sadler, Dr. Cindy Smith-Walters & Dr. Amy Phelps
Departments of Biology and Chemistry
zat2c@mtsu.edu, ksadler@mtsu.edu, csmithwa@mtsu.edu, ajphelps@mtsu.edu

Subject: "The Impact of Summer Field Study Research Internships on Attitudes…"
IRB # 08-083, **Exempt Research**

Dear Investigator:

Based upon my review, I have found your proposed study to be exempt from Institutional Review Board (IRB) continued review. The exemption is pursuant to 45 CFR 46.101(b)(2) which involves the use of educational tests, survey procedures, interview procedures or observation of public behavior. To keep the exemption, no identifiers can be involved and any disclosure of the human subjects' responses could not reasonably place the subjects at risk.

You will need to submit an end-of-project report to the Office of Compliance upon completion of your research. Complete research means that you have finished collecting and analyzing data. Should you not finish your research within the three (3) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Your study expires on **October 18, 2010.**

Any change to the protocol must be submitted to the IRB before implementing this change. According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. **If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance before they begin to work on the project.**

Also, all research materials must be retained by the PI or **faculty advisor (if the PI is a student)** for at least three (3) years after study completion. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Tara M. Prairie
Compliance Officer

Appendix D: Model of Results