ABSTRACT

BURNETT, EDMUND CODY. Evaluation of the Conservation Education Program in Serra Malagueta Natural Park, Cape Verde. (Under the Direction of Erin Sills.)

Two of the objectives of protected areas in Cape Verde are to help preserve the country's biodiversity and to educate visitors about environmental issues (Áreas Protegidas Cabo Verde [APCV], 2011b). This study evaluates the conservation education program in one of the protected areas: Serra Malagueta Natural Park on Santiago Island. This park protects many endemic species and provides visitors with the opportunity to learn about conservation and biodiversity. The majority of visitors to the park are students from primary and secondary schools on Santiago Island. The visiting students participate in a conservation education program. This thesis examines the environmental knowledge, attitudes, and behavior of students in Cape Verde and evaluates the impacts of visiting the park and participating in the conservation education program.

The evaluation is based on a self-administered questionnaire completed by 5th-12th grade students who visited the park between March and June of 2011. The students completed the questionnaire when they arrived at the park, before participating in the conservation education program, and then they took the same questionnaire two more times (i.e., approximately one week later and one month later at their schools). Also, the questionnaire was administered to similar classes who did not visit the park, in a similar time frame. Even before participating in the conservation education program, students have a basic understanding of the park and conservation and positive attitudes towards them. Grade

level and age were important influences on environmental knowledge, attitudes, and behaviors. Controlling for these, students who were about to visit the park had significantly greater knowledge about the environment, suggesting that one important impact pathway is more effective classroom learning about the environment, in anticipation of the visit. Another impact pathway was learning about biodiversity during the visit, as confirmed by the positive effect of visiting the park on the change in environmental knowledge between the first and second questionnaires. However, there was no evidence the park visit affected attitudes and behavior. In a sub-sample that completed the questionnaire three times, knowledge and attitudes remain stable a month after the park visit while reported behaviors become less environmentally friendly.

Evaluation of the Conservation Education Program in Serra Malagueta Natural Park, Cape Verde

by
Edmund Cody Burnett III

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APPROVED BY:

Erin Sills
Committee Chair

Nils Peterson

Chris DePerno

BIOGRAPHY

Cody Burnett attended North Carolina State University where he graduated with a Bachelor of Science in Fisheries and Wildlife Sciences and minors in Entomology and Environmental Sciences. Afterwards he continued on at NCSU and entered the Masters International Program, a combination of Peace Corps and a Master of Science in Natural Resource Management with an International Resource concentration. He was a small enterprise development: environmental education Peace Corps volunteer in Cape Verde.

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1 INTRODUCTION AND LITERATURE REVIEW

1.1 Problem Statement

Protected areas around the world invest time on conservation education and interpretation programs and host visitors with the objectives of improving knowledge and generating positive attitudes and behaviors towards the protected area and conservation. In comparison to developed countries, there is relatively little known about the effectiveness of these education programs in developing countries, especially Africa and small island developing states (SIDS). Cape Verde, an archipelago and SIDS located in the Sahel region of Africa, created a system of protected areas to help preserve and conserve terrestrial and marine areas and their biodiversity. One of the protected areas created was Serra Malagueta Natural Park (SMNP), which offers protection to part of Cape Verde's biodiversity, and offers visitors a chance to experience and learn about the unique biodiversity found in Cape Verde. Little is known about the effectiveness of SMNP's conservation education program.

Cape Verde faces numerous environmental challenges such as soil erosion, drought, desertification, overhunting, invasive species and clearing land for agriculture. These environmental issues pose threats to Cape Verde's biodiversity. As an archipelago with an arid/semi-arid climate, Cape Verde does not have high levels of species diversity (Duarte, Rego, Romeiras, and Moreira, 2008; Heckman, 1985). According to Leyens and Lobin, Cape Verde has about 240 native vascular plants (as cited in Duarte, Rego, and Moreira, 2005), and according to Brochmann et al. about one third of the approximately 240 native vascular species are endemic (as cited in Duarte et al., 2005). A large portion of the flora is

made up of close to 400 naturalized species (Duarte et al., 2005). Many of the endemic plants remaining grow in areas that are inaccessible to people such as escarpments and other extremely steep slopes. Most areas that can be farmed are cleared, but some trees or other plants are typically left standing. Approximately 70-90% of the population farms (Heckman, 1985) and traditional farming practices are still widely practiced. Much of the land is cleared for agriculture, and plants are pulled up and then used as fodder. Steep slopes are cleared for agriculture and terraces are usually not built to protect the soil. According to Smolikowski, Puig, and Roose (2001) people will farm on slopes up to 60%. Grub hoes are used to dig holes for the seeds. Corn, beans, squash, and pumpkins are the major crops that are grown. After the rainy season, grape hoes are used to weed between the crops. The heavy rains tend to wash away the soil, and according to the Arid Lands Information Centre, a heavy rain can carry away 12-15 mm of soil on steep corn farmed slopes (as cited in Sandys-Winsch & Harris, 1992; Sandys-Winsch & Harris, 1994). Smolikowski et al. (2001) concluded that 48mm of soil can be washed away on 50% slopes with intense rains (more than 40mm and more than 40 mm/h). Soil erosion is a serious problem in areas (like Serra Malagueta) that are more mountainous and have limited flat areas to farm because the steep slopes continue to be farmed (Sandys-Winsch & Harris, 1992).

Much of the original ecosystems have been changed by man. Early introduction of goats and animals damaged much of the native vegetation (Sandys-Winsch & Harris, 1992; Heckman, 1985). Santiago Island was predominantly scrub vegetation, and much of that has been cleared for farming. Also, many trees and woody plants were cut down for firewood. Many families still cook over fire. Gas for cooking has become more common but is

expensive, resulting in families continuing to cook over fire. Thirty years ago families required 22 kg of wood a day for cooking (Heckman, 1985). Also, crop residues and other vegetation are removed from steep slopes and used as fuel which contributes to soil erosion (Lopes & Meyer, 1993). Certain areas have been forested with non-native trees: *Azadirachta indica*, *Khaya senegalensis*, *Ceratonia siliqua*, *Parkinsonia aculeate*, *Grevillea robusta*, *Prosopis juliflora*, *Eucalyptus spp*., *Cupressus spp*., *Acacia spp*., and *Pinus spp*. (Haagsma and Reij, 1993; Sandys-Winsch & Harris, 1992). The only endemic tree of Cape Verde, marmulano (*Sideroxylon marmulano*) is very rare and is now primarily located on steep slopes and rock cliffs (Gomes et al., 2003). Different agencies have tried to use the marmulano for reforestation work, but getting the seeds to germinate has typically not been successful. Non-native and invasive species pose threats to Cape Verde's biodiversity. Invasive species like lantuna (*Lantana camara*) and carapati (*Furcraea foetida*), have taken over certain areas. Overhunting has negatively impacted species of birds and sea turtles (Sandys-Winsch & Harris, 1994). According to Duarte and Moreira, human influences have left Santiago Island with almost no natural ecosystems (as cited in Duarte et al., 2005), and native and endemic species are constrained to limited ecological niches (Duarte et al., 2005).

1.2 Purpose of Study

Serra Malagueta Natural Park was created in 2003 and became a functioning park in 2005 (Park staff, personal communication, February 11, 2013). The park aims to preserve biodiversity, promote the sustainable development of communities living in and around the park, and educate the people of Cape Verde about biodiversity and nature conservation. To

raise awareness about biodiversity and conservation, the park offers various activities during the year, including training workshops and informational meetings. These include workshops on how to make handicrafts, information sessions on UN holidays, and meetings with community groups. However, most of the park visitors are student groups from primary and secondary schools throughout Santiago Island. Also, the park receives national and foreign tourists and university students.

From 2008-2010 the numbers of students that visit the park has risen each year (the number of visitors recorded in 2011 is incomplete). In 2008, 1980 students visited the park, which increased to 2053 students in 2009 and 2203 students in 2010 (Park Statistics). As more teachers and schools take advantage of the educational opportunity provided by SMNP, it is important for the park to know how its conservation education program impacts students. Evaluation is an important aspect of any environmental or conservation education program (Bennett, 1989; Jacobson, 1987b; Thomas, 1990), letting program facilitators know what they are doing well and what can be improved.

My objective is to evaluate the conservation education program at SMNP by assessing its impacts on student visitors' knowledge, attitudes, and behaviors relevant to the environment. Data were collected via a self-administered questionnaire, completed by students before and after their visit to the park, and by students in similar classrooms that did not visit the park. This evaluation will help park staff understand students' knowledge of environmental concepts, their attitudes about conservation and the park, and a few of their environmental behaviors, including how they vary across students and how they are affected by the park visit.

1.3 Research Questions

This study was designed to answer the following three research questions, applying different statistical methods to different subsets of the data.

Question 1: Among primary and secondary school students in sub-Saharan Africa and small island developing states (SIDS), how much is known about conservation and biodiversity, what are their attitudes or beliefs regarding the environment, and do they engage in environmentally friendly behaviors? Specifically, how do knowledge, attitudes, and behavior about natural parks, biodiversity, and conservation in Cape Verde vary across students? Based on a content analysis of tropical conservation education programs most programs are not achieving their objectives, and over half of the programs in Africa did not achieve their objectives (Norris & Jacobson, 1998). Therefore, it important to learn more about environmental knowledge, attitudes, and behaviors in Africa, so programs can be informed on how best to teach visitors/students. Also, the ecotourism department staff at the park can benefit from a better understanding of the general level of knowledge about and attitudes towards the park and biodiversity among the student population that supplies most of their visitors. For example, this could help the park staff adjust the focus of the conservation education program so students learn the most during their limited time at the park. To address this question, I tested bivariate relationships between characteristics of students and their schools and their knowledge, attitudes, and behavior towards the environment, using responses to the first questionnaires completed by both students who visited the park (treatment) and students who did not visit the park (control). The characteristics that I considered included gender, age, grade, urban versus

rural, if the student had previously visited the park, if the student had a family member who had previously visited the park, and wealth. Car ownership is a significant indicator of wealth in Cape Verde and served as my proxy for wealth of the student's family. School variables such as private versus public and the school's distance from the park were examined to assess their relationship with environmental knowledge, attitudes, and behaviors.

Question 2: How effective are conservation education programs for student visitors to protected areas? Specifically, how does the conservation education program of Serra Malagueta Natural Park influence the knowledge, attitudes, and behavior of participants? One of the goals of many national parks/protected areas is to educate visitors and influence their environmental attitudes and behaviors. While there have been numerous studies of the effectiveness of these programs in developed countries (Beaumont, 2001; Bogner, 1998; Madin & Fenton, 2004; Olson, Bowman, & Roth, 1984; Powell & Ham, 2008; Tubb, 2003), there is less known about their effectiveness in tropical countries (listed studies from developed countries includes Australia) (Norris & Jacobson, 1998). Information on whether and how students are affected by their visit to the park can help the park staff decide whether they are getting a good return on time invested in the conservation education program and whether and how the program could be re-designed to increase its impact (e.g., by identifying topics that need more emphasis in the program). Therefore, I compared the change in knowledge, attitudes, and reported behaviors between pre- and post-tests across the treatment and control groups. By comparing visitors with non-visitors, I could rule out other possible reasons for changes, such as press coverage or just the fact that respondents have

previously seen the questionnaire. Also, I include the characteristics used to answer the first research question in order to control those sources of variation and to determine if the conservation education program has different impacts on different groups of students.

Question 3: Do environmental education programs at parks have long term impacts? Specifically, do student visitors to Serra Malagueta Natural Park retain information they learn through the conservation education program? While students' knowledge, attitudes, and reported behavior may be influenced soon after their visit to the park, it is more important to know whether these impacts are lasting. I examined whether students retain information learned during the park visit and whether that information still influences their attitudes and behavior one month after they visit the park. In this case, I focus on data from park visitors only (the treatment group), comparing their responses to the pre-test and the two post-tests approximately one week and one month after their visit. Influential characteristics identified in answering the first question are again included in the analysis. Further, I consider whether characteristics of the park visit affect students' knowledge, attitudes, and behavior in the short or medium run including size of the school group, staff person who served as their guide, and characteristics of the teacher who brought them to the park (i.e., did the teacher discuss the park before the visit, had the teacher previously visited the park, gender, and education level).

1.4 Background Information

I was a community and small enterprise development: environmental education volunteer in the Peace Corps in Cape Verde (2009-2011). My first two months in Cape

Verde were spent with a host family learning the language, Kriolu (a Portuguese creole) and experiencing the rural Cape Verdean culture. I participated in language and culture class with two other Peace Corps trainees and a host country national teacher. I was involved in technical training in community and small enterprise development. After training, I began working at Serra Malagueta Natural Park as an environmental education volunteer in the Ecology Department. Even though most of my work was in the Ecology Department, I became familiar with the conservation education program by assisting with the school groups that visited the park. The proposal for this thesis evolved from that experience, and my interpretation of the statistical results is informed by my first-hand knowledge of rural Cape Verde and of the conservation education program at Serra Malagueta Natural Park.

1.5 Study Area

The school children who participate in the conservation education program considered in this thesis live on Santiago Island, one of nine inhabited islands of the West African country of Cape Verde. Cape Verde is an archipelago of 10 islands and 8 islets located approximately 600 km west of Senegal and Mauritania (Duarte et al., 2005; Heckman, 1985; Sandys-Winsch & Harris, 1992), with a total land area of 4030 km^2 (Heckman, 1985). None of Cape Verde's islands were inhabited until the Portuguese settled there in the 15th century (Heckman, 1985). In 2010, the population was 491,638 (Instituto Nacional de Estatística Cabo Verde [INE], 2010).

Cape Verde is located in the Sahel region of Africa; therefore, much of the country is semi-arid (Heckman, 1985). The capital, Praia, has a mean annual temperature of 25 degrees

Celsius; while the mean annual temperature on Santiago Island, as measured at Serra Malagueta Natural Park, is 20 degrees Celsius. The country receives approximately 100-900 mm of rainfall per year, depending on altitude (Sandys-Winsch & Harris, 1992; Sandys-Winsch & Harris, 1994). The annual rainfall on Santiago Island is about 254-305 mm with more rainfall typical in the mountains, approximately 508mm (Heckman, 1985). According to Duarte et al. (2005) the arid lowlands of Santiago Island receive about 100 mm of rain and the highlands about 1200mm. The dry season in Cape Verde is from November to June and the rainy season is July-October (Heckman, 1985), but most rain is concentrated in August and September. The rain may only come in several large rain events (Heckman, 1985). Total rainfall typically does not pass 10 mm total from December-July (Mannaerts & Gabriels, 2000). Freshwater supplies are a major issue in Cape Verde because of this short rainy season. Additionally, there are no lakes or rivers and only intermittent streams on the islands, which are of volcanic origin (Heckman, 1985).

According to CNUCED, because of difficult farming and climatic conditions, only approximately 10-15% of the food consumed in Cape Verde is produced in the country (as cited in Atchoaréna, Da Graça, & Marquez, 2008). Nine percent of the land is cultivated with rain fed agriculture (Haagsma and Reij, 1993). Only 11.41% of the land is considered arable (CIA The World Factbook, 2013). Cape Verde is dependent on aid and remittances from citizens living abroad, and in 2005 the unemployment rate was 24.4% (Atchoaréna et al., 2008).

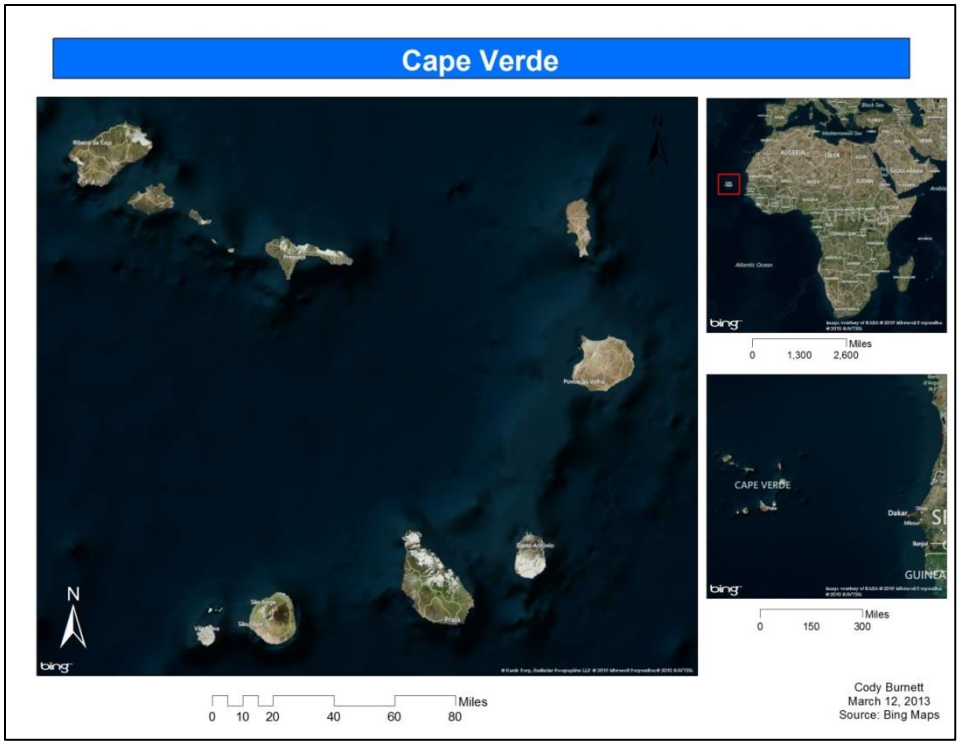

Figure 1.1. Map of Cape Verde Islands

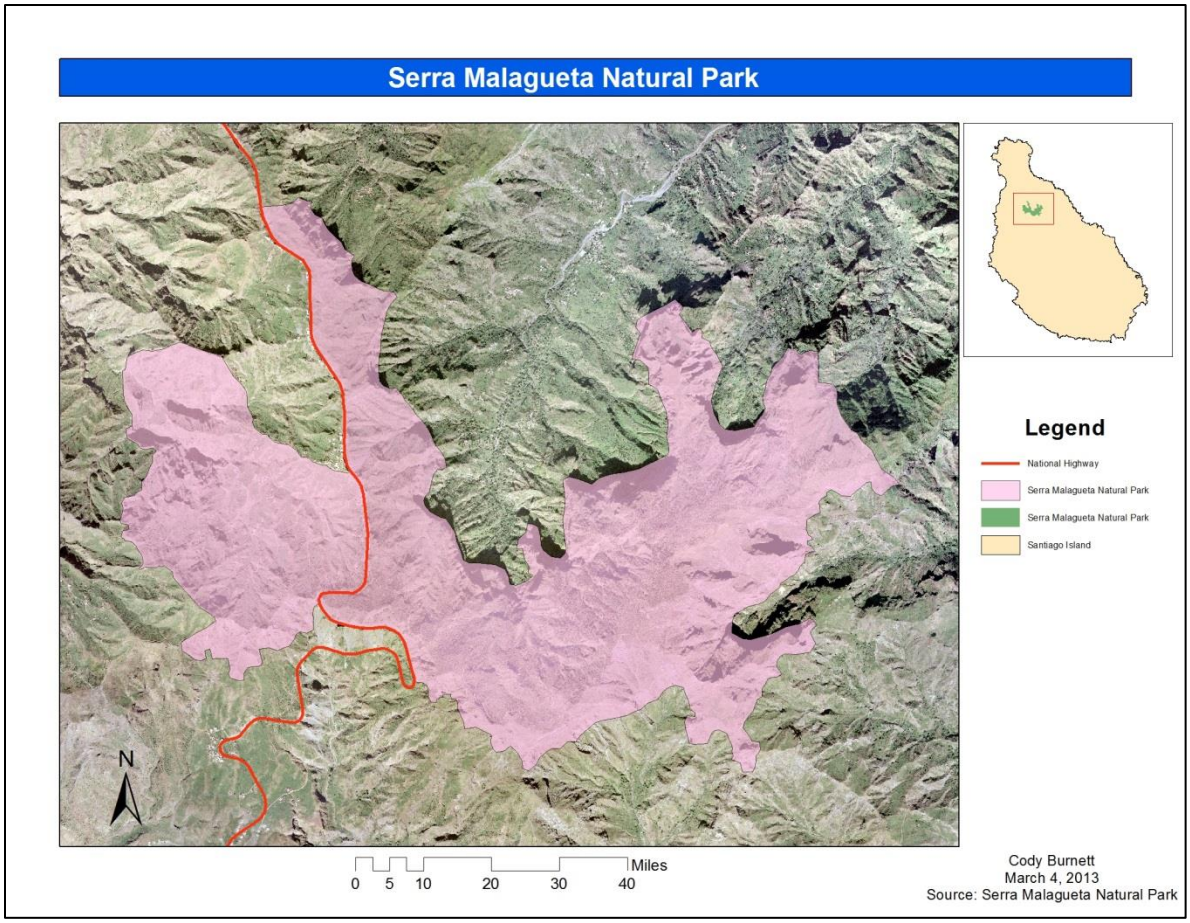

Figure 1.2. Map of Serra Malagueta Natural Park on Santiago Island

1.6 Park System

In 2003, Cape Verde created a system of protected areas (Áreas Protegidas Cabo Verde [APCV], 2011a), and now has 47 protected areas (Park staff, personal communication, February 11, 2013). The protected areas are divided into six categories: nature reserves, national parks, natural parks, natural monuments, protected landscapes, and sites of scientific interest (Áreas Protegidas Cabo Verde [APCV], 2011a). Natural parks like Serra Malagueta are supposed to be "little-disturbed natural spaces that carry principally natural systems with

their ecosystems, habitats, species and representative samples of the country's biodiversity. In these parks resident local population can live and take advantage of the natural resources following traditional practices" (Endemic Book, p.8).

Serra Malagueta has a high level of endemism, reflecting the high levels of diversity on Santiago Island. There are 123 plant species in Serra Malagueta, and 28 of those species are endemic to Cape Verde. The 123 plant species represent 42% of the plant species of Santiago Island and 16% of the plant species of Cape Verde. According to the Banco de dados de biodiversidade de Cabo Verde, Serra Malagueta has 28 of the 39 endemic angiosperms present on Santiago Island and 28 of the 66 endemic angiosperms in Cape Verde (as cited in Áreas Protegidas-Plano de Gestão, n.d.). According to Leyens and Lobin, eighteen plant species in SMNP are on the first red list of Cape Verde (as cited in Áreas Protegidas-Plano de Gestão, n.d.). One of the endemic plants, carqueja-de-Santiago (*Limonium lobinii*) is located only in Serra Malagueta. The Banco de dados de biodiversidade de Cabo Verde states that there are 20 bird species with 8 endemic species/subspecies in the park (as cited in Áreas Protegidas-Plano de Gestão, n.d.).

The park administration is divided into three departments: Ecology, Ecotourism, and Community Development. The Ecology Department monitors endemic animal and plant species and invasive species and collaborates with a group of local community members that are employed in the park. The community members collect seeds and cuttings of endemic plants in the park, grow the plants in the park/community nursery, and plant them in priority zones of the park. The park/community nursery is primarily used to grow endemic plants for reforestation in the park and fruit trees for the communities within the park. During parts of

the year, they help remove invasive species and maintain the trails and campsite. Also, some community members are employed as forest guards.

The Community Development Department works with the communities within the park and the buffer zone and help with micro-credit loans and assists in setting up trainings and workshops for the community and work with the communities to educate them on what is going on in the park and work with community organizations to help meet their needs. Some of the park staff will visit the different primary school in the park and the schools in the buffer zone to conduct outreach with the students regarding environmental issues, the park, and biodiversity.

The Ecotourism department is responsible for visitors including both students and tourists. They provide information, sell souvenirs (locally made handicrafts), and guide both tourist and school groups. When school groups visit, one of the guides meets the students at the park headquarters to talk with them about park history, conservation, and biodiversity. Afterwards, they invite the students to explore the exhibition room, which has pictures of plants and animals that can be found in the park, and local handicrafts, made from recycled paper, carapti fibers, or other traditional materials. The guide then takes the students and the teachers to the community plant nursery (same nursery as mentioned above). The students are able to observe and learn about some of the endemic plants. After the nursery, the majority of school groups follow their guide up the Oriental trail. This trail goes through the forested section of the park to a campsite, which takes about one hour to reach by hiking. The distance hiked varies by school group based on how much time they have, with only a few hiking all of the way to the campsite. During the hike the guide talks with the students

and points out different features of the park. One of the first features that guides often show are the fog nets. These are nets that capture moisture from the fog that travels up the mountains and then carry the water to tanks for use in the communities and/or the school garden. Most of the groups hike at least to the fog nets. Other features and sites include the Principal Valley (which is a very productive agricultural valley), the Assomada plateau, the picnic area, areas reforested with endemic plants, and the campsite facilities. According to Bettinger, Kuhar, Lehnhardt, Cox, and Cress (2010) "An effective education program should strive to increase knowledge about the topic, promote a positive attitude toward animals and conserving their habitat and, finally, teach and inspire people to practice behaviors that support conservation of wildlife and habitat" (p. 446).

Serra Malagueta Natural Park is located in the northern interior part Santiago Island, which is the largest island of the archipelago and also supports the largest population. Santiago Island covers around 991km^2 (Duarte et al 2005). Approximately 273,919 people live on Santiago Island and 131,602 of those live in the conselho of Praia (county containing the capital) (INE, 2010). The 774 HA park is 51 km north of Praia (Google Maps, 2013a). The park is mountainous, and its tallest peak is 1064m. Assomada and Tarrafal are the closest cities to the park, and the national highway cuts through the middle of the park connecting those two cities. Serra Malagueta is 14 km north of Assomada and 15 km south of Tarrafal (Google Maps, 2013b; Google Maps, 2013c). Additionally, there are approximately 265 people living in four traditional communities located inside the park (Park staff, personal communication, February 11, 2013).

A portion of the park is forested. However, the forest is composed mostly of non-native species: *Eucalyptus spp.*, *Pinus spp.*, *Grevillea robusta* and *Cupressus sempervirens*. The primary two invasive species are lantuna (*Lantana* camara) and carapati (*Furcraea foetida*), which take over areas and prevent the native and endemic vegetation from growing. Sections of the park are still farmed, but there are rules that no chemical fertilizers or pesticides can be used. Most farmers grow corn, beans, squash, and pumpkin, and raise chickens, cows, goats, or pigs. Only the chickens are allowed to roam freely, for a limited time period. Pigs are raised in pens, and cows are typically raised in small shelters where they are fed collected plants. At times, goats maybe tied up and allowed to graze a small area, but are not allowed to graze freely. Firewood is still the main source of fuel for cooking. However, within the park people are not allowed to cut down trees for firewood or other purposes. People used to hunt in Serra Malagueta, but it is now illegal to hunt inside the park. There are still incidents with people hunting birds; including the Cape Verde purple heron (*Ardea purpurea bournei*) an endemic subspecies that is now endangered (Áreas Protegidas-Plano de Gestão, n.d.).

Trash is an environmental issue in the park. Even though there are several dumpsters lots of trash is still dumped in fields and valleys and along the roads. Throughout Santiago Island trash is present along the roads, in fields, and in cities. Some areas do not have dumpsters and trash pick-up, so trash is thrown in valleys and is carried away by the rains. Even in areas that do have dumpsters there may be an inadequate number and those may need more frequent emptying. In certain areas people are paid to clean/pick up trash along the roads.

The park keeps records on the number of visitors, which are available for the years 2008 through 2010 (Figure 1.3). Each visitor is categorized as student, national, foreigner, or emigrant. The number of student, national, and foreign visitors has increased each year.

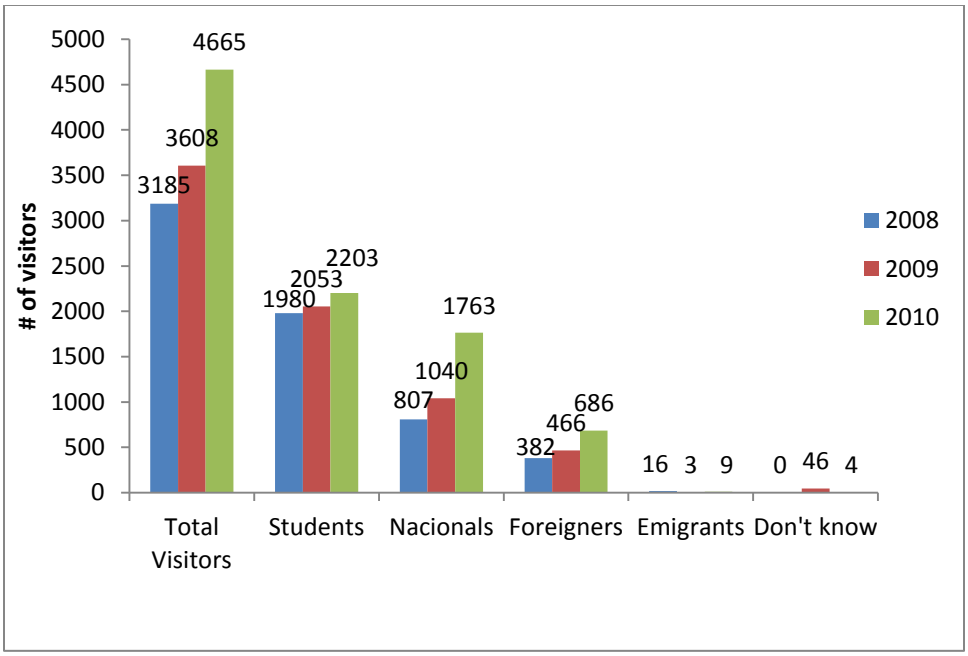

Figure 1.3. Number of visitors to SMNP from 2008-2010.

The type of school is recorded with the visitor data: primary, secondary, and university (Figure 1.4). The number of primary school students visiting the park has decreased since 2008, while the number of secondary school students has increased.

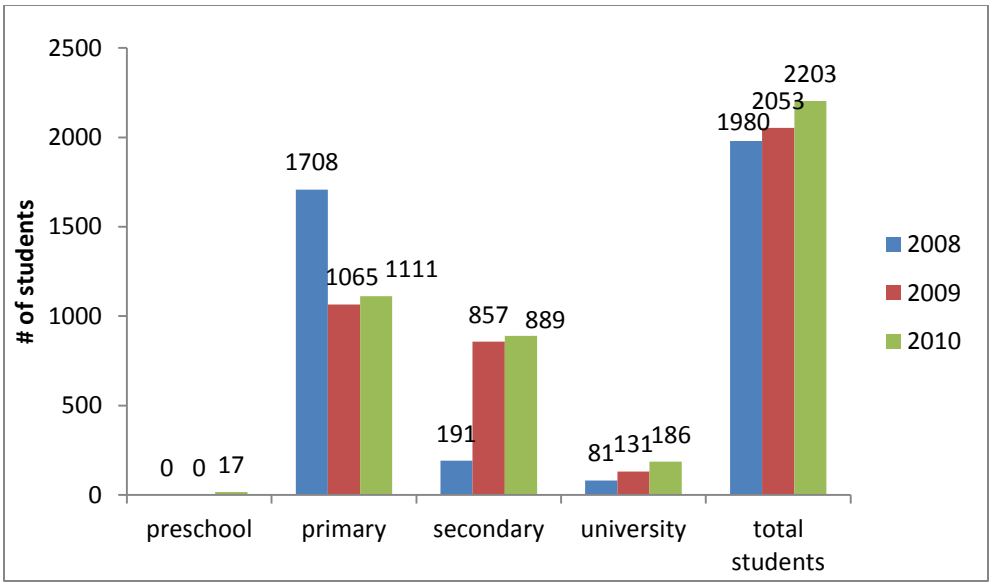

Figure 1.4. Number of student visitors to Serra Malagueta Natural Park by school.

The number of student visitors was collected for 2011 from January to August (Figure 1.5). The number of students in 2011 (Jan.-Aug.) (2794) is greater than the number of students in any of the three previous years (1980, 2053, 2203). (Granted, the number of 2011 students probably did not increase much because not many school groups visit September-December). The number of primary and university students increased from 2010. Slightly fewer secondary students visited in 2011; however, more school groups could have visited the park the remainder of the year after the data collection time period.

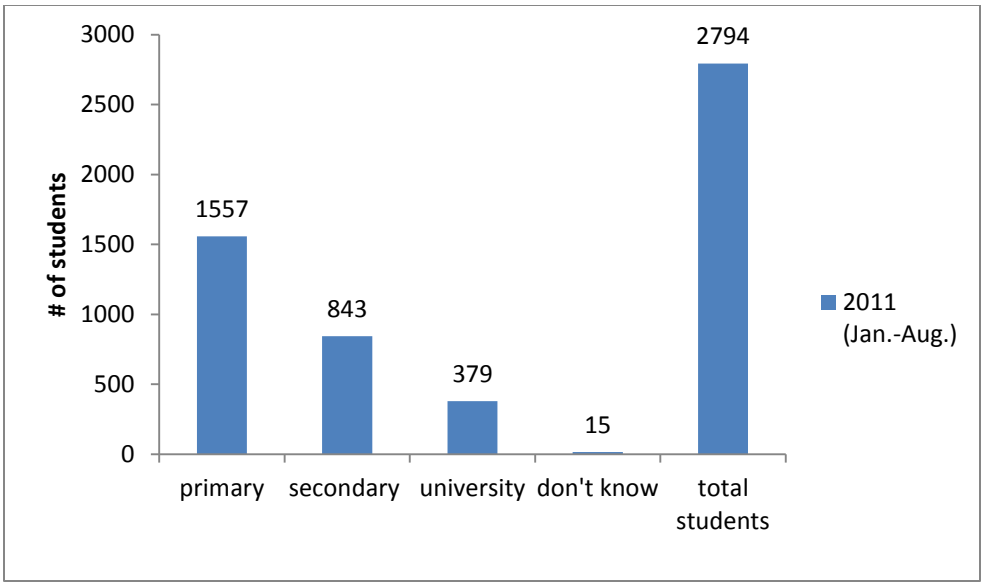

Figure 1.5. Number of student visitors to SMNP from January to August, 2011.

1.7 School System

The schools are divided into primary and secondary schools, with primary including grades one through six and secondary having grades seven through twelve. In smaller primary schools, typically there is one teacher per grade. In larger primary schools, students in a particular grade typically are divided into *turmas* (groups of students that stay together for that grade). Each teacher will teach several different subjects, switching between the *turmas*. Secondary schools divide the students into *turmas*, which have different teachers for the different subjects. Students typically stay in the same *turmas* through 10th grade, and then select their area of study in 11th grade. Public schools are not free, charging each student an annual fee. Several different organizations help students pay school fees if they need assistance. Also, pre-schools are available, but like primary and secondary schools,

they charge fees. The ages of students in particular grades vary, because many students miss a year when they are unable to pay school fees. Also, students may fail and be held back.

In 2005-2006 the net enrollment for primary schools was 95%, with no differences between genders. However, this percentage does not reflect the prevalence of students failing and being held back. Twenty-seven percent of students drop out in primary school. Access to secondary schooling is still a limiting factor and varies between islands and between rural and urban areas. In 2006, 81% of students continued on to secondary school, and in 2005-2006, two-thirds of 12-17 year olds were in secondary school. However, girls had a higher net enrollment of 73% compared to boys' 62%. In 2003-2004, the graduation rate for secondary school was only 35%, and only 5% completed secondary school without having to repeat a grade. Thirty-five percent to 40% of secondary graduates continue their education depending on the year, and only 20-25% of those continuing their education study in Cape Verde (from 2001/2002-2005/2006) (Atchoaréna et al., 2008). The remainder study abroad. Ninety percent of the education investment budget is derived from external aid (Atchoaréna et al., 2008).

1.8 Environmental Education in Cape Verde

Field trips outside of school including trips to SMNP or São Jorge (has botanical garden and INIDA- an agricultural research facility) are environmental educational tools used by schools. Students begin learning about the environment in first grade, and continue learning about the environment, habitats, and animals throughout primary school in integrated sciences classes. Seventh grade students study biodiversity in their class "man and

the environment," and continue to study this in ninth and tenth grade in the natural sciences classes. If students study science and technology in 11th and 12th grade, they can take biology where they learn more about biodiversity. In 12th grade English class students learn about the environment and climate change. Outside of school, if students become involved with environmental education activities it usually involves protection of sea turtles or tree planting (Cape Verdean teacher, personal communication, January 30, 2013).

1.9 Literature Review: Methodology

Evaluations can be used to look at the impact of environmental education on knowledge, attitudes, and behavior. This study uses the pencil and paper test in the pre-post-test design with program and non-program students (described by Bennett, 1989), which is designed to investigate similarities and differences between performance of both students that participated and did not participate. Follow-up tests are important to measure if new attitudes are retained. The use of treatment and control groups is crucial if the measure of program results are to be valid and reliable (Jacobson, 1987b).

Many studies have evaluated environmental education programs in zoos, environmentally oriented camp programs, interpretation programs in parks, and others, using a variety of methods. Some studies rely on self-reported knowledge gain while others employed test style questions (multiple choice or true/false). Likert scale questions are commonly used to measure attitudes. Typically behavior is not observed in these studies, but rather is self-reported, and thus the studies actually measure the "intention to act"

(Beaumont, 2001; Gough, Woodland, & Hill, 2007; Orams, 1997; Stepath, 2007; Tisdell & Wilson, 2005).

There are several systematic literature reviews and meta-analyses on the impacts of environmental education programs. Most criticize the weak methodology that is typically employed, making it difficult to attribute impacts to the programs (Leeming, Dwyer, Porter, & Cobern, 1993). Munro, Morrinson-Saunders, and Hughes (2008) reviewed the literature reporting interpretive evaluations to look for linkages between success and type of interpretation, but they could not find any evaluations that met all of their validity criteria: statistically valid sample size, paired pre- and post-testing, use of a control group, and a follow-up test of three months or later. In comparison, the evaluation reported in this thesis employs a large sample size of pre- and post-test data on treatment and controls, but because of time limitations, the last follow-up took place only a month after the park visit.

The questionnaire and experimental design used in this study were informed by the literature. For example, Stepath (2007) noted that many students answered 'no opinion' or chose the middle of the Likert scale in his pilot test. To avoid the same issue, I used a 6-point scale to help ensure that students provide an informative response. The attitude statements in this study were presented as both positive and negative to avoid bias (not just one or the other) after Jaus (1984) acknowledged the questionnaire used in his study could have been biased because all the statements were presented as positive. The environmental behavior frequency scale employed in this study was similar to Beaumont's (2001) study of ecotourists at a national park in Australia. Some of the questions about environmental attitudes and demographics used this study were based on the questionnaire from the

Jacobson (1987a) study. Further insight was obtained from the questionnaires employed by Tubb (2003), Wagner, Chessler, York, and Raynor (2009), and Shepard and Speelman (1986).

Paired pre- and post-tests were recommended by Munro et al. (2008) as a measure for a valid study, and were used in this study. I used a pre-test with two post-tests (one week and one month after participation in the conservation education program). Bogner (1998) used a post-test one month after the program. Kruse and Card (2004) and Kuhar, Bettinger, Lehnhardt, Tracy, and Cox (2010) administered an immediate post-test and a delayed-post-test a month after the program. Finson and Enochs (1987) administered a post-test approximately one week after the program being evaluated, and obtained information from teachers as well as students by having them complete a teacher questionnaire eliciting information on teacher demographics and planned use of their visit (STS museum). Also, Stevenson, Peterson, Bondell, Mertig, and Moore (2013) examined the relative importance of teacher attributes (e.g., education and experience), student attributes (e.g., demographics), and environmental education treatments (e.g., outdoor classrooms, environmental education school programs). Control groups are not always used, but both Jacobson (1987b) and Munro et al. (2008) acknowledge that control groups are important for valid results. One example is Dettman-Easler and Pease (1999), who surveyed students who did not visit a residential environmental education program, but who received only an in-class environmental education program. They selected their control group from the same geographic areas as the treatment group who participated in the residential environmental education program, and the control group took a pre- and post-test.

1.10 Literature Review: Effects of Environmental Education and Interpretation

This section summarizes the results of previous evaluations of environmental education, interpretation, conservation education, zoo, and museum programs. Most of the studies assess impacts on knowledge and/or attitudes, while a few consider behavior (mainly self-reported or intended). Results vary widely. Intense environmental education programs can positively influence behavior (Asch and Shore, 1975, measured observed behavior). Even with limited in-class instruction (about 2 hours), environmental attitudes can be influenced over the long-term (from 3rd to 5th grade, but there were weaknesses in the study) (Jaus, 1984). Some programs seem to influence only knowledge (Beaumont, 2001; Braun et al., 2010; Gough et al., 2007; Kuhar et al., 2010 [only looked at knowledge], Madin & Fenton, 2004 [only looked at knowledge]; Orams, 1997; Tubb, 2003 [slightly influenced atitudes],) or only attitudes (Dettman-Easler & Pease, 1999 [only looked at attitudes]; Jacobson, 1987a [only looked at attitudes]). Some programs appear to impact knowledge and attitudes (Kruse & Card, 2004; Olson et al., 1984; Powell & Ham, 2008; Wagner et al., 2009; de White & Jacobson, 1994), while others had limited impact (Kostka, 1976). Leeming et al. (1993) reviewed 34 environmental education articles that evaluated program effects on knowledge, attitudes, and behavior. Seventeen of the studies considered out-of-class interventions, while the others evaluated classroom interventions. The majority of the out-of-class interventions were longer than a day, and nearly all lasted at least several hours. Most evaluations of out-of-class interventions did not detect positive impacts. Zelezny (1999) performed a meta-analysis of previous studies on classroom (9 studies) and non-classroom (9 studies) environmental education interventions. Only 4 of the 9 studies

involving non-traditional settings (i.e., out-of-classroom) reported improved environmental behavior, while all 9 classroom setting studies reported improved behavior. Important to note, many of the study groups in the non-traditional settings were adults, weak research methods were used for some studies, and self-reported – rather than observed - behaviors were recorded in most studies. However, Stevenson et al. (2013) noted that outdoor education can help improve environmental literacy (including behavior) among students.

There are mixed results regarding whether knowledge about the environment can help shape attitudes. According to Ham (2007), most research indicates that attitudes are not necessarily influenced by gains in knowledge. However, de White and Jacobson (1994) found that "the relationship between knowledge and attitude toward wildlife conservation revealed in the linear regression analyses showed a strong effect of the knowledge scores on the attitude scores" (p. 209) of Columbian fourth graders. Olson et al. (1984) detected a positive significant relationship between knowledge and attitudes in a study on interpretation at state nature preserves in the US. Bradley, Waliczek, and Zajicek (1999) used a pre- and post-test to look at how a 10-day science course (with a 50 minute class on each day) influenced high school (9th-12th) students' environmental knowledge and attitudes. There were significant correlations between attitudes and knowledge (pre-test knowledge and pre-test attitudes; post-test knowledge and post-test attitudes). As knowledge scores increased, attitudes became more positive. Also, students that started with positive attitudes usually had more positive attitudes afterwards, while those students who did not have as positive attitudes regarding the environment prior to the program had more negative attitudes afterwards (Bradley et al., 1999).

Most of the literature on environmental education focuses on more developed countries. Of the three studies in tropical countries (excluding Australia and studies involving foreign tourists in tropical countries), only one evaluation is from Africa (Kuhar et al., 2010) and none are from SIDS. Kuhar et al. (2010) noted long-term (2 years) knowledge retention by students who participated in an environmental education program at a forest reserve in Uganda. Norris and Jacobson (1998) performed a content analysis of 56 reports of tropical conservation education programs. According to their study less than half of the programs were successful in completing at least half of their objectives. A literature review of interpretive evaluations (developed countries) to look for linkages between success and type of interpretation by Munro et al. (2008) noted that 19 out of 21 case studies were successful or partially successful in accomplishing management objectives. Most of the case studies evaluated knowledge gain and attitude change, but a few looked at changes in behavior. These case studies were interpretive programs (both non-personal and interpersonal), so they do differ from the SMNP program. Museum and more formal interpretation were not included in these case studies (Munro et al., 2008).

2 METHODS

2.1 Survey Implementation

To evaluate the conservation education program, students and teachers were surveyed about their environmental knowledge, attitudes, and behavior, following a protocol approved by the NCSU Institutional Review Board (#1894).

Students and teachers from fifth through twelfth grades were sampled. The sample included a "treatment" and a "control" group. The "treatment" group consisted of student groups (10 groups made up of approximately 16 classes) who visited the park and participated in the conservation education program between 3/1/11 and 6/20/11. The objective was to have these students fill out the questionnaire three times: once *before* they participated in the conservation education program (called a pre-test) and twice *after* they participated (post-tests). Ten groups from 10 schools completed the pre-test, and 10 from 10 schools completed at least one post-test. The "control" group consisted of similar classes who did not visit the park. The objective was to have these students fill out the questionnaire twice. Twelve groups from seven schools completed the questionnaire at least once, which I considered "pre-tests" (first time taking test) and "post-tests" (second time taking the test). The pre-tests for the control groups were typically completed around the same time as the post-tests for the treatment group. In both treatment and control groups, teachers were asked to complete questionnaires.

2.2 Questionnaire

The student questionnaire in Portuguese and the English translation are in appendices 1 and 2. After having helped escort visiting groups and listening to the information given by the guides, the questionnaire was created. The knowledge questions attempted to address the main topics covered by the guides. The questionnaire is composed of four parts. The first part had questions about demographics (mostly yes/no questions). The second part was composed of knowledge questions: 4 multiple choice questions, four questions where they were given a plant or animal species and they had to label if it was endemic, introduced, or invasive, and one fill in the blank question where they were given the definition of biodiversity. The questions were designed to evaluate the students' level of understanding about the park and conservation. The third section considered students' attitudes towards the park and conservation. This section consists of twelve statements in which the students used a Likert scale to select from 1-6 how much they agree or disagree with each statement. Statements that sought disagreement and agreement were used, so students would not be biased in their responses by putting only agree or disagree (Jaus, 1984). For the analyses, the statements that sought disagreement had their responses reversed so that larger numbers would signify positive attitudes for all the attitude statements (Bonneau, Darville, Legg, Haggerty, & Wilkins, 2009). The fourth part elicits information on students' behavior relevant to the environment. For three actions, the students used a Likert scale (from 1-6) to indicate how frequently they perform the action.

The survey instrument was pilot tested with different grade levels to ensure they all understood the survey. Both classes that had and had not visited the park participated in

these pilot tests. Changes were made to the questionnaire based on questions they asked and their responses. However, after the questionnaire had been completed by one group (composed of several classes) that visited the park and three classes that did not visit park, it was determined that a few additional modifications were needed. Two answer choices in the knowledge/multiple choice section had to be changed because of confusion and two technical terms had to be removed from the attitude section of the questionnaire. Thus, in the final sample, responses from four groups were based on the older questionnaire (for pre-test and post-tests). All of the other classes were administered the final version of the questionnaire (Appendix 1).

The teacher questionnaires (both treatment and control group) collected information on teacher gender, how many students regularly attended class, how many years they had been a professor, how many years they had been teaching at their current school, education level, and course of study (Appendices 3, 4, 5, and 6). Also, the questionnaire asked about their previous experience with the park including if they had previously visited and brought their students, when was the last time they visited, and if they taught their students about the park. The same attitude section in the student questionnaire is also in the teacher questionnaire. The only differences between the treatment and control teacher questionnaires is the treatment questionnaire asked if they had taught their students about the park before their visit while the control questionnaire asks if they taught their students about the park.

The control group teacher questionnaires were not analyzed because when the control groups were selected and participated in the questionnaire it was possible students could have been in a language arts class, math class, etc. where the professor would have been less likely

to teach about the park. In secondary school, students have different teachers for different subjects. Therefore, it is possible one teacher could have taught them about the park but others did not.

Some school groups did not visit the park as individual classes but came as mixed groups of students and had teachers as chaperones, but the teachers were not necessarily their teacher, so these teacher questionnaires were not analyzed. Teacher questionnaires were only analyzed for the treatment groups that came as individual classes. The teacher questionnaire for one school group made up of several classes was not filled out.

2.3 Protocol

For the treatment sample, when student groups arrived at the park, I asked their teachers if they were willing to have their classes participate in the study. The park guides and/or I explained the informed consent to the students in Kriolu, the local language, and asked if they would like to participate. All of the students who were asked to participate agreed to the informed consent. I then handed out questionnaires and pencils for students to complete. After the students completed the pre-test, they participated in the park's conservation education program.

After the school groups visited the park, I traveled to their school to administer the same questionnaire a second time (first post-test). The only difference between the pre-test and post-test was a question asking if the students had ever filled out this questionnaire before. Because of scheduling conflicts between my work obligations and school schedules including exams, the delay between the pre-test and first post-test ranged from 7-27 days.

A second post-test was administered if time permitted. I traveled to the students' schools a second time and had them fill out the same questionnaire. As with the first post-test test, scheduling conflicts prevented the second post-test from being completed one month after the park visit. The range of days between the pre-test and second post-test was 26-47 days.

For the control sample, classes that did not visit the park were selected. When I traveled to schools to administer the post-test, I sampled classes of similar grade level in the same school or in a school close to the school with the treatment group that had the same grade levels, urban or rural area, distance from the park, etc. The non-visiting students were given the same questionnaire as the students who visited the park. If time permitted, the control group took the questionnaire a second time when I administered the second post-test to the treatment group.

2.4 Sampling frame

The sample includes school groups between fifth and twelfth grade that visited the park between 5 March, 2011 and 20 June, 2011. School groups below fourth grade were excluded because they might not be able to read and respond to a written questionnaire. University students were not selected because few university students visit the park compared to primary and secondary school students. Also, university students could be more motivated to learn because they have chosen to continue their education. Only a few groups in this grade range who visited the park did not participate in the study. I was absent from

the park when several groups visited, and a few groups only briefly stopped at the park and did not fully participate in the conservation education program.

2.5 Sample size

In the ten school groups who were part of the treatment sample, 392 students filled out the pre-test before they participated in the conservation education program. Of the 392 students, 222 also completed at least one post-test and 116 completed both post-tests. Twelve classes consisting of 296 students that did not visit the park participated in the control group for the study. Of the 296 students, 170 completed the questionnaire just one time and 126 completed the questionnaire twice.

2.6 Exceptions to sampling plan and protocol

One group of three classes was originally going to be part of the control sample. When I went to their school, two classes filled out the questionnaire, but seven days later the two classes plus an additional class came to the park together and participated in the conservation education program. The class that had not previously completed the questionnaire filled it out at the park. This group became part of the treatment sample.

2.7 Variables

Table 2.1 displays the data collected during the study. The first set of variables is from the questionnaires completed by students. The second, third, and fourth set are the variables from the knowledge (Table 2.2), attitudes (Table 2.3), and behavior (Table 2.4)

section of the student questionnaire. Table 2.5 describes the total and mean scores of knowledge, attitude, and behavior. The next set of variables describes survey administration (Table 2.6). Table 2.7 describes the park visit, for the treatment group only, and is based on direct observation. Table 2.8 describes the school groups that participated in the study. Finally, the last set of variables is from the questionnaire given to the participating teachers (Table 2.9).

Table 2.1. Variables Collected from the Questionnaire Given to Students

Variables	Variable Description
grade	Grade the student is currently studying
grade_cycle	Combination of 2 grades: 5= 5th and 6th; 7=7th and 8th; 9=9th and 10th; 11=11th and 12th
age	Age of the student at the time of the questionnaire
sex	Male or female
zone	Live in a rural or urban area
prev_visit	Had the student previously visited the park
if_yes_guide	If the student had previously visited the park, did they have a guide
other_fam_visit	Had another family member previously visited the park
emigrants	Does the student have family members who are emigrants overseas (Used as a measure of wealth because remittances have a large role in the economy)
car	Does the student's family own a car (Used as a measure of wealth)

Table 2.2. Variables from the Knowledge Section of the Questionnaire

Variables	Variable Description
def_end	What does *"endemic specie"* mean?
def_intr	What does "*introduced plant*" mean?
why_park	Why is Serra Malagueta considered a *"Natural Park "*?
soil_ero	Which is the main cause of *"soil erosion"*?
monk	Monkey is an endemic, introduced, or invasive specie
lant	Lantuna (a plant) is an endemic, introduced or invasive specie
ling	Lingua-de-vaca (a plant) is an endemic, introduced, or invasive specie
kalip	Eucalyptus is an endemic, introduced, or invasive specie
biodiv	What word means "*the variety of all living things"*?

Table 2.3. Variables from the Attitude Section of the Questionnaire

Variables	Variable Description
loose_goats_pos	People should be allowed to let their goats graze freely in Serra Malagueta (responses reversed to become positive)
park_rich_pos	Natural Parks are for rich people and foreign tourists (responses reversed to become positive)
remove	Determined plants should be removed from natural parks
no_preserv_pos	It is not necessary to preserve natural areas that don't have forests (responses reversed to become positive)
lots_nat_pos	There are still lots of natural areas on Santiago Island (responses reversed to become positive)
too_big_pos	Serra Malagueta Natural Park is too large (responses reversed to become positive)
future_vis	I would like to visit Serra Malagueta in the future
camp	If Serra Malagueta offered services for an environmental camp, I would like to participate
know_nat	It is important to know/visit natural or protected areas
good_prot	It is good that Serra Malagueta is protected as a Park
refor	It is important to reforest the Park with native plants
ero_prob	Soil erosion on Santiago Island is a big problem

Table 2.4. Variables from the Behavior Section of the Questionnaire

Variables	Variable Description
trash	I avoid throwing trash on the ground
learn_an	I try to learn about local plants and animals
hike	I go hiking in natural areas

Table 2.5. Total Scores and Mean Scores for Knowledge, Attitude, and Behavior Sections

Variables	Variable Description
Total_know	Total number of questions in the knowledge section answered correctly
Percent_know	Total number of questions in the knowledge section answered correctly divided by the number of questions answered
Percent_know_miss_incl	Total number of questions in the knowledge section answered correctly divided by the number of knowledge questions (9)
Avg_attitude	Sum of Likert scale responses in the attitude section divided by the number of student's responses in the attitude section
Avg_behav	Sum of Likert scale responses in the attitude section divided by the number of student's responses in the behavior section

Table 2.6. Variables Describing Survey Administration

Variables	Variable Description
treatment	Treatment or control group
old_test	Did the student take the original version or modified version
number_tests	How many times was the questionnaire filled out
pre_test	Did the student fill out a pre-test

Table 2.7. Variables from the Park Visit

Variables	Variable Description
temp	What was the temperature like during the park visit
bruma_seca	Was the park hazy because of the Saharan sands in the air during the park visit
fog	Was the park foggy during the visit
day_of_week	What day of the week did the student visit the park
saturday	Was the park visited on a Saturday
lang	Did the guide speak Portuguese or Kriolu during the visit
lecturer	Which guide led the group on the park trip
park_visit	Did the student visit the park
date_pre	Date the pre-test was taken
date_post1	Date the first post-test was taken
date_post2	Date the second post-test was taken
days_pre_p1	Number of days between the pre-test and first post-test
days_pre_p2	Number of days between the pre-test and second post-test
days_p1_p2	Number of days between the first and second post-test
hours_at_park	Number of hours spent at the park during the visit
interact	Did the students interact with other people in the park
number_stud_at_park	Number of students in the group that visited park
teacher_walk	Did the teacher hike in the park with the students
travel_time	Distance in minutes between the school and park
power_point	Did the visiting group view a PowerPoint

Table 2.8. Variables about the School Groups

Variables	Variable Description
private_school	Was the school group from a private school
club	Was the group a school club
ind_class	Was the group an individual class or mixed group of students from different classes
cheat	Was the group's answers influenced by the teacher
percent_urban_pre	Percent of students at the school who said they were from an urban area on the pre-test (1st test for control group)

Table 2.9. Variables Collected from the Teacher Questionnaire

Variables	Variable Description
teacher_gender	Male or female teacher
teach_prev_visit	Had the teacher previously visited the park
teacher_prev_students	Had the teacher previously visited the park with their students
teach_discuss_park	Did the teacher discuss the park and environmental topics with the students before the park visit
teach_educ	Does the teacher have a bachelor's degree

2.8 Data

All of the data were entered into Excel spreadsheets. After all data had been entered, each response was double checked against the original questionnaire. The final spreadsheet was exported to SAS 9.2, and SAS Enterprise Guide 4.3, SAS 9.2, and JMP Pro 9.0.2 were used for the analyses.

2.9 Study Limitations

Although commonly used to evaluate educational programs, self-reported knowledge, attitudes, and behaviors elicited through questionnaires have some drawbacks. Bennett (1989) described the limitations of using a "paper and pencil test" for evaluation: "(1) the "guinea pig effect," or awareness of being tested, which may cause a respondent to answer in ways that he or she knows will please or defy the teacher; (2) lack of motivation; and (3) general emphasis on reading and writing skills, which may camouflage a variable being tested" (p. 17-18). In the SMNP study, the students knew the questionnaire was not a test to be graded, which could have reduced their motivation to take the questionnaire seriously and

answer honestly, particularly the knowledge section. Because I administered the survey, students may have tried to provide what they perceived to be my preferred answers in the attitudes and behavior sections. Alternatively, they could have given answers they thought I would not like, just because I was not their teacher or because they did not like completing the questionnaire. Even though I clearly stated that completing the questionnaire was optional, all students in the classes that I approached did accept the questionnaires to complete. These are examples of potential "normative influences," which Newhouse (1990) says "can exert a strong force over behavior. … Normative influences may also affect the way a person responds to a questionnaire. For example, there is now a social norm against polluting, so when asked about personal attitudes, respondents are likely to say they have negative attitudes toward polluting, regardless of their true feelings" (p. 27-28).

The impact of students' low literacy on students' ability to read the questionnaire could have affected the results, as has been acknowledged in other studies (Jacobson, 1987a; Stepath, 2007). One indicator is the younger students in fifth and sixth grade took longer to complete the questionnaire than the older students. This could have been due to lower reading comprehension skills. In particular, even though Portuguese is the official language and is used in school, Kriolu is the language used in everyday interactions in Cape Verde. Kriolu was not used for the questionnaire, because it is not a written language. Portuguese may have been more difficult for younger students to read and comprehend, because they had fewer years of exposure in school.

Difficulty with reading comprehension may explain why students did not follow instructions in some sections. For example, some students selected numerous answers to

multiple choice questions, even though the instructions clearly indicated that only one choice was correct. In the section where students were supposed to indicate if a particular species is endemic, invasive, or introduced, some students wrote responses like “plant,” “animal,” “or,” “mammal,” or “hint.” The instructions for that section said “fill in the blank with “endemic”, “introduced”, or “invasive”: (Hint: You will use all of the options at least once.)” A few students might have been confused and written “or” or “hint” because they thought they were possible answers. Some students answered the attitude and behavior sections incorrectly with true/false and yes/no responses. While students may simply have not followed directions, it is possible they did not understand the directions because of limited literacy.

The question about biodiversity had the highest item non-response rate, with 50% of students not answering. This may have been because it required students to fill in the blank, rather than choose an option in the multiple choice questions or choose a word to describe each species. Another possible reason is that the word “seres” in the biodiversity question was misspelled “series.” Evidently, many students guessed that this was a typo and correctly answered the question. If students asked, the question was explained to them. Thus the more likely reason for the low response rate is that students simply were not familiar with the term biodiversity. Another question with a high rate of incorrect answers asked why SMNP is considered a natural park. The correct answer choice was all of the above. Students may have quickly read over the question, seen the first answer choice was correct, and not given much attention to the other choices.

While it would have been ideal to conduct the survey with all school groups that visited during the spring 2012 semester, the process of obtaining IRB approval and finalizing

the questionnaire delayed the start until the very beginning of March. Further, several groups that visited the park had limited time, so they did not fully participate in the conservation education program or this study. Another several groups visited the park when I was not on site, so they also did not participate. The majority of the groups that participated in this study visited the park in May and June. This made planning follow-up visits with those classes, and identification and administration of the survey to matching control classes, challenging because of conflicts with exams and end of the school year. At three schools, classes were not present when I was supposed to meet with them to administer post-tests. This led to substantial variation in the number of days between the pre-test and first (7-27 days) and second (26 – 47 days) post-tests.

2.10 Numbers of Participants

Seven hundred and twenty-one students participated in the study. The treatment group (students that visited the park or in classes that visited the park) consisted of 425 students from 10 different schools. Of the 425 students: 54 of them only took the pre-test, 222 took the pre-test and the post-test one time, 116 took the pre-test and the post-test twice, 23 took only one post-test and no pre-test, and 10 took the post-test twice and no pre-test . The control group (students in classes that did not visit the park in the 2010-2011 school year) was composed of 296 students from 7 different schools. Of the 296 students in the control group, 170 students filled out the questionnaire once and 126 filled it out twice. There were 889 treatment questionnaires and 422 control questionnaires for a total of 1311 questionnaires that were filled out during the study.

3 RESULTS AND ANALYSIS OF PRE-TESTS

3.1 Introduction: Cape Verdean Students' Knowledge, Attitudes, and Behaviors about Biodiversity, Conservation, and Protected Areas

Cape Verde faces large environmental threats like invasive species and clearing of land for agriculture that negatively impact their biodiversity. To conserve their high levels of biodiversity, they created a system of protected areas. However, the future of these protected areas will depend fundamentally on local understanding, attitudes, and behaviors towards conservation and biodiversity. We examined knowledge, attitudes, and behaviors regarding biodiversity, conservation, and protected areas in Cape Verde. We considered school children, grades 5 through 12, based on a survey conducted in 2011, which elicited information on student, classroom, and teacher characteristics, allowing us to examine variation across students.

Evaluations of conservation education programs such as offered by SMNP should control for other factors that can influence students' performance on the questionnaire. This includes characteristics of the education program, of the school, classroom, and teacher, and of the students themselves. The most commonly considered characteristics of the students include (i) prior experience with and exposure to nature, (ii) grade level or age, and (iii) gender.

Prior experience with nature and rural environments is believed to affect knowledge, attitudes, and behaviors regarding the environment. For example, Shepard and Speelman (1986) suggest that urban campers might need some time to adjust to a rural and woodland

environment. Inner-city students did not perform as well on pre-tests that looked at environmental attitudes as suburban students according to Kostka (1976). Campers with prior camp experience have shown higher self-reported knowledge and more pro-conservation attitudes in pre-tests completed before a conservation education camp (Kruse & Card, 2004). Stepath (2007) noted that "students' environmental knowledge, attitudes, and ecological intention to act were significantly and directly correlated to previous reef experience. Previous experiences of reefs, camping, and snorkeling correlated strongly to knowledge and intention to act responses" (p.49). Also, Madin and Fenton (2004) stated that visitors' reef knowledge scores were related to prior visits to the Great Barrier Reef and prior exposure to formal education about reefs. Students may be influenced by their family's prior experience. For example, Kuhar et al. (2010) hypothesized that a possible reason students were performing better on pre-tests after the initial year was they were siblings (or friends) of students who had already visited and then shared information with their family.

Previous studies have detected mixed results on the influence of grade level and gender. Braun et al. (2010) evaluated two educational outdoor programs dealing with non-native bird species in Germany. They considered whether gender was related to knowledge and/or attitudes towards exotic species; no differences were detected between girls' and boys' attitudes either before or after the program. For the retention test after the outdoor program girls did better with the specie specific questions but there was not a significant difference between boys and girls among the general non-native questions. Stronck (1983) also did not find any differences in attitude toward a natural history museum between boys and girls except for one item on their questionnaire. Olson et al. (1984) found no

relationships between sociodemographic variables and knowledge or attitudes in their study of interpretation at state nature preserves (for adults rather than students). Likewise, Lisowski and Disinger (1991) tested sex, grade level, academic standing in science, course background in science, extra-curricular involvement in science related activities, and travel and outdoor experience as predictors of knowledge gain after a seven-day field program in several locations in the Caribbean. They did not find any of these variables to be statistically significant in any of the groups' participation in the program. Cable, Knudson, Udd, and Stewart (1987) evaluated an interpretation program at a Canadian national forestry institute (including a visitor center, outdoor exhibit loop, 2 self-guiding interpretive trails, and a self-guiding road tour) and found that visitor origin, occupation, age, and education level had some impact on attitudes, while visitor gender did not. Conversely, Finson and Enochs (1987) noted that males had more positive attitudes towards the role of science and technology in society in a pre-test before a visit to a science and technology museum in Kansas. Students from public versus private school did not have significantly different attitudes after the visit, but grade level (6th-8th) did influence attitudes in the post-test after the visit. Socioeconomic status did not significantly affect students' attitudes after the visit. Surprisingly, many studies of environmental education programs do not explicitly compare age groups (Leeming et al. 1993).

According to Norris and Jacobson's (1998) content analysis of 56 reports of tropical conservation education programs, program location (what continent), publication type (journal, book, or proceedings), sponsorship (multiagency, international, national, private), or program length (greater or less than 3 years) were not significant attributes with success.

However, there was a trend that programs with existence of at least three years were more successful than programs that had existed less than three years. Formative (evaluation during the program) and long-term evaluations (evaluation occurred at least 6 months after the program) were associated with program success, while summative evaluation (evaluation directly after the program) was not.

Group size, duration of the field trip, and grade level are factors that can influence a field trip. It is harder for large groups to stick close together and be able to hear all the information that is presented (Bitgood, 1989). Group size was recorded in the SMNP questionnaire to see if it influences students.

I hypothesize that students that have previously visited the park and students in upper grade levels/older students will know more of the knowledge questions and have more pro-environmental attitudes and behaviors. I hypothesize that females, students from higher SES, and urban students will perform better on the knowledge section and will have higher pro-environmental attitudes and behaviors.

3.2 Methods

To evaluate the conservation education program, students were surveyed about their environmental knowledge, attitudes, and behavior. Students from fifth through twelfth grades were sampled. The participants consisted of student groups who visited the park and student groups of similar classes who did not visit the park. The student groups that visited the park completed the questionnaire before their participation in the conservation education program. I would then travel to schools to find classes of similar grade level in the same

school or in a school close by that had the same characteristics, including same grade levels, urban or rural area, distance from the park, etc. The non-visiting students were given the same questionnaire as the students who visited the park.

The questionnaire was composed of four parts. The first part has questions about demographics (mostly yes/no questions). The second part was composed of knowledge questions: 4 multiple choice questions, four questions where they were given a plant or animal species and they had to label if it was endemic, introduced, or invasive, and one fill in the blank question where they were given the definition of biodiversity. Questions were designed to evaluate the students' level of understanding about the park and conservation. The third section considered students' attitudes towards the park and conservation. This section consists of twelve statements in which the students used a Likert scale to select from 1-6 how much they agree or disagree with each statement. Statements that sought disagreement and agreement were used, so students would not be biased in their responses by putting only agree or disagree (Jaus, 1984). For the analyses, the statements that sought disagreement had their responses reversed so that larger numbers would signify positive attitudes for all the attitude statements (Bonneau et al., 2009). The fourth part elicits information on students' behavior relevant to the environment. For three actions, the students used a Likert scale (from 1-6) to indicate how frequently they perform the action.

The questionnaire used in this study was informed by the literature. For example, Stepath (2007) noted that many students answered 'no opinion' or chose the middle of the Likert scale in his pilot test. To avoid the same issue, I used a 6-point scale to help ensure that students provide an informative response. The environmental behavior frequency scale

employed in this study was similar to Beaumont's (2001) study of ecotourists at a national park in Australia. Some of the questions about environmental attitudes and demographics used this study were based on the questionnaire from the Jacobson (1987a) study. Further insight was obtained from the questionnaires employed by Tubb (2003), Wagner et al. (2009), and Shepard and Speelman (1986).

The survey instrument was pilot tested with different grade levels to ensure they all understood the survey. Both classes that had and had not visited the park participated in these pilot tests. Changes were made to the questionnaire based on questions they asked and their responses. However, after the questionnaire had been completed by one group (composed of several classes) that visited the park and three classes that did not visit park, it was determined that a few additional modifications were needed. Two answer choices in the knowledge/multiple choice section had to be changed because of confusion and two technical terms had to be removed from the attitude section of the questionnaire. Thus, in the final sample, responses from four groups were based on the older questionnaire (for pre-test and post-tests). All of the other classes were administered the final version of the questionnaire (Appendix 1).

All of the data were entered into Excel spreadsheets. After all data had been entered, each response was double checked against the original questionnaire. The final spreadsheet was exported to SAS 9.2, and SAS Enterprise Guide 4.3, SAS 9.2, and JMP Pro 9.0.2 were used for the analyses.

Descriptive statistics were created for all of the questions, and different variables such as age, grade, gender, urban vs. rural, etc. were tested to examine how they influence

students' knowledge, attitudes, and behaviors. Chi square tests were used to test for association between the knowledge questions and binomial variables. Mann-Whitney U tests were used to test binomial variables impact on attitudes and behaviors. Ordinal logistic regressions were considered and found consistent results with the Mann-Whitney U tests. (Important to note for Mann-Whitney U tests that students are clustered into groups and thus not really entirely independent observations). Nominal logistic regressions were used to examine grade and ages' influence on the knowledge questions, and ordinal logistic regression was used to examine grade and ages' influence on the attitude and behavior statements. (Intercepts are omitted from the tables in the results).

3.3 Results: Descriptive Statistics

Three hundred ninety two students who visited the park filled out the questionnaire and 296 students who did not visit the park filled out the questionnaire for a total of 688 participants. Table 3.1 displays the characteristics of all the students who took the pre-test in this study (both treatment and control). The average age was 15 years old, ranging from 10 to 22 years old. Fifty-three percent were female, and 68% are from urban areas. Sixty percent had a family member who owned a car. The vast majority (92%) had an emigrant in their family, so this variable was not used in further analyses. Twenty-one percent had previously visited Serra Malagueta Natural Park, and of those 21%, 71% had a guided tour on their previous visit. Fifty-seven percent had a family member who had visited the park.

Table 3.1. Characteristics from Pre-Tests, Combined Treatment and Control

Variable	Mean	Std Dev	N
grade	8.766	2.416	688
grade_cycle	8.131	2.476	688
age	14.931	2.661	677
sex	0.531	0.499	655
zone	0.678	0.468	633
prev_visit	0.214	0.410	682
if_yes_guide	0.711	0.455	135
other_fam_visit	0.576	0.495	665
emigrants	0.919	0.272	682
car	0.601	0.490	682

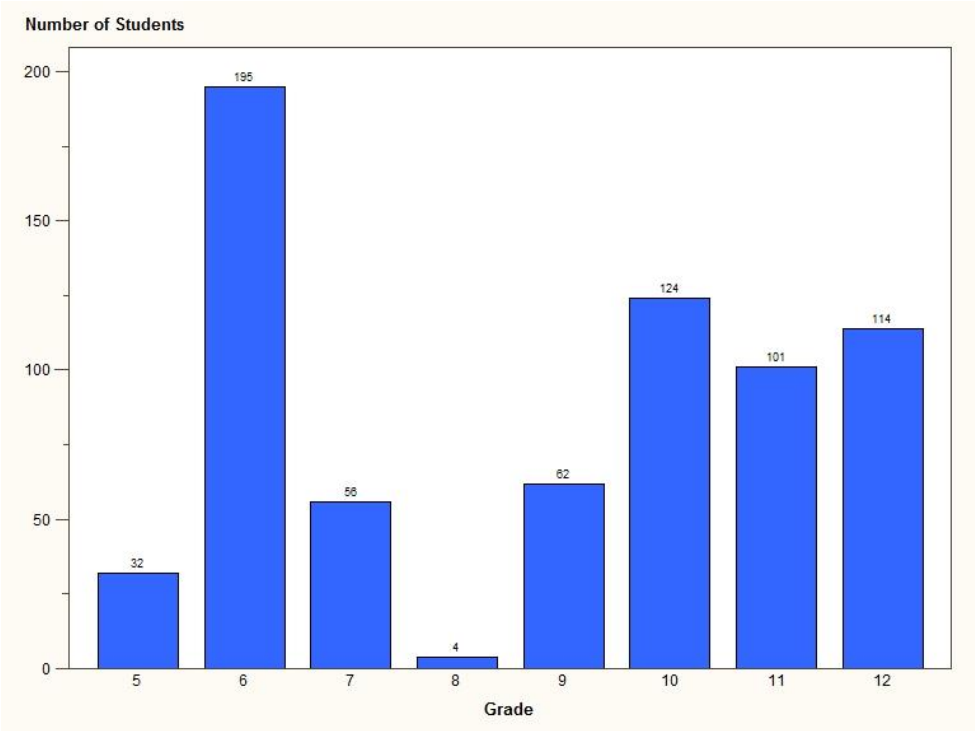

Figure 3.1. Number of students by grade level (pre-test)

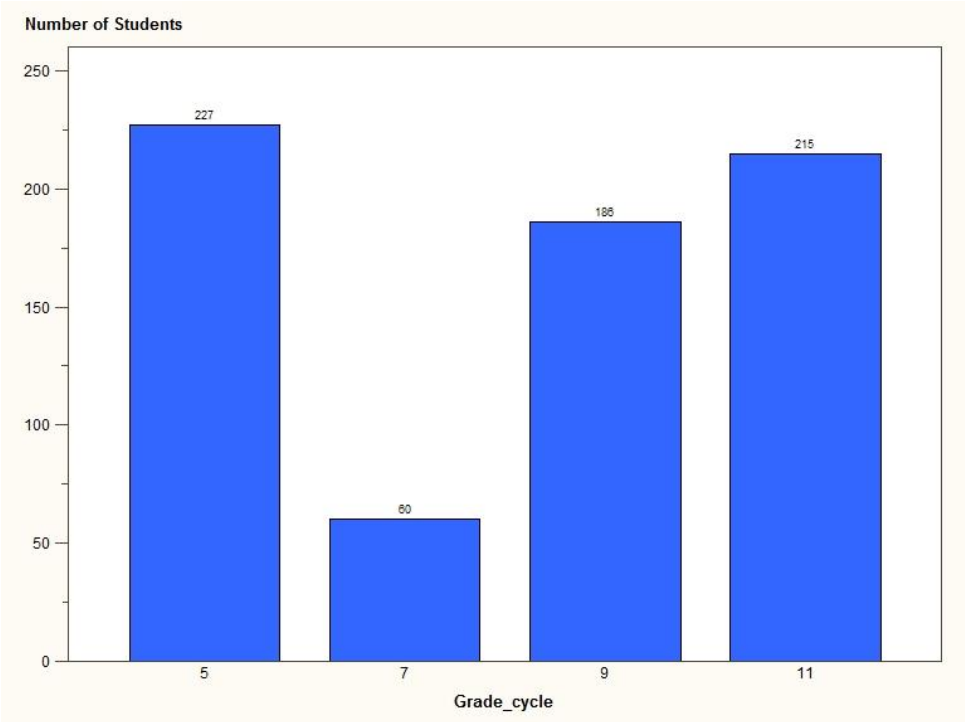

Figure 3.2. Number of students by grade_cycle (5th&6th, 7th&8th, 9th&10th, 11th&12th) (pre-test)

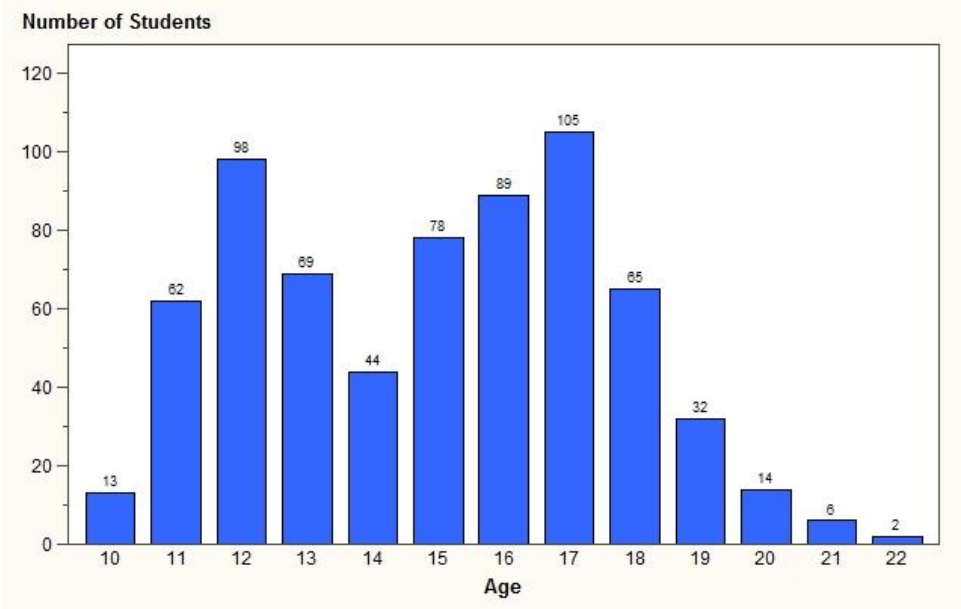

Figure 3.3. Number of students by age (pre-test)

Environmental knowledge was assessed based on correct answers to a series of nine questions. The percent of respondents who answered correctly is between 40 and 50% for seven of the nine questions, considering only the students who attempted an answer (Table 3.2). For example, although the percent correct for biodiv is relatively high at 46%, only about half of the students answered this question. Even among respondents, a smaller percentage (25%) correctly answered questions about why the park was created and if monkeys are an endemic, introduced, or invasive specie. Many of the students who answered incorrectly about why the park was created simply picked the first answer, whereas the correct response was "all of the above." One hundred thirteen students responded they had never heard of the term 'endemic specie' before, and 57 had never heard of 'introduced plant' (Table 3.2). Considering missing values as incorrect responses, students answered 32% correctly (percent_know_miss_incl), and considering only the questions attempted, students answered 39% correctly (percent_know) (Table 3.2).

Table 3.2. Percent Correct Knowledge Questions, Combined Control and Treatment (Pre-Test)

Variable	Mean	Std Dev	N	# Never Heard Term Before
def_end	0.436	0.496	440	113
def_intr	0.488	0.500	559	57
why_park	0.250	0.433	597	32
soil_ero	0.435	0.496	589	34
monk	0.256	0.437	582	-
lant	0.399	0.490	566	-
ling	0.480	0.500	581	-
kalip	0.486	0.500	574	-
biodiv	0.464	0.499	345	-
total_know	2.895	1.915	678	-
percent_know	0.391	0.230	678	-
percent_know_miss_incl	0.322	0.213	678	-

Students indicated their level of agreement with 12 attitude statements, on a Likert scale from strongly disagree (1) to strongly agree (6) (Table 3.3). Five of the statements were worded such that disagreement should be considered a more pro-environmental response, and these were recoded so that higher scores always represent more pro-environmental responses. The average response to all questions was 4.5, demonstrating a positive view towards the park and conservation (Table 3.3). The average response to most individual statements was greater than 4, with three exceptions. Disagreement with the statement ‘there are lots of natural areas’ was considered more pro-environmental, since it implicitly recognizes the need for conservation of such natural areas. However, students tended to agree with the statement, resulting in a mean re-coded response of just 2.7. Students may have been less likely to give a pro-environmental response, because they do not understand how much the landscape of Santiago Island has been impacted by people,

and/or because they consider agricultural fields to be natural. ‘Determined plants should be removed’ and ‘the park is too big’ evoked responses slightly below 4 on average. The purpose of the first statement was to assess whether students agreed that invasive plants should be removed, but based on pre-testing, the term “invasive” was replaced with “determined.” Students may think that it is detrimental to the environment if any plant is removed. Responses to the second statement suggest that students do not understand the importance of protecting a large area. One student wrote that the park was too big because he had to hike a long way and his legs were tired.

Table 3.3. Mean Likert Scores for Attitude Statements, Combined Control and Treatment (Pre-Test)

Variable	Mean	Std Dev	Median	N
loose_goats_pos	5.020	1.325	5	643
park_rich_pos	5.038	1.305	6	652
remove	3.412	1.528	3	622
no_preserv_pos	4.603	1.422	5	627
lots_nat_pos	2.727	1.307	2	633
too_big_pos	3.263	1.353	3	608
future_vis	5.211	1.205	6	645
camp	5.246	1.047	5	623
know_nat	5.241	1.084	6	642
good_prot	5.218	1.190	6	638
refor	4.494	1.327	5	605
ero_prob	4.357	1.514	5	628
avg_attitude	4.485	0.556	4.545	659

Environmental behaviors were assessed on a Likert scale ranging from never (1) to always (6) perform a given behavior. The mean response was over 4 for questions about not throwing trash on the ground and learning about local plants and animals. On average,

students responded that they go hiking ‘sometimes’ (Table 3.4). This may have more to do with lack of opportunities than lack of desire.

Table 3.4. Mean Likert Scores for Behavior Statements, Combined Control and Treatment (Pre-Test)

Variable	Mean	Std Dev	Median	N
trash	4.100	1.883	5	658
learn_an	4.053	1.546	4	647
hike	3.111	1.585	3	651
avg_behav	3.741	0.970	3.667	661

Most students answered less than half the questions in the knowledge section correctly (Figure 3.4). Most students had a positive average attitude toward the environment while very few students had a negative average attitude (Figure 3.5). On average, most students tended to report performing the environmental behaviors sometimes, many/sufficient times, and almost always while few students reported performing the behaviors never, almost never, and always (Figure 3.6).

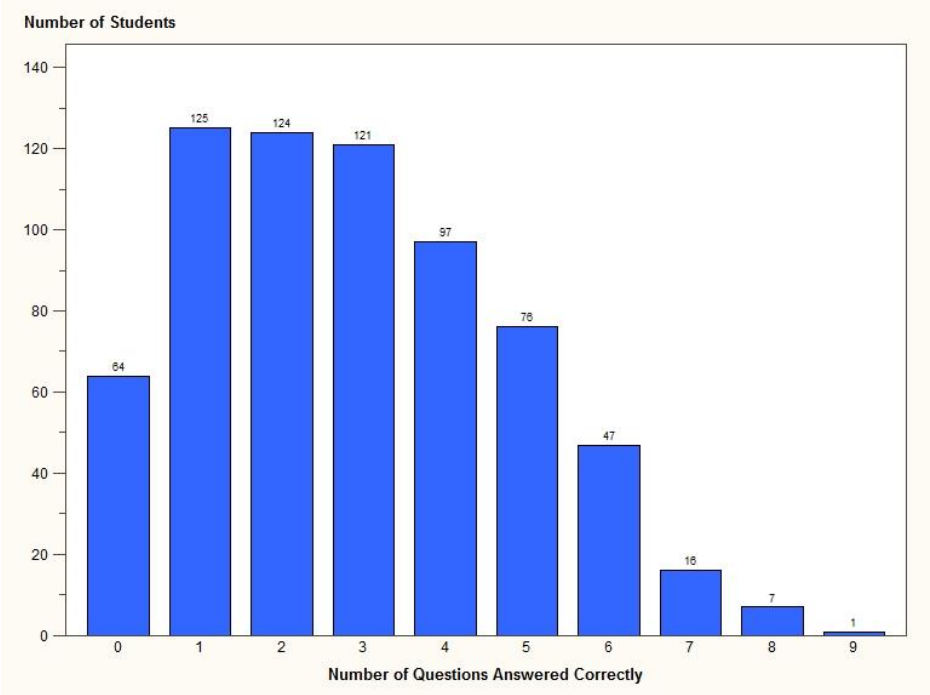

Figure 3.4. Number of questions answered correctly in knowledge section.

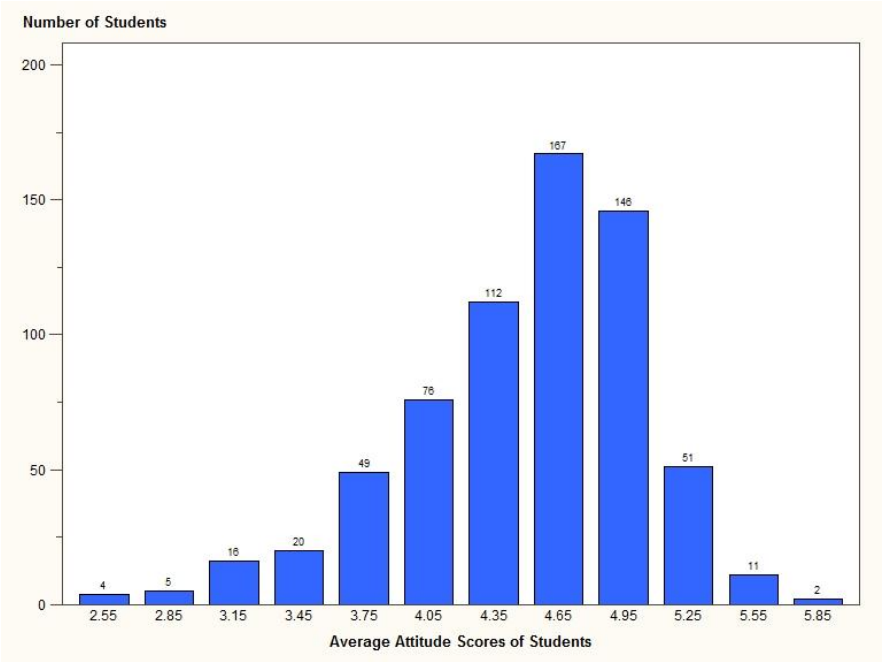

Figure 3.5. Average attitude scores of students.

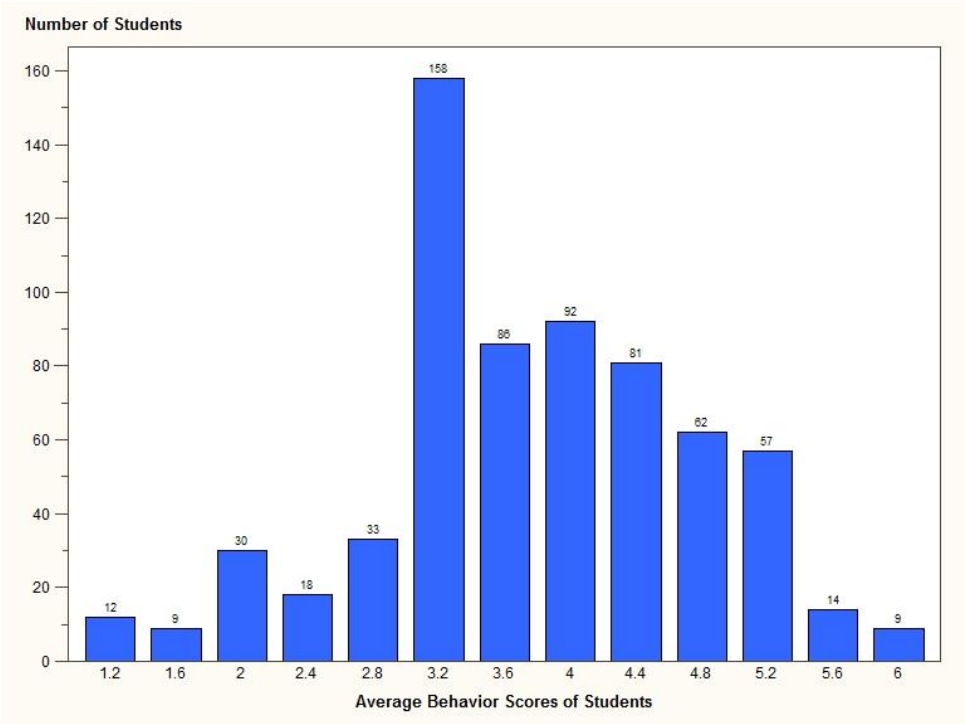

Figure 3.6. Average behavior scores of students.

3.4 Results: Variables Influence on Knowledge, Attitudes, and Behavior

Male and female students do not differ in their environmental knowledge, except on the question of 'what does introduced plant mean' (Table 3.5). Fifty-three percent of females answered correctly while only 44% of males answered correctly. Sex was a slightly significant predictor for three of the attitude statements (no_preserv_pos, camp, know_nat) (Table 3.6). Females had a slightly more pro-environmental view about preserving non-forested natural areas and expressed more desire to go to an environmental camp at SMNP if one was offered. Also, females thought it is more important to know/visit natural or protected areas. For the average attitude score, females had slightly more pro-environmental

view than males. However, males indicated they hiked more frequently (score = 3.3) than females (2.9). The other behaviors did not vary significantly with sex of the respondent.

Table 3.5. Chi Square Tests of Association between Sex and Environmental Knowledge (Pre-Test)

Variable	Value	Prob	N
def_end	0.0070	0.9335	426
def_intr	4.3983	0.0360**	540
why_park	0.0882	0.7665	576
soil_ero	0.3285	0.5665	569
monk	1.0291	0.3104	564
lant	0.3709	0.5425	546
ling	1.7971	0.1801	565
kalip	0.0161	0.8989	562
biodiv	0.0066	0.9353	337

Table 3.6. Mann-Whitney U Tests Comparing Attitude Statements by Sex (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N male	N female
loose_goats_pos	1.0190	0.3082	286	326
park_rich_pos	-0.7271	0.4672	291	332
remove	-1.0820	0.2792	279	315
no_preserv_pos	-1.7552	0.0792*	279	320
lots_nat_pos	-0.0449	0.4821	284	321
too_big_pos	1.3639	0.1726	271	307
future_vis	-1.0478	0.2947	286	327
camp	-1.9136	0.0557*	273	323
know_nat	-1.9526	0.0509*	281	330
good_prot	-1.2468	0.2125	282	327
refor	-0.1582	0.8743	274	305
ero_prob	-1.3311	0.1831	280	320
avg_attitude	-2.8465	0.0044***	293	334
percent_know	-0.7096	0.4779	303	347
percent_know_miss_incl	-0.6285	0.5297	303	347

Table 3.7. Mann-Whitney U Tests Comparing Behavior Statements by Sex (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N male	N female
trash	-0.8249	0.4094	291	335
learn_an	1.1837	0.2365	285	332
hike	2.4295	0.0151**	288	332
avg_behav	1.2356	0.2166	293	336

Whether students are from an urban or rural area could impact their knowledge, attitudes, and behavior. Students from urban areas were significantly more likely to know the terms endemic, introduced, and biodiversity (Table 3.8). Students' attitudes about 'the park being for rich people', 'not needing to preserve non-forested land', 'desire to visit the park in the future', 'thinking it is important to know/visit natural area', and 'thinking that it is good SMNP is protected' are also affected by where students live, with urban students having more pro-environmental views (Table 3.9). Likewise, rural versus urban is a significant predictor for all three behavior statements. Urban students avoid throwing trash on the ground more than rural students. However, rural students hike more frequently and try and learn more about local plants and animals (Table 3.10).

Table 3.8. Chi Square Tests of Association between Zone of Residence and Environmental Knowledge (Pre-Test)

Variable	Value	Prob	N
def_end	4.2380	0.0395**	414
def_intr	8.3791	0.0038***	520
why_park	0.0002	0.9880	557
soil_ero	1.2533	0.2629	548
monk	1.7348	0.1878	541
lant	0.8895	0.3456	526
ling	2.1354	0.1439	539
kalip	0.6091	0.4351	535
biodiv	21.1564	<.0001***	324

Table 3.9. Mann-Whitney U Tests Comparing Attitude Statements by Zone of Residence (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N rural	N urban
loose_goats_pos	-1.5950	0.1107	186	409
park_rich_pos	-6.1006	<.0001***	188	414
remove	1.4217	0.1551	176	398
no_preserv_pos	-4.9568	<.0001***	177	401
lots_nat_pos	1.2751	0.2023	183	403
too_big_pos	-1.2512	0.2109	176	385
future_vis	-2.3915	0.0168**	186	410
camp	-0.9225	0.3563	174	399
know_nat	-5.3455	<.0001***	183	410
good_prot	-4.0541	<.0001***	184	404
refor	-0.7911	0.4289	170	388
ero_prob	-1.4982	0.1341	181	400
avg_attitude	-4.4804	<.0001***	191	417
percent_know	-3.5145	0.0004***	198	429
percent_know_miss_incl	-4.3591	<.0001***	198	429

Table 3.10. Mann-Whitney U Tests Comparing Behavior Statements by Zone of Residence (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N rural	N urban
trash	-3.4814	0.0005***	191	412
learn_an	3.0734	0.0021***	184	410
hike	2.1833	0.0290**	187	409
avg_behav	-0.6682	0.5040	193	413

I evaluated whether students who have visited Serra Malagueta had more knowledge and more positive attitudes towards biodiversity, conservation, and the park. Having visited the park significantly increases total percent correct; however, knowledge of eucalyptus being introduced is the only question in the knowledge section that students who had visited the park are more likely to get correct. Students who have visited the park are more likely to disagree that the park is too big (too_big_pos). Students who had visited the park were more likely to report hiking (Table 3.13), perhaps because they enjoyed their experience in the park.

Table 3.11. Chi Square Tests of Association between Previous Visit and Environmental Knowledge (Pre-Test)

Variable	Value	Prob	N
def_end	0.4202	0.5169	439
def_intr	0.8648	0.3524	556
why_park	0.2922	0.5888	594
soil_ero	2.6499	0.1036	587
monk	0.0105	0.9183	579
lant	0.0899	0.7643	563
ling	1.5521	0.2128	578
kalip	6.6841	0.0097***	572
biodiv	0.0840	0.7719	342

Table 3.12. Mann-Whitney U Tests Comparing Attitude Statements by Previous Visit (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N no previous visit	N previous visit
loose_goats_pos	0.5968	0.5507	498	139
park_rich_pos	-0.6451	0.5188	504	142
remove	0.2967	0.7667	481	136
no_preserv_pos	-0.2761	0.7825	484	137
lots_nat_pos	1.3019	0.1930	488	139
too_big_pos	1.7077	0.0877*	466	136
future_vis	-1.1486	0.2507	500	139
camp	1.0050	0.3149	481	136
know_nat	1.4492	0.1473	498	138
good_prot	0.3789	0.7047	493	139
refor	0.4436	0.6573	468	133
ero_prob	-0.9939	0.3203	483	140
avg_attitude	0.7345	0.4626	511	142
percent_know	2.1235	0.0337**	529	145
percent_know_miss_incl	2.3843	0.0171**	529	145

Table 3.13. Mann-Whitney U Tests Comparing Behavior Statements by Previous Visit (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N no previous visit	N previous visit
trash	-0.2710	0.7864	511	142
learn_an	-1.2201	0.2224	502	140
hike	2.4305	0.0151**	505	141
avg_behav	0.2308	0.8175	514	142

While visiting the park exposes students to environmental resources, they should learn more about those resources if they participate in a guided hike in the park. Tables 3.14, 3.15, and 3.16 compare students who had a guided tour when they visited the park with students who had visited the park but not participated in a guided hike. Compared to other

students who had also visited the park, students who had participated in a guided hike were significantly less likely to know that monkeys were introduced to Cape Verde. Because wild monkeys are located on Santiago Island, many people perceive them as being native. Evidently the park guides did not effectively communicate to visitors that the monkeys were in fact introduced to Cape Verde. Previous guided visit was a significant predictor for only two attitudes and one behavior: know_nat, ero_prob, and hike. Students who had a guided visit agreed more with the statements that it is important to visit/know natural or protected areas and that soil erosion is a big problem on Santiago Island. Compared to other students who had visited the park, students who had participated in a guided hike reported they go hiking more frequently. In general, participating in a guided hike does not appear to have a significant impact on student knowledge, attitudes, or behavior, above and beyond the impact of simply visiting the park.

Table 3.14. Chi Square Tests of Association between Previous Guided Visit and Environmental Knowledge (Pre-Test)

Variable	Value	Prob	N
def_end	1.4912	0.2220	103
def_intr	0.0080	0.9285	115
why_park	0.3394	0.5602	126
soil_ero	0.9843	0.3211	118
monk	3.0534	0.0806*	114
lant	0.0449	0.8321	115
ling	0.4215	0.5162	121
kalip	0.9784	0.3226	115
biodiv	0.0140	0.9059	74

Table 3.15. Mann-Whitney U Tests Comparing Attitude Statements by Previous Guided Visit (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N no previous guided visit	N previous guided visit
loose_goats_pos	-0.5562	0.5781	38	90
park_rich_pos	1.3370	0.1812	39	92
remove	1.2603	0.2076	38	88
no_preserv_pos	0.1301	0.8965	39	88
lots_nat_pos	1.1665	0.2434	38	90
too_big_pos	0.1149	0.9085	38	87
future_vis	-0.3775	0.7058	39	90
camp	0.1133	0.9098	39	89
know_nat	-1.7602	0.0784*	38	89
good_prot	1.2633	0.2065	39	90
refor	-0.5063	0.6127	37	87
ero_prob	-2.1587	0.0309**	39	91
avg_attitude	-0.1740	0.8619	39	92
percent_know	0.7707	0.4409	39	95
percent_know_miss_incl	0.9229	0.3561	39	95

Table 3.16. Mann-Whitney U Tests Comparing Behavior Statements by Previous Guided Visit (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N no previous guided visit	N previous guided visit
trash	0.5757	0.5648	39	92
learn_an	-1.0079	0.3135	39	91
hike	-2.4776	0.0066***	39	91
avg_behav	-1.5623	0.1182	39	92

I tested the influence of having a family member who had visited the park on knowledge, attitudes, and behavior. Students who had another family member that had visited SMNP were significantly more likely to know why SMNP is considered a park and what the main cause of soil erosion is, compared to students who did not have a family member who had visited SMNP (Table 3.17). Students who had another family member that

had visited the park were more likely to disagree with the statement that there are lots of natural areas left on Santiago Island (Table 3.18) and expressed that they hike more often (Table 3.19).

Table 3.17. Chi Square Tests of Association between Having a Family Member who Visited the Park and Environmental Knowledge (Pre-Test)

Variable	Value	Prob	N
def_end	0.3782	0.5386	429
def_intr	0.7855	0.3755	540
why_park	3.8531	0.0497**	578
soil_ero	5.4182	0.0199**	572
monk	0.0120	0.9128	562
lant	0.5235	0.4694	549
ling	0.1194	0.7297	563
kalip	0.9862	0.3207	558
biodiv	0.8010	0.3708	334

Table 3.18. Mann-Whitney U Tests Comparing Attitude Statements by Having a Family Member who Visited the Park (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N no family member visit	N family member visit
loose_goats_pos	1.1037	0.2697	264	356
park_rich_pos	-0.7833	0.4334	268	362
remove	1.0654	0.2867	255	345
no_preserv_pos	-1.4065	0.1596	254	351
lots_nat_pos	-1.9262	0.0541*	256	356
too_big_pos	-0.0934	0.9256	250	337
future_vis	-0.8307	0.4061	264	359
camp	-0.8741	0.3820	254	347
know_nat	0.2650	0.7910	263	356
good_prot	-0.6593	0.5097	262	353
refor	0.3635	0.7162	247	338
ero_prob	-0.3217	0.7477	259	348
avg_attitude	-0.6348	0.5256	272	364
percent_know	-1.0019	0.3164	278	378
percent_know_miss_incl	-1.2545	0.2096	278	378

Table 3.19. Mann-Whitney U Tests Comparing Behavior Statements by Having a Family Member who Visited the Park (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N no family member visit	N family member visit
trash	-0.4030	0.6870	269	367
learn_an	0.4289	0.6680	264	361
hike	-2.8377	0.0045***	266	363
avg_behav	-1.7036	0.0884*	270	368

Socio-economic status is often associated with knowledge, attitudes, and behaviors. In Cape Verde, ownership of a car is generally considered to be an indicator of wealth. However, car ownership was only related to one environmental attitude and none of the behaviors. It was only significant with the variable refor, so students whose families own a

car are more likely to think that is important for the park to reforest with native plants (Table 3.21). Car ownership did have significant associations with def_end, monk, and biodiv (Table 3.20). Students whose families own cars were significantly more likely to know the definitions of endemic and biodiversity and know that monkeys are not native to Cape Verde (Table 3.20). The overall percent correct for the knowledge section (both when missing values are excluded and treated as incorrect responses) was significantly greater for students whose family owns a car (Table 3.21).

Table 3.20. Chi Square Tests of Association between Family Car and Environmental Knowledge (Pre-Test)

Variable	Value	Prob	N
def_end	7.8672	0.0050***	438
def_intr	1.7620	0.1844	555
why_park	0.8141	0.3669	593
soil_ero	2.1780	0.1400	585
monk	3.3278	0.0681*	577
lant	1.5384	0.2149	561
ling	0.0008	0.9775	576
kalip	1.1389	0.2859	570
biodiv	3.9648	0.0465**	341

Table 3.21. Mann-Whitney U Tests Comparing Attitude Statements by Family Car (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N no family car	N family car
loose_goats_pos	-0.4168	0.6769	251	386
park_rich_pos	0.3857	0.6997	255	391
remove	-0.7609	0.4467	241	375
no_preserv_pos	-1.2068	0.2275	243	378
lots_nat_pos	0.5466	0.5846	247	380
too_big_pos	-0.7778	0.4367	234	368
future_vis	0.6036	0.5461	251	388
camp	-0.1424	0.8868	244	374
know_nat	0.5030	0.6150	250	386
good_prot	-1.4105	0.1584	251	381
refor	-2.1274	0.0334**	240	360
ero_prob	-1.5358	0.1246	245	377
avg_attitude	-1.2220	0.2217	257	396
percent_know	-2.2198	0.0264**	269	404
percent_know_miss_incl	-1.7808	0.0749*	269	404

Table 3.22. Mann-Whitney U Tests Comparing Behavior Statements by Family Car (Pre-Test)

Variable	Normal Approx. Z	Pr > |Z|	N no family car	N family car
trash	-1.5825	0.1135	258	394
learn_an	0.5486	0.5833	249	392
hike	-0.5971	0.5505	251	394
avg_behav	-1.2922	0.1963	258	397

Age has a significant relationship with almost all of the variables. As expected, older children had more knowledge about the environment and also reported more pro-environmental attitudes. Knowing whether monkey and eucalyptus are endemic, introduced, or invasive are the only knowledge questions that were not significantly impacted by age (Table 3.23). Age is a significant predictor of all the attitudes except if 'loose goats should

be allowed to roam freely.' Only two of the attitudes became more positive as age decreased: 'should determined plants be removed from the park' and 'there are lots of natural areas on Santiago Island.' The rest of the attitude statements became more pro-environmental as age increased (Table 3.24). 'Learning about local plants and animals' was the only behavior that is not significantly impacted by age. As age decreased students hike more frequently, but as students become older they are more likely to avoid throwing trash on the ground (Table 3.25).

Table 3.23. Nominal Logistic Regression with Age as the Predictor and Knowledge Questions as the Response (Pre-Test)

Variable	ChiSquare	Prob>Chi Square	Parameter	Pr	N	R^2
def_end	25.4127	<.0001***	-0.1987	<.0001	434	0.0428
def_intr	26.8932	<.0001***	-0.1736	<.0001	554	0.0350
why_park	8.8571	0.0029***	-0.1085	0.0032	590	0.0133
soil_ero	20.4310	<.0001***	-0.1468	<.0001	582	0.0256
monk	0.0036	0.9520	-0.0022	0.9520	572	0.0000
lant	8.2109	0.0042***	-0.0939	0.0045	556	0.0109
ling	18.8598	<.0001***	-0.1386	<.0001	570	0.0239
kalip	0.9034	0.3419	-0.0305	0.3423	564	0.0012
biodiv	85.8123	<.0001***	-0.4863	<.0001	340	0.1827
percent_know	98.9715	<.0001***	0.0311	<.0001	667	0.1295
percent_know_ miss_incl	124.0275	<.0001***	0.0318	<.0001	667	0.1572

The DF for all the models is 1
Percent_know and percent_know_miss_incl are linear regressions and display F ratio and Prob > F
Negative parameter estimates for the logistic regressions signifies positive increase in knowledge with increase in age
*Intercepts are not included in any of the regression results tables

Table 3.24. Ordinal Logistic Regression with Age as the Predictor and Attitude Statements as the Response (Pre-Test)

Variable	ChiSquare	Prob>Chi Square	Parameter	Prob	N	R^2
loose_goats_pos	1.2325	0.2669	-0.0315	0.2651	632	0.0007
park_rich_pos	136.333	<.0001***	-0.3562	<.0001	641	0.0808
remove	20.5420	<.0001***	0.1229	<.0001	612	0.0096
no_preserv_pos	53.7282	<.0001***	-0.2078	<.0001	616	0.0280
lots_nat_pos	7.8266	0.0051***	0.0771	0.0052	622	0.0041
too_big_pos	9.5890	0.0020***	-0.0854	0.0018	597	0.0048
future_vis	25.0031	<.0001***	-0.1472	<.0001	634	0.0171
camp	2.9116	0.0879*	-0.0507	0.0842	612	0.0021
know_nat	30.9819	<.0001***	-0.1648	<.0001	631	0.0219
good_prot	10.4449	0.0012***	-0.0943	0.0013	627	0.0071
refor	4.9132	0.0267**	-0.0627	0.0255	595	0.0027
ero_prob	7.5736	0.0059***	-0.0757	0.0054	617	0.0038
avg_attitude	62.6760	<.0001***	0.0618	<.0001	648	0.0884

DF is 1 for all models
Avg_attitude is a linear regression and displays F ratio and Prob > F
Negative parameter estimates for the logistic regressions signifies positive increase in attitudes with increase in age

Table 3.25. Ordinal Logistic Regression with Age as the Predictor and Behavior Statements as the Response (Pre-Test)

Variable	ChiSquare	Prob>Chi Square	Parameter	Prob	N	R^2
trash	41.1226	<0.0001***	-0.1813	<.0001	647	0.0198
learn_an	1.7373	0.1875	0.0349	0.1904	637	0.0008
hike	8.8765	0.0029***	0.0790	0.0031	640	0.0041
avg_behav	8.3047	0.0041***	0.0411	0.0041	650	0.0127

DF is 1 for all models
Avg_behav is a linear regression and displays F ratio and Prob > F
Negative parameter estimates for the logistic regressions signifies positive increase in behavior with increase in age

Grade was also a highly significant predictor of knowledge, attitudes, and behavior (Table 3.26, 3.27, and 3.28). Children in higher grades knew more about the environment, and have more pro-environmental attitudes. As grade level increases students were more likely to respond correctly to all of the knowledge questions except for knowing that monkey

is an introduced specie (Table 3.26). As with age, the only two attitude statements that become more pro-environmental as grade level decreases are 'determined plants should be removed from the park' and 'there are lots of natural areas on Santiago Island' (Table 3.27). Students were more likely to avoid throwing trash on the ground as grade level increases, but were less likely to hike as grade level increases. Trying to learn about local plants and animals was not influenced by grade level (Table 3.28). Thus, grade not only impacts what students know, but also their attitudes about the park and conservation and their environmental behaviors.

Table 3.26. Nominal Logistic Regression with Grade as the Predictor and Knowledge Questions as the Response (Pre-Test)

Variable	ChiSquare	Prob>Chi Square	Parameter	Prob	N	R^2
def_end	47.1924	<.0001***	-0.2978	<.0001	440	0.0783
def_intr	51.7943	<.0001***	-0.2689	<.0001	559	0.0669
why_park	17.0866	<.0001***	-0.1702	<.0001	597	0.0255
soil_ero	45.1255	<.0001***	-0.2440	<.0001	589	0.0560
monk	2.4804	0.1153	-0.0641	0.1174	582	0.0037
lant	10.2656	0.0014***	-0.1167	0.0015	566	0.0135
ling	29.6020	<.0001***	-0.1930	<.0001	581	0.0368
kalip	3.4992	0.0614***	-0.0666	0.0621	574	0.0044
biodiv	133.3684	<.0001***	-0.7086	<.0001	345	0.2799
percent_know	200.4754	<.0001***	0.0457	<.0001	678	0.2287
percent_know_ miss_incl	261.4999	<.0001***	0.0467	<.0001	678	0.2789

*DF for all models is 1
Percent_know and percent_know_miss_incl are linear regressions and display F ratio and Prob > F
Negative parameter estimates for the logistic regressions signifies positive increase in knowledge with increase in grade

Table 3.27. Ordinal Logistic Regression with Grade as the Predictor and Attitude Statements as the Response (Pre-Test)

Variable	ChiSquare	Prob>Chi Square	Parameter	Prob	N	R^2
loose_goats_pos	4.9964	0.0254**	-0.0692	0.0247	643	0.0030
park_rich_pos	200.7445	<.0001***	-0.4821	<.0001	652	0.1162
remove	27.3284	<.0001***	0.1570	<.0001	622	0.0126
no_preserv_pos	81.0204	<.0001***	-0.2806	<.0001	627	0.0415
lots_nat_pos	5.0672	0.0244**	0.0686	0.0229	633	0.0026
too_big_pos	24.9549	<.0001***	-0.1519	<.0001	608	0.0123
future_vis	36.1001	<.0001***	-0.1937	<.0001	645	0.0242
camp	8.3563	0.0038***	-0.0935	0.0038	623	0.0059
know_nat	51.1388	<.0001***	-0.2340	<.0001	642	0.0354
good_prot	23.8666	<.0001***	-0.1584	<.0001	638	0.0160
refor	17.1362	<.0001***	-0.1294	<.0001	605	0.0092
ero_prob	12.7131	0.0004***	-0.1084	0.0003	628	0.0062
avg_attitude	133.8722	<.0001***	0.0949	<.0001	659	0.1693

DF is 1 for all models
Avg_attitude is a linear regression and displays F ratio and Prob > F
Negative parameter estimates for the logistic regressions signifies positive increase in attitudes with increase in grade

Table 3.28. Ordinal Logistic Regression with Grade as the Predictor and Behavior Statements as the Response (Pre-Test)

Variable	ChiSquare	Prob>Chi Square	Parameter	Prob	N	R^2
trash	55.4485	<.0001***	-0.2285	<.0001	658	0.0264
learn_an	2.2703	0.1319	0.0442	0.1289	647	0.0010
hike	15.1802	<.0001***	0.1147	<.0001	651	0.0068
avg_behav	9.3507	0.0023***	0.0476	0.0023	661	0.0140

DF is 1 for all models
Avg_behav is a linear regression and displays F ratio and Prob > F
Negative parameter estimates for the logistic regressions signifies positive increase in behavior with increase in grade

Only two classes surveyed were from a private school. All the rest of the groups in the study are from public schools. On average, students from private schools answered an average of 64% correct, in comparison to the public school students (38% correct on

average) (Table 3.29). Their average attitude and behavior score were similar, but both average attitude and behavior scores for private school students were significantly higher than public school students when using Mann-Whitney U tests.

Table 3.29. Comparison between Public and Private School Scores

Variable (Public)	Mean	Std Dev	N	Variable (Private)	Mean	Std Dev	N
%_know***	0.3756	0.2217	639	%_know	0.6405	0.225	39
%_know_miss_incl***	0.3067	0.2043	639	%_know_miss_incl	0.5670	0.202	39
avg_attitude***	4.4702	0.5597	620	avg_attitude	4.7257	0.440	39
avg_behav*	3.7197	0.9641	622	avg_behav	4.0855	1.017	39

3.5 Discussion

About 40-50% of the students correctly answered each of the knowledge questions, suggesting that 5th-12th grade students on Santiago Island do have some level of environmental knowledge. The only two exceptions were the questions about why Serra Malagueta is a natural park (25% correct) and whether monkeys are introduced, endemic, or invasive (26% correct). It is possible that students did not correctly answer why Serra Malagueta is a natural park because all of the answers listed were correct and thus they were supposed to choose "all of the above." Nevertheless, park educators should emphasize the diversity of reasons for designating natural parks and the many different values of the protected areas system. Students had answer choices for all of the questions except for one fill in the blank question. Four questions were multiple-choice with four options to choose

from, so it is expected that about 25% answer each multiple-choice question correctly by random chance. Students had three options to select from for the other four questions, so it is expected that approximately 33% answer each of these questions correctly. None of the questions had more than a 50% correct response rate, and thus, all of the question topics would be worth including in conservation education programs in Cape Verde.

In general, student attitudes towards conservation, biodiversity, and natural parks are positive. However, students tend to think that it is not good to remove determined plants from the park, that there are lots of natural areas on Santiago Island, and that the park is too big. It is possible that previous environmental or ecological education in the schools had taught students to think that no plants should be removed from natural areas. Also, students may have learned about the remaining natural areas on Santiago Island and been impressed with the size of the park, but not received this information in the context of how relatively little is left of Cape Verde's natural ecosystems and endemic biodiversity. The conservation education program in the park could help address these perceptions by explaining why it is important to remove invasive plants and by emphasizing the change in land cover on Santiago Island, showing that there are relatively few remnants of original vegetation and that the park covers only a small portion of the island. The survey results indicate that it would also be relevant to provide information on habitat requirements and to explain the benefits of protecting larger areas. Finally, the students' reported behaviors suggest that they are interested in learning about local plants and animals, but they perhaps have limited opportunities because on average, they only go hiking "sometimes."

Age and grade had the most influence on students' knowledge, attitudes, and behaviors. Older students and students in higher grade levels had a higher percent correct for the knowledge questions, which confirms the expectation that students gain knowledge about biodiversity, conservation, and protected areas as they grow older and proceed through school grades. Generally, attitudes become more positive as age and grade level increase, with the exception of responses to two of the attitude statements: determined plants should be removed from the park and there are lots of natural areas on Santiago Island. As students increased in grade level and age they were more likely to avoid throwing trash on the ground but are less likely to go hiking. Even though regressions of most knowledge, attitudes, and behaviors on age or grade are significant, the R-square values are not very high, especially for attitudes and behaviors. While this suggests that age and grade explain very little of the variation, the estimation results do still suggest that conservation education programs can assume that older students in more advanced grades start with more knowledge and more favorable attitudes. Even though age and grade influence students' environmental knowledge, attitudes, and behaviors, Leeming et al.'s (1993) review of environmental education studies noted that many do not compare age groups.

Whether students had previously visited SMNP did not have a significant effect on their responses to most of the individual questions about environmental knowledge, attitudes, and behavior. However, students who had previously visited the park do answer a significantly higher mean percentage of the knowledge questions correctly, suggesting that visiting the park increases overall knowledge. However, because student groups usually spend only a couple hours at the park, students may not retain enough of what they learned to

have a significant impact on individual questions. Alternatively, teachers may cover the same material with students who do not visit the park, thus reducing the differences between students who visited the park and those who did not. Among students who had previously visited the park, having a guided tour or not does not have any statistically significant impact on knowledge, attitudes or behaviors. It is surprising that previous park visit does not have a stronger influence on knowledge and attitudes because Kruse and Card (2004) did find more pro-conservation attitudes and higher self-reported knowledge on a pre-test with campers who had prior camp experience. Also, it is surprising that one fifth of the students who filled out the pre-test had previously visited the park. Therefore, the park has the opportunity to influence a lot of students. Whether a family member had previously visited the park does not significantly influence students' knowledge or attitudes, but it does impact overall behavior. Students with a family member that has previously visited the park express more pro-environmental behaviors. Kuhar at al. (2010) hypothesized that siblings/friends share information based on their experience at a conservation education program in Uganda and that is a possible reason why pre-test performance increased after the initial year. Family members who visited SMNP could be sharing information about their park visit that is influencing students' behaviors.

Student knowledge, attitudes and behavior were affected by some other socio-demographic characteristics suggested by the literature. In general, females had more environmentally positive attitudes, but males hike more. This differs from one previous study, where Braun et al. (2010) did not find a significant difference in attitudes towards non-native species between boys' and girls' pre-test scores. Students who lived in urban (rather

than rural) areas generally had more knowledge of environmental concepts and more positive attitudes towards the environment. Urban students were more likely to avoid throwing trash on the ground, while rural students try to learn more about local plants and animals and hike more frequently. Students' socioeconomic status, as proxied by whether their family owns a car, does not influence their responses to the questionnaire. Understanding how these different factors influence students' environmental knowledge, attitudes, and behavior can help park staff prepare for visiting school groups.

This information can help SMNP to plan their conservation education programs to address gaps in students' knowledge about biodiversity, conservation, and nature. Park staff in charge of these programs can also benefit from information on the attitudes and behaviors of students when they arrive at the park. For example, this might suggest topics requiring greater emphasis or simpler explanations.

4 COMPARISON OF PRE AND POST-TESTS (RESULTS AND ANALYSIS)

4.1 Introduction

Protected areas around the world are investing in conservation education and interpretation programs; they host visitors with the objectives of improving knowledge and generating positive attitudes and behaviors towards the protected area and biodiversity conservation. While there is a large body of research on these programs in developed countries, these findings may not apply to developing countries, where there are typically higher rates of absolute poverty, higher proportions of the population directly dependent on agriculture and harvest of natural resources, and lower educational attainment. Additionally, there is relatively little research on the effectiveness of conservation education programs in developing countries. I evaluated the impact of a typical conservation education program on the environmental knowledge, attitudes, and behaviors of schoolchildren who participated in the program in a protected area in Cape Verde. Typically, schoolchildren who visit Serra Malagueta Natural Park (SMNP) participate in a conservation education program. I hypothesize that these students will gain knowledge of, develop more positive attitudes towards, and increase behaviors compatible with the protected areas system and conservation of biodiversity.

Cape Verde (located in the Sahel region of Africa) is a typical "small island developing state" (SIDS), with many endemic species threatened by high human population density and the resulting intense pressure on natural resources. With support from United Nations Development Program (UNDP), Global Environment Facility (GEF), and Cape

Verdean government, Cape Verde created a system of protected areas in 2003 to help conserve terrestrial and marine areas and their biodiversity. Of the 47 protected areas in the system, nine are "natural parks," (park staff, personal communication, March 14, 2013) which "…are little-disturbed natural spaces that carry principally natural systems with their ecosystems, habitats, species and representative samples of the country's biodiversity. In these parks resident local population can live and take advantage of the natural resources following traditional practices (Gomes et al., 2003:8)."

Serra Malagueta Natural Park is one of the first functioning natural parks. SMNP protects Cape Verde's biodiversity, and offers visitors a chance to experience and learn about that biodiversity. One of the major tasks for the ecotourism department of the park is hosting visitors, especially school children who participate in a conservation education program. An evaluation of the program would help the park staff decide whether they are getting a good return on the time invested in the conservation education program and whether and how the program could be re-designed to increase its impact.

Cape Verde is an archipelago of 10 islands and 8 islets located approximately 600 km west of Senegal, with a total land area of 4030 km^2 (Heckman, 1985). None of Cape Verde's islands were inhabited until the Portuguese settled there in the 15th century (Heckman, 1985). In 2010, the population was 491,638 (INE, 2010). Cape Verde faces numerous environmental challenges such as soil erosion, drought, desertification, overhunting, invasive species and clearing land for agriculture, which threaten Cape Verde's biodiversity. According to Duarte and Moreira, human influences have left Santiago Island with almost no

natural ecosystems (as cited in Duarte et al., 2005), and native and endemic species are constrained to limited ecological niches (Duarte et al., 2005).

Serra Malagueta Natural Park is located in the northern interior part of Santiago Island, which is the largest island of the archipelago and supports the largest population. Santiago Island covers around 991km^2 (Duarte et al., 2005). Approximately 273,919 people live on Santiago Island (INE, 2010), and there are approximately 265 people living in four traditional communities located inside the park. Serra Malagueta Natural Park was created in 2003, but began functioning in 2005 (Park staff, personal communication, February 11, 2013). The park aims to preserve biodiversity, promote the sustainable development of communities living in and around the park, and educate the people of Cape Verde about biodiversity and nature conservation. Most of the park visitors are student groups from primary and secondary schools throughout Santiago Island.

This chapter evaluates the conservation education program at SMNP by assessing its impacts on student visitors' knowledge, attitudes, and behaviors relevant to the environment. Data were collected via a self-administered questionnaire, completed by students before and after their visit to the park, as well as by students in similar classrooms that did not visit the park. This evaluation will not only help SMNP, but can assist the other parks and protected areas in Cape Verde with their current and future environmental education programs. This study contributes to the literature on environmental education by implementing a rigorous, quantitative evaluation of a conservation education program in an African SIDS.

Evaluations are important tools that can be used to improve conservation education programs (Bennett, 1989; Jacobson, 1987b; Thomas, 1990). Even though evaluations have

numerous positive benefits, they are not always undertaken, for a variety of reasons: lack of funding, shifting resources to evaluation, not included in the initial plan, thinking the program is fine, and the perception that evaluation can create negative opinions (Thomas, 1990). This study overcomes these evaluation barriers. Neither funding nor diversion of funds or human resources was an issue because I was self-funded and it had little impact on my other duties as a Peace Corps volunteer. This evaluation was not initiated by the park administration, but they did assist with the research and were very supportive.

There are many factors that can influence students' environmental knowledge, attitudes, and behaviors. Variables selected for this study were based on my experience in Cape Verde and literature about program evaluation of environmental and interpretive education programs (Beaumont, 2001; Bitgood, 1989; Braun et al., 2010; Hendricks, 2000; Lisowski & Disinger, 1991; Shepard & Speelman, 1986, Stephath, 2007; Wagner et al., 2009). In terms of variables that impact students' learning from conservation education programs, Shepard and Speelman (1986) suggest that possible correlates of environmental attitude development appear to be program length, previous camp experience, camper age, and area of residence in their study based on groups of 4-H campers that participated in an outdoor education program during their camp in Ohio. Previous experience and knowledge has been found to be an important factor in effectiveness of education and interpretation programs (Beaumont, 2001; Lisowski & Disinger, 1991; Shepard & Speelman, 1986; Stepath, 2007). Socio-demographic characteristics of participants may also mediate the impact of conservation education programs on participants (Braun et al, 2010; Hendricks,

2000; Stevenson et al., 2013). Bitgood (1989) also acknowledges that grade level could influence how much students learn from field trips.

Characteristics of the conservation program also influence how much impact it has on students' knowledge attitudes, and behaviors. Kuhar et al. showed that the effectiveness of a conservation education program varies across program presenters and audiences (as cited in Bettinger et al., 2010). In general, the delivery of a program, the audience, and the content all influence the effectiveness of conservation education programs (Bettinger et al., 2010). For example, Wagner et al. (2009) noted quality of staff and quality of exhibits were the major factors influencing conservation outcomes (knowledge, motivation, attitudes, readiness to take action, and pro-conservation consumer skills) at a zoo. Bitgood (1989) argued that group size and duration of programs both matter to school fieldtrips; larger groups could encounter problems because of limited space and distance between participants and instructors.

According to Norris and Jacobson's (1998) content analysis of 56 reports of tropical conservation education programs, program location (what continent), publication type (journal, book, or proceedings), sponsorship (multiagency, international, national, private), and program length (greater or less than 3 years) are not significantly associated with findings of success. However, they did observe a trend that programs in existence at least three years were more successful than relatively new programs that had existed less than three years. Also, they noted that formative (evaluation during the program) and long-term evaluations (evaluations at least 6 months after the program) are more likely to find that

programs are successful, while summative evaluation (evaluation directly after the program) is not associated with program success.

4.2 Methods

To evaluate the conservation education program at SMNP, students and teachers were surveyed about their environmental knowledge, attitudes, and behavior[1]. Students and teachers from fifth through twelfth grades were sampled. The sample included a "treatment" and a "control" group. The "treatment" group consisted of student groups (10 groups from 10 schools made up of approximately 16 classes) who visited the park and participated in the conservation education program between 3/1/11 and 6/20/11. The objective was to have these students fill out the questionnaire three times: once *before* they participated in the conservation education program (called a pre-test) and twice *after* they participated (post-tests). The purpose of the second post-test was to evaluate retention of knowledge, attitudes, and behaviors over time. Kruse and Card (2004) and Kuhar et al. (2010) used a delayed-post-test a month after the program, but they used an immediate first-post-test. All ten groups completed the pre-test and at least one post-test, while only two groups with approximately seven classes completed two post-tests. Throughout the rest of the chapter I will only refer to the first post-test. The "control" group consisted of similar classes who did not visit the park. The objective was to have these students fill out the questionnaire twice. Twelve groups from seven schools completed the questionnaire at least once. I label these "pre-test" (first time taking test) and "post-test" (second time taking the test). They were

[1] Survey protocol and instruments were reviewed and approved by NCSU IRB #1894

typically completed around the same time as the post-tests for the treatment group. For both treatment and control groups, I asked teachers to complete questionnaires as well. The questionnaires for students (Appendix 1 & 2) and teachers (Appendix 3, 4, 5 & 6) were developed based on the literature, my first-hand experience and participation in the conservation education program, and expert review.

The student questionnaire is composed of four parts. The first part elicited information on the students' socio-demographic characteristics (mostly yes/no questions). The second part assessed environmental knowledge with four multiple choice questions; four questions that stated a plant or animal species and asked respondent to label as endemic, introduced, or invasive; and one fill in the blank question testing whether students knew the term "biodiversity" by presenting the definition and asking for the term. These questions were designed to evaluate the students' level of understanding about the park, biodiversity, conservation, focusing on topics emphasized in the conservation education program. The third section elicited students' attitudes towards the park and conservation with Likert scale questions. The section presents twelve statements and asks students to identify how much they agree (6) or disagree (1) with each statement on a Likert scale. To avoid having respondents answer on "auto-pilot," some statements were framed as pro-environmental and others as the opposite, so that students could not indicate a pro-environmental stance simply be selecting all "1"s or all "6"s on the Likert scale. For the analyses, the responses were reversed for the statements for which disagreement was the more pro-environmental stance. Thus, larger numbers always signify more pro-environmental attitudes. The fourth section of the questionnaire elicited information on students' behavior relevant to the environment. For

three actions, students were asked how frequently they performed the action recently on a Likert scale ranging from 1 (never) to 6 (always).

The questionnaire for teachers collected information on gender, education level, whether they had previously visited and brought their students to SMNP, and whether they had taught their students about the park.

The students in the treatment group completed the pre-test when they arrived at the park, and afterwards they participated in the park's conservation education program. Within a month after each school group visited the park, I traveled to their school to administer the same questionnaire a second time (post-test). The only difference between the pre-test and post-test was a question asking if the students had ever filled out the questionnaire before. The objective was to have the students complete the first post-test one week after their park visit. However, because of scheduling conflicts related to my work obligations and school exams, the delay between the pre-test and first post-test ranged from 7 to 27 days. For the control sample, I identified classes of similar grade level as the treatment group in schools that were broadly similar to the schools that had sent students to the park. This usually meant selecting a control group in the same school or in a school nearby the school of the treatment group, and thus similar in terms of distance to park and whether urban or rural. The students in the control group completed the same questionnaire as the students who visited the park. When possible to schedule, the control group also completed the questionnaire a second time.

To assess whether the control and treatment groups are actually similar, I used chi-square tests, Mann-Whitney U tests, and simple ordinal logistic regressions to test the null hypothesis of no difference in socio-demographic characteristics and in environmental

knowledge, attitudes, and behaviors reported the first time the questionnaire was completed, before the treatment group visited the park. To evaluate the impact of the conservation education program, I compare differences in treatment pre- and post-tests to control pre- and post-tests. McNemar tests were employed to compare pre- and post-tests for each question in the knowledge section, and Wilcoxon signed rank tests were used to test for differences in Likert scores in the attitudes and behavior sections. By comparing differences in differences across the two groups, I control for any learning from taking the questionnaire more than once or from other sources of information about the environment (e.g., television show).

I estimate regressions to identify any factors that influence changes in students' answers between the pre-test and post-test. The key variable of interest is whether or not the student visited the park, and I also controlled for number of days between the pre- and post-test. In addition to student characteristics, I included school characteristics such as percent of urban students in the class and distance from the park, and class characteristics such as individual class (students that are all in the same class together) versus a group of students made up from different classes and if the participating group is a school club or regular class. Private school was also included, but none of the students in the control group were from a private school. Private school and school club have a small sample size. I estimated two types of models, one with a sample size equal to the total number of students interviewed and changes in answers (first post-test minus pre-test) as the dependent variables, and the other with a sample size equal to the total number of pre-tests and first post-tests completed ("stacked" data) and the answers as the dependent variables. For the "stacked" models, the

standard errors were clustered by student. They were estimated by recognizing that the same person completed pre-test and post-test.

Certain characteristics were examined only for students who participated in the park program: weather during visit, had their teacher previously brought students to the park, did the teacher discuss the park visit, teacher gender and education, how many students were in the group, how many hours did they spend at the park, and who the guide was.

Regression models were specified based on the literature reviewed above, my first-hand knowledge of Cape Verde and SMNP, and exploration of the data using the stepwise function in JMP. All models include the following key variables: grade or age, sex, and urban vs. rural residence or percent of urban students in school. In all regression models estimated with both treatment and control observations, I was primarily interested in the effect of park visit on environmental knowledge, attitudes, and behaviors, and thus these models always included a variable for park visit. In regression models with stacked data (pooled pre-test and post-test data), I always included a variable indicating number of times the student completed the questionnaire.

I constructed several summary measures of environmental knowledge, attitudes, and behaviors. These included the percent of correct answers in the knowledge section (excluding missing answers), the percent of correct answers in the knowledge section with missing answers counted as incorrect, the average attitude score (excluding missing answers), and the average behavior score (excluding missing answers). As an alternative to percent correct and average scores, I examined first principal components of the answers in each section. Principal components were calculated using the polychoric PCA package in

STATA, which employs polychoric correlations for categorical variables and tetrachoric correlations for binary variables instead of Pearson correlation coefficients to find the linear combination that captures the most variation. These principal components were calculated separately for pre-test, post-test, and stacked pre- and post- test data. The principal components calculated with the stacked data were used to create measures of changes in answers (or differences). First principal component of knowledge, first principal component of attitudes, and first principal component of behavior were calculated. All of these dependent variables were modeled both as differences (post-test minus pre-test) and levels (pooled answers to pre-test and post-test).

4.3 Results: Comparisons between Treatment and Control Pre-Tests

Seven hundred and twenty-one students participated in the study. The treatment group (students that visited the park or in classes that visited the park) consisted of 425 students from 10 different schools. Of the 425 students: 54 of them only took the pre-test, 338 took the pre-test and the post-test, and 33 took only the post-test and no pre-test. The control group (students in classes that did not visit the park in the 2010-2011 school year) was composed of 296 students from 7 different schools. Of the 296 students in the control group, 170 students filled out the questionnaire once and 126 filled it out twice.

The average age for students in both the control and treatment groups was 15 years old (Table 4.1). Percent female is also similar: 55% of the control group and 52% of the treatment group. The majority of both control (90%) and treatment (93%) groups have family members who are emigrants overseas. Sixty percent of the control group and 63% of

the treatment groups are in families that own a car. One key difference between the groups is that a higher percentage (79%) of the control group lives in an urban area compared to the treatment group (59%) (Table 4.1).

Twenty percent of the control group and 22% of the treatment group had previously visited the park, prior to my study. Sixty-seven percent of the 20% of the control group that had visited before had a guide on their previous visit, and 74% of the 22% of the treatment group that had visited before had a guide. Sixty-one percent of the control group and 54% of the treatment group had a family member who had visited the park (Table 4.1).

Table 4.1. Characteristics of Control and Treatment Groups (Pre-Test)

Variable (Control)	Mean	Std Dev	N	Variable (Treatment)	Mean	Std Dev	N
grade	8.865	2.154	296	**grade**	8.691	2.597	392
grade_cycle	8.209	2.337	296	**grade_cycle**	8.071	2.578	392
age	15.027	2.310	291	**age**	14.858	2.898	386
sex	0.550	0.498	289	**sex**	0.516	0.500	366
zone	0.792	0.407	274	**zone**	0.591	0.492	359
prev_visit	0.203	0.403	296	**prev_visit**	0.223	0.417	386
if_yes_guide	0.672	0.473	58	**if_yes_guide**	0.740	0.441	77
other_fam_ visit	0.612	0.488	289	**other_fam_ visit**	0.548	0.498	376
emigrants	0.902	0.298	295	**emigrants**	0.933	0.251	387
car	0.559	0.497	295	**car**	0.633	0.483	387

The control and treatment groups differ significantly on grade, grade_cycle and zone, while other_fam_visit and car were different at the 0.10 level (Table 4.2). The treatment group has more students in grades 12 and 5, while the control group includes more in grade

10 (Figure 4.1). Overall, very few eighth graders participated and most students were from grades 6, 10, 11, or 12 (Figure 4.1). The variable grade_cycle pairs grades together. In terms of grade_cycle, the control had more 9th and 10th graders while the treatment has more 11th and 12th graders (Figure 4.2). The age distribution followed the same pattern as the grade distribution (Figure 4.3). There is not a significant difference in age between the treatment group and control group using a Mann-Whitney U test (p=0.36).

Table 4.2. Chi Square Tests for Association between Control and Treatment Characteristics

Variable	Statistic	DF	Value	Prob
grade	Chi Square	7	86.4162	<.0001***
grade_cycle	Chi Square	3	37.7747	<.0001***
sex	Chi Square	1	0.7400	0.3897
zone	Chi Square	1	28.8708	<.0001***
prev_visit	Chi Square	1	0.4021	0.5260
if_yes_guide	Chi Square	1	0.7412	0.3893
other_fam_visit	Chi Square	1	2.7907	0.0948*
emigrants	Chi Square	1	2.1868	0.1392
car	Chi Square	1	3.7977	0.0513*

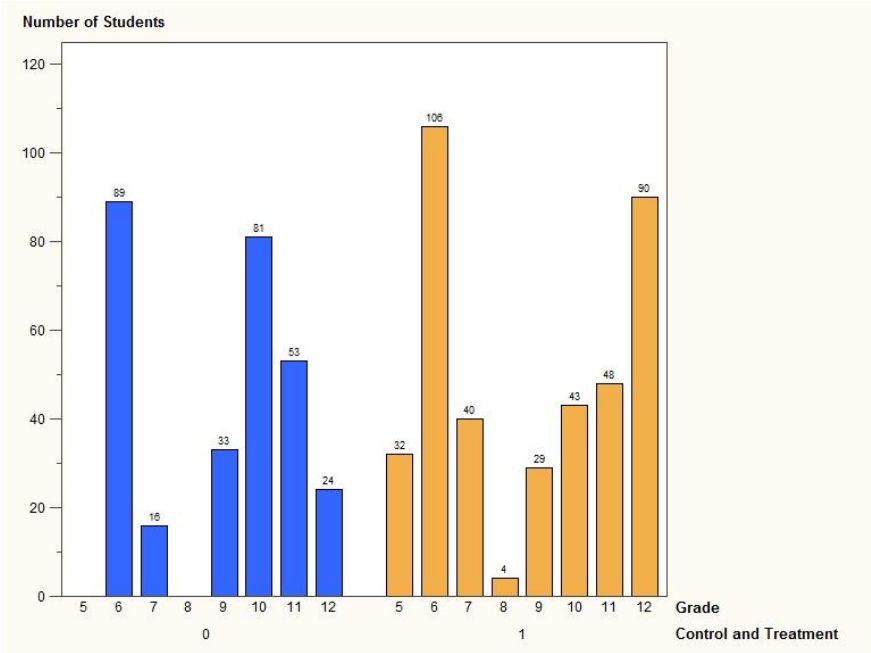

Figure 4.1. Grade level grouped by control (0) and treatment (1) (pre-test)

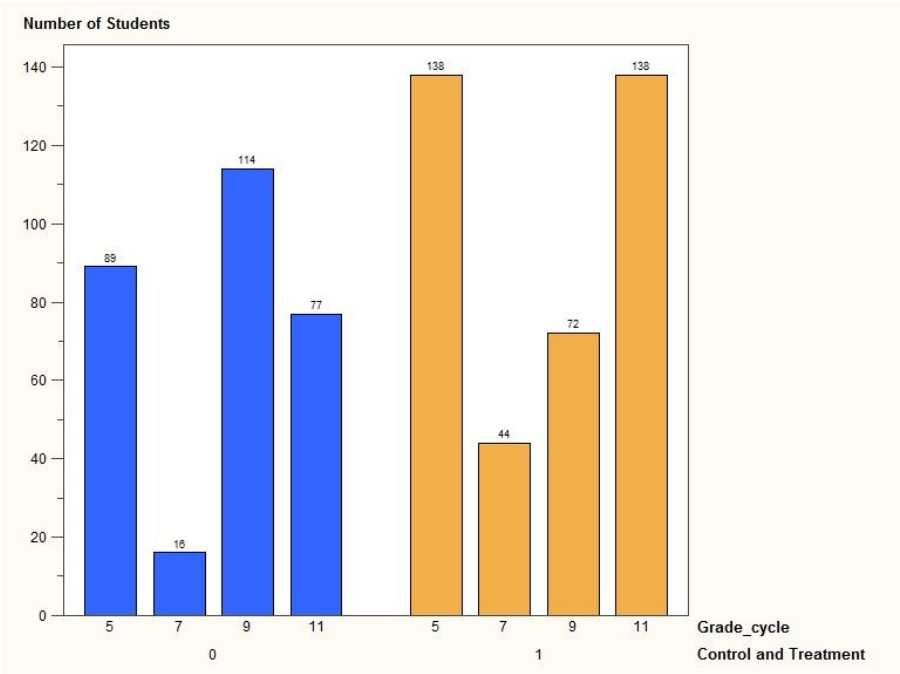

Figure 4.2. Grade_cycle grouped by control (0) and treatment (1) (pre-test)

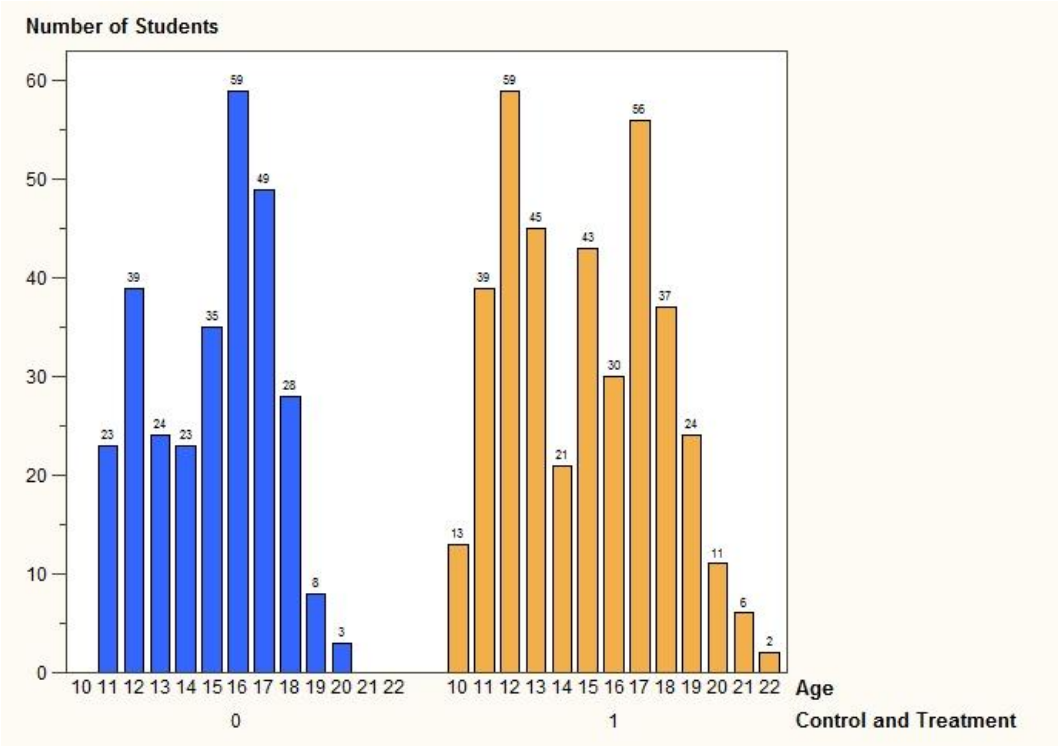

Figure 4.3. Age grouped by control (0) and treatment (1) (pre-test)

A higher percentage of the treatment group gave correct answers to all of the questions except for those asking if the plants lantuna (*Lantana camara*) and eucalipto (*Eucalyptus spp*.) were endemic, invasive, or introduced (Table 4.3). Only 31% of the control group knew what endemic meant, while 52% of the treatment group knew what endemic meant before their park visit. Fifty-three percent of the treatment group knew the term "introduced," while 43% of the control group was familiar with the term. On average, students in the treatment group answered three questions correctly, while students in the control group answered 2.5 questions correctly, which is significantly different according to a Mann-Whitney U test (p=0.0008).

The probability of answering the knowledge questions correctly in the pre-test is significantly different across the control and treatment groups in all cases except the questions why_park, soil_ero, and kalip (Table 4.3). According to a Mann-Whitney U test, the treatment group had a significantly higher total percent correct for the knowledge section as compared to the control group, both when missing values are excluded (p=0.0006) and included (p=0.0008).

Because the students in the treatment group completed the questionnaire upon arrival at the park, this cannot be the result of knowledge gained from the conservation education programs. One likely explanation for the difference is that the planned park visit encouraged teachers to spend more time, give more emphasis, or otherwise more effectively impart knowledge about the environment. In fact, of the 12 teachers who completed the questionnaire[2], nine indicated they taught their students about the park before the visit. Eight of the 12 teachers said they had been to the park before, and six of them had brought their students on previous visits. The same proportion of teachers in the control group (4 out of 6) had visited the park previously, but only one of them had brought their students. Only two of the control group teachers indicated they had taught their students about the park. (It is important to note that in both the control and treatment group, other teachers who did not complete the questionnaire may have taught students about the park.)

[2] In two of the groups who visited the park, the teacher was unable to complete the questionnaire. In one group of three classes, only one teacher filled out the questionnaire.

Table 4.3. Percent of Control and Treatment Groups who Correctly Answered Knowledge Questions and Chi Square Tests of Association between Treatment Status and Knowledge (Pre-Test)

	Control			Treatment			Chi-Square	
Variable	**Mean**	**St Dev**	**N**	**Mean**	**St Dev**	**N**	**Stat**	**Prob**
def_end	0.309	0.463	175	0.521	0.501	265	19.2933	<.0001***
def_intr	0.433	0.496	245	0.532	0.500	314	5.4194	0.0199**
why_park	0.242	0.429	264	0.255	0.437	333	0.1294	0.7190
soil_ero	0.406	0.492	266	0.458	0.499	323	1.6169	0.2035
monk	0.180	0.385	245	0.312	0.464	337	12.9738	0.0003***
lant	0.466	0.500	234	0.352	0.478	332	7.3591	0.0067***
ling	0.398	0.491	256	0.545	0.499	325	12.2589	0.0005***
kalip	0.492	0.501	264	0.481	0.500	310	0.0792	0.7784
biodiv	0.311	0.465	132	0.559	0.498	213	20.1680	<.0001***
total_know	2.587	1.751	293	3.130	2.002	385		
%know	0.355	0.220	293	0.418	0.234	385		
%know_ miss_incl	0.287	0.195	293	0.348	0.222	385		

In general, the mean responses about attitudes and behaviors were very similar between the control and treatment groups in the pre-test (Tables 4.4-4.7). The only significant differences were for the variables: park_rich_pos, remove, too_big_pos, future_vis, and ero_prob (statement number 2, 3, 6, 7 and 12 in the questionnaire) (Table 4.4). Ordinal logistic regression confirms the statistical significance of treatment status in determining responses to remove, future_vis, and ero_prob, and also suggests significant difference (p=0.0645) in know_nat.[3] The control group had a significantly more pro-

[3] The different findings from the ordinal logistic and chi-square tests may be due to different underlying distributional assumptions or may be due to failure to meet the assumption of chi-square (specifically small counts in some categories). Mann-Whitney/Wilcoxon tests confirm the finding from ordinal logistic regressions that responses to the statement remove, future_vis, ero_prob, and know_nat are significantly different across treatment and control.

environmental attitude, on average, based on a Mann-Whitney U test (p <0.0001), although the difference is very small in absolute terms: 4.6 for control vs. 4.4 for treatment (Table 4.4).

Table 4.4. Mean Likert Scores for Attitude Statements for Control and Treatment Groups and Chi Square Tests of Association between Treatment Status and Attitudes (Pre-Test)

	Control			Treat-ment			Chi-Square	
Variable	**Mean**	**St Dev**	**N**	**Mean**	**St Dev**	**N**	**Value**	**Prob**
loose_goats_pos	4.982	1.302	273	5.049	1.343	370	3.6231	0.6049
park_rich_pos	5.204	1.102	279	4.914	1.427	373	34.5980	<.0001***
remove	3.728	1.457	268	3.172	1.539	354	32.6283	<.0001***
no_preserv_pos	4.662	1.358	269	4.559	1.469	358	2.9377	0.7096
lots_nat_pos	2.781	1.368	274	2.685	1.259	359	4.1388	0.5296
too_big_pos	3.356	1.351	253	3.197	1.353	355	12.9063	0.0243**
future_vis	5.355	1.056	279	5.101	1.298	366	18.2996	0.0026***
camp	5.258	0.974	271	5.236	1.101	352	2.6930	0.7472
know_nat	5.345	0.963	278	5.162	1.164	364	6.0328	0.3030
good_prot	5.241	1.129	274	5.201	1.236	364	1.8245	0.8729
refor	4.549	1.283	257	4.454	1.358	348	6.9731	0.2226
ero_prob	4.578	1.442	268	4.192	1.548	360	14.7319	0.0116**
avg_attitude	4.588	0.502	282	4.408	0.582	377		

Table 4.5. Chi-Square for Whole Model Test of Ordinal Logistic Regression with Treatment as the Predictor Variable for Attitude Statements (Pre-Test)

Dependent Variable	ChiSquare	Prob>ChiSquare
loose_goats_pos	1.3174	0.2511
park_rich_pos	2.3281	0.1271
remove	19.5564	<.0001***
no_preserv_pos	0.2933	0.5881
lots_nat_pos	0.4005	0.5268
too_big_pos	2.5901	0.1075
future_vis	5.4464	0.0196**
camp	0.1777	0.6734
know_nat	3.4177	0.0645*
good_prot	0.0181	0.8929
refor	0.5781	0.4471
ero_prob	10.5319	0.0012***

For the behavior statement "I avoid throwing trash on the ground," the control group had a slightly higher mean than the treatment group, which was significantly different according to a chi-square test but not the ordinal regression (Tables 4.6 & 4.7). Both control and treatment had a mean of 4 (many/sufficient times) for the statement "I try to learn about local plants and animals," demonstrating that students had an interest in local plants and animals. For the statement "I go hiking in natural areas," students in the treatment group had a slightly higher mean score (Table 4.6). This may be because the control group included a higher percentage of students from urban areas, which offer fewer opportunities for hiking. Several students wrote beside their response that they like nature and/or like hiking but do not have opportunities to participate in that activity. According to a Mann-Whitney U test, the average behavior scores of treatment and control groups were not significantly different (P=0.9206).

Table 4.6. Mean Likert Scores for Behavior Statements for Control and Treatment Groups and Chi Square Tests of Association between Treatment Status and Behavior (Pre-Test)

	Control			Treatment			Chi-Square	
Variable	Mean	St Dev	N	Mean	St Dev	N	Value	Prob
trash	4.254	1.723	279	3.987	1.987	379	23.2244	0.0003***
learn_an	4.014	1.574	277	4.081	1.526	370	4.0354	0.5443
hike	2.899	1.557	278	3.268	1.589	373	19.5448	0.0015***
avg_ behav	3.721	0.964	281	3.757	0.976	380		

Table 4.7. Chi-Square for Whole Model Test of Ordinal Logistic Regression with Treatment as the Predictor Variable for Behavior Statements (Pre-Test)

Dependent Variable	ChiSquare	Prob>ChiSquare
trash	1.8975	0.1684
learn_an	0.1542	0.6946
hike	9.0506	0.0026***

4.4 Results: Changes in Responses between Pre-Test and Post-Test

One way to assess the impact of the conservation education program was by the difference in knowledge, attitudes, and reported behaviors before and after the park visit. The percent of students correctly answering knowledge questions increased significantly for all questions except those about soil erosion and whether eucalyptus is an endemic, introduced, or invasive specie between the pre-test and the post-test (Table 4.8). Soil erosion was not a major focus of the conservation education program. Introduced species like eucalyptus are given much less emphasis than endemic species and invasive species. In the control group, there were no significant improvements in the percent of students correctly answering questions, except for the question about biodiversity. More students answered this

correctly in the post-test, although, the non-response rate was very high, with only 50 students in the control group answering this question in the pre- and post-test.

Table 4.8. Paired Comparison between Pre- and Post-Tests using McNemar's Test (Treatment)

Variable	Change in % Correct	Statistic	Asymptotic Pr>S	N
def_end	11.5%	10.2676	0.0014***	235
def_intr	10.9%	11.2133	0.0008***	266
why_park	5.3%	2.7778	0.0956*	284
soil_ero	-1.5%	0.2667	0.6056	269
monk	19.4%	24.2000	<.0001***	283
lant	17.3%	21.6306	<.0001***	284
ling	7.2%	3.6364	0.0565*	278
kalip	-4.2%	1.1101	0.2921	262
biodiv	9.3%	9.8462	0.0017***	172

On five of the twelve attitude statements students demonstrated a statistically significant positive change (loose_goats, park_rich, remove, future_vis, good_prot) between pre- and post-tests. However, none of these changes were larger than 3 tenths of a point, with the largest being an increase of 0.232 in mean student agreement with the statement 'certain plants should be removed.'

Students' views on 'it's not necessary to preserve natural areas that don't have forests' and 'the park is too big' had statistically significant negative changes, with more students agreeing with these statements in the post-test. In fact, the largest change in mean attitudes between pre and post-test was -0.269 for 'the park is too big.' Mean attitudes in response to other statements did not change after the program.

In the control group, mean responses to two of the statements (loose_goats*** and park_rich**) became significantly more positive, and two (know_nat* and refor*) became significantly more negative, while others did not change. This suggests that on average, taking the test twice does not systematically influence students' attitudes towards a more or less pro-environmental stance.

Table 4.9. Wilcoxon Signed Rank Tests Comparing Paired Pre- and Post-Test Attitudes (Treatment)

Variable	Change in Score	Statistic	Pr ≥ |S|	N
loose_goats_pos	0.217	1521.5	0.0036***	314
park_rich_pos	0.186	989.5	0.0295**	317
remove	0.232	1953	0.0254**	298
no_preserv_pos	-0.197	-1490.5	0.0375**	304
lots_nat_pos	-0.016	-143	0.8509	307
too_big_pos	-0.269	-2709.5	0.0020***	301
future_vis	0.228	1509.5	0.0046***	311
camp	0.024	94.5	0.8484	293
know_nat	0.104	707	0.1319	309
good_prot	0.168	703	0.0764*	310
refor		994	0.1154	290
ero_prob		6	0.9938	302

Students did not express positive behavior change on the post-test. Perhaps not surprisingly given the short time between the park visit and the post-test, there were no differences in how frequently students hiked. The reported mean frequency of trying to learn about local plants and animals actually significantly decreased from the pre-test to post-test. During the program, the park guides warn students not to throw trash on the ground. In the post-test, there was a slight increase in mean agreement with the statement that "I avoid

throwing trash on the ground." As with the attitudes, the change in mean Likert scores for behaviors was small, with none changing by more than two tenths of a point. In the control group, the only significant change was a decrease in the mean reported score for 'trying to learn about local plants and animals.'

Table 4.10. Wilcoxon Signed Rank Tests Comparing Paired Pre- and Post-Test Behaviors (Treatment)

Variable	Change in Score	Statistic	Pr ≥ |S|	N
trash	0.188	1007	0.0461**	324
learn_an	-0.173	-1486	0.0699*	313
hike	-0.113	-982.5	0.2132	318

Students appear to gain knowledge from the conservation education program. On average, students who participated in the program answered one more question correctly on the post-test compared to the pre-test. Students increased their percent correct in the knowledge section by an average of 13% when missing values were coded as incorrect. However, the control group also demonstrated a significant 6% improvement in percent correct, answering half a question more correct on the post-test. The 13% change was significantly (p=0.0003) more than the 6% change based on a Mann-Whitney U test. The average attitude score also became more pro-environmental in the treatment group while the control group remained the same, but this reflects very small changes in the average response to most of the attitude statements. The slight increase in average attitude score for the treatment group is not significantly more than essentially zero change in the control group

(Mann-Whitney U test, p=0.4198). This may be partly because responses were already generally positive in the pre-test, so there was little room for improvement. The average behavior score did not change in the treatment group, but the control group expressed more negative behavior on the post-test.

Table 4.11. Wilcoxon Signed Ranks Tests Comparing Paired Pre- and Post-Test Average Scores (Treatment)

Variable	Change in Score	Statistic	Pr ≥ |S|	N
percent_know	9.0%	10174	<.0001***	332
percent_know_miss_incl	12.9%	11919.5	<.0001***	332
avg_attitude	0.062	2924	0.0589*	323
avg_behav	-0.009	-509	0.6547	325

4.5 Results: How the Impact of the Park Visit Varies Across Different Student Types (or What Influences the Impact of the Conservation Education Program?)

In this section models of change in percent knowledge, average attitudes, and average behavior score will be presented. Next a robustness check is presented by re-estimating with change in first principal component as the dependent variables. Then further investigation is presented on what affects the impact of the park visit by estimating models with just students who visited the park, including characteristics of their visit. Finally, "stacked data" are presented examining students' responses to knowledge, attitude, and behavior questions.

4.5.1 Impact of park visit controlling for student and school characteristics

To identify factors that influence how much students are affected by participation in the conservation education program, I estimated linear least squares regression models of changes between the pre- and post- tests as a function of park visit (treatment status) and characteristics of the students and their schools hypothesized to have an influence. Based on the literature and first-hand knowledge of Cape Verde, I considered grade level, gender, urban vs. rural, previous park visit, other family member that had visited the park, whether the family owns a car, number of days between pre- and post-test, distance of school from the park, private school, school club, and individual class vs. mixed group of students. In a model including grade, gender, urban vs. rural, park visit during the study, and private school, only two variables were significant at the 0.01 level: 'if students visited the park (treatment group)' and 'if students were from a private school' (Table 4.13). Because only 8% of students that filled out a pre- and post-test attended private school, I estimated the model without the private school variable. Regardless of specification, visiting the park has a statistically significant positive influence on knowledge. Attending private school had a significant but small negative effect on the change in percent correct, but the average scores of private school students were still higher than the average scores of public school students in both the pre- and post-tests (considering non-paired data). Grade level has a negative and significant influence on knowledge only for students from urban areas. Even though there are several significant variables, the overall explanatory power of this model was quite low, with an r-squared of 0.038 without and 0.058 with the variable for private school. This may reflect the fact that many time-invariant factors influencing knowledge are netted out by

considering only the change in knowledge between pre- and post- test. However, this same fact results in a very robust estimate of the park visit's impact on student knowledge.

Table 4.12. Data Summary and Fit Statistics for Change in Percent Correct on the Knowledge Section (Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	412
Mean of change_per_know	0.073
R-square without private_school	0.038
Root MSE without private_school	0.216
F Value without private_school	3.39
Pr>F without private_school	0.0052***
R-square with private_school	0.058
Root MSE with private_school	0.214
F Value with private_school	3.92
Pr>F with private_school	0.0008***
R-square with percent_know	0.315
Root MSE with percent_know	0.183
F Value with percent_know	29.11
Pr>F with percent_know	<.0001***

Table 4.13. Parameter Estimates for Change in Percent Correct on the Knowledge Section (Treatment and Control)

Parameter	Estimate	Pr >|t|	Estimate	Pr >|t|	Estimate	Pr >|t|
intercept	0.039	0.5732	0.016	0.8130	0.067	0.2794
grade	0.002	0.8277	0.002	0.7592	0.018	0.0080***
sex	0.025	0.2308	0.021	0.3058	0.015	0.4124
zone	0.117	0.2416	0.167	0.1048	0.094	0.2928
park_visit	0.050	0.0421**	0.071	0.0057***	0.095	<.0001***
grade*zone	-0.016	0.1290	-0.019	0.0758*	-0.009	0.3370
private_school			-0.116	0.0060***	-0.001	0.9780
percent_know					-0.556	<.0001***

As another robustness check, I re-created percent correct, treating missing answers as incorrect. As in the previous model, the variables park visit and private school were significant. However, in this model, sex and zone were also significant; boys and students from urban areas show more change in knowledge about the environment, all else equal. In specification without private school, sex is no longer significant. Private school has a negative effect on change in percent correct, so they are gaining less knowledge. Age had a significant interaction with both urban/rural and gender. Female students gained knowledge with age while males do not. All else equal, older urban students gain less knowledge. For the control group, the number of days between tests was significant and positive, perhaps because teachers were more likely to cover topics included in the questionnaire during a longer interval between tests. Finally, with missing values treated as incorrect answers, visiting the park (treatment) had a large, positive, and statistically significant effect on percent correct. Also, the model had a small R-square value (R^2=0.090).

Table 4.14. Data Summary and Fit Statistics Table for Change in Percent Correct on the Knowledge Section (Missing Values Coded as Incorrect) (Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	409
Mean of change_per_know_9	0.108
R-square without private_school	0.076
Root MSE without private_school	0.195
F Value without private_school	3.72
Pr>F without private_school	0.0002***
R-square with private_school	0.090
Root MSE with private_school	0.194
F Value with private_school	3.73
Pr>F with private_school	<.0001***
R-square with percent_know_miss_incl	0.289
Root MSE with percent_know_miss_incl	0.172
F Value with percent_know_miss_incl	15.95
Pr>F with percent_know_miss_incl	<.0001***

Table 4.15. Parameter Estimates for Change in Percent Correct on the Knowledge Section (Missing Values Coded as Incorrect) (Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	-0.190	0.3668	-0.266	0.2116	-0.362	0.0519*
age	0.001	0.9404	0.001	0.9372	0.008	0.2182
sex	-0.179	0.1426	-0.209	0.0825*	-0.242	0.0295**
zone	0.254	0.0609*	0.345	0.0125**	0.394	0.0018***
park_visit	0.356	0.0470**	0.412	0.0230**	0.470	0.0029***
days_pre_p1	0.010	0.0597*	0.011	0.0422*	0.011	0.0221**
travel_time	-0.001	0.1933	0.000	0.7282	0.001	0.0247**
park_visit*days_pre_p1	-0.009	0.1223	-0.010	0.0863*	-0.010	0.0528*
age*zone	-0.018	0.0535*	-0.024	0.0117**	-0.027	0.0016***
age*sex	0.013	0.1001	0.015	0.0590*	0.017	0.0197***
private_school			-0.096	0.0332*	-0.035	0.3530
percent_know_miss_incl					-0.478	<.0001***

Visiting the park and participating in the conservation education program was not a significant predictor of changes in attitude. Gender and grade were significant at the 0.05 level and distance from park was significant at the 0.10 level. Students in upper grade levels experienced less positive change in attitudes. Female students experienced less positive change in attitudes compared to boys. As distance from the park increased, students experienced an increase in change in attitudes. It is important to note that percent urban and distance from park were highly correlated (0.84) and thus likely to suffer from multi-collinearity. However, when distance to the park was dropped from the model, percent urban did not become significant.

Table 4.16. Data Summary and Fit Statistics Table for Change in Average Attitude on the Attitude Section (Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	426
Mean of change_avg_attitude	0.031
R-square	0.039
Root MSE	0.475
F Value	3.12
Pr>F	0.0089***
R-square with avg_attitude	0.414
Root MSE with avg_attitude	0.372
F Value with avg_attitude	40.05
Pr>F with avg_attitude	<.0001***

Table 4.17. Parameter Estimates for Change in Average Attitude on the Attitude Section (Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	0.196	0.1599	2.384	<.0001***
grade	-0.033	0.0141**	0.017	0.1320
sex	-0.098	0.0335**	-0.016	0.6620
percent_urban_pre	-0.005	0.1264	-0.002	0.3101
park_visit	0.041	0.4211	0.042	0.3158
travel_time	0.006	0.0532*	0.005	0.0190**
avg_attitude			-0.619	<.0001***

Unexpectedly, visiting the park during the study had a significant negative effect on average reported pro-environmental behavior. This could reflect greater student awareness of their own behavior, and therefore be a change in reporting rather than a change in actual or intended behavior. The interaction term with sex was also significant, indicating the park visit was negatively associated with change in reported behavior only for boys. For girls, the impact was nearly zero. A family car and the number of days between pre- and post-test were significant. The more days between the pre- and post-test, the smaller (or more negative) the change in behavior. Students from wealthier families (as indicated by car ownership) also had smaller (or more negative) change in behavior.

Table 4.18. Data Summary and Fit Statistics Table for Change in Average Behavior on the Behavior Section (Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	400
Mean of change_avg_behav	-0.063
R-square	0.068
Root MSE	0.924
F Value	3.15
Pr>F	0.0011***
R-square with avg_behav	0.317
Root MSE with avg_behav	0.792
F Value with avg_behav	14.71
Pr>F with avg_behav	<.0001***

Table 4.19. Parameter Estimates for Change in Average Behavior on the Behavior Section (Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	0.745	0.1157	1.892	<.0001***
grade	0.007	0.8639	0.058	0.1120
sex	-0.047	0.7578	0.047	0.7312
zone	0.094	0.5581	0.006	0.9607
car	-0.835	0.0928*	-0.188	0.6508
park_visit	-0.425	0.0204**	-0.240	0.1356
days_pre_p1	-0.022	0.0017***	-0.018	0.0038***
travel_time	-0.003	0.2026	-0.001	0.4841
sex*park_visit	0.339	0.0824*	0.167	0.3301
grade*car	0.076	0.1291	0.014	0.7419
avg_behav			-0.512	<.0001***

4.5.2 Robustness Checks

Change in knowledge can be measured by the difference in the first principal components of the answers in the pre-test and the answers in the post-test. The regression model using principal components to examine change in knowledge (all missing values coded as incorrect) detected the same significant variables as the model that looked at change

in percent correct, although grade was used instead of age in this model. The variable 'if the students had visited the park during the study' had a positive and significant coefficient, but the coefficient on an interaction with the number of days between the pre- and post-test was significant and negative, indicating the knowledge gained from the park visit diminishes with time. Grade level had the expected positive impact on knowledge of female students. Female students gain less knowledge (in model specification including private school variable), but this difference between girls and boys diminishes at higher grade levels. Compared to students from rural zones, students from urban areas gained more knowledge, but this difference between rural and urban students diminished in higher grades. As with the non-principal components, private school showed a decrease in change in percent correct.

Table 4.20. Data Summary and Fit Statistics Table for Change in Principal Components on the Knowledge Section (Missing Values Coded as Incorrect) (Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	416
Mean of change_pcrecode	0.564
R-square without private_school	0.089
Root MSE without private_school	0.949
F Value without private_school	4.61
Pr>F without private_school	<.0001***
R-square with private_school	0.103
Root MSE with private_school	0.943
F Value with private_school	4.56
Pr>F with private_school	<.0001***
Number of Observations with percent_miss_incl	413
Mean of change_pcrecode with percent_miss_incl	0.557
R-square with percent_know_miss_incl	0.232
Root MSE with percent_know_miss_incl	0.871
F Value with percent_know_miss_incl	11.88
Pr>F with percent_know_miss_incl	<.0001***

Table 4.21. Parameter Estimates for Change in Principal Components on the Knowledge Section (Missing Values Coded as Incorrect) (Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	-1.164	0.2253	-1.583	0.1090	-1.415	0.1249
grade	0.007	0.8708	0.006	0.8880	0.056	0.1786
sex	-0.584	0.1675	-0.700	0.0997*	-0.955	0.0182**
zone	1.071	0.0293**	1.398	0.0075***	1.358	0.0061***
park_visit	1.970	0.0244**	2.287	0.0105**	2.112	0.0102**
days_pre_p1	0.056	0.0336**	0.061	0.0210**	0.050	0.0454**
travel_time	-0.003	0.3541	0.000	0.9501	0.003	0.2486
grade*zone	-0.131	0.0213**	-0.166	0.0058***	-0.159	0.0054***
grade*sex	0.072	0.0983*	0.083	0.0575*	0.108	0.0094***
park_visit* days_pre_p1	-0.048	0.0805*	-0.054	0.0514*	-0.042	0.1035
private_school			-0.476	0.0200***	-0.182	0.3258
percent_know_ miss_incl					-1.932	<.0001***

No significant models were detected when the change in student attitudes was represented by the difference in a first principal component of attitudes created by stacking answers to the pre- and post- tests. Using this as the dependent variable, models using the previous specifications and other variations were not significant; that is, there is no discernible pattern in the change in attitudes. In particular, park visit did not have a statistically significant effect on change in attitudes measured using principal components.

Turning to the principal component of reported behaviors, the estimation results for change in principal component were similar to those for change in the average behavior score. In particular, “park visit during this study” remained negative for boys and close to zero for girls, although it is only statistically significant at the 0.10 level. Additionally, the number of days between the pre- and post-test and two characteristics of the school (distance from the park, and the percent of students from an urban area) were significant. As the

number of days between the two tests increases, the reported change in behavior diminishes. The change in behavior was negatively related to distance from the park and positively related to percent urban. However, this model explained less than 5% of the variation in the difference in the first principal component of behavior.

Table 4.22. Data Summary and Fit Statistics Table for Change in Principal Components on the Behavior Section (Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	415
Mean of change_behave	-0.141
R-square	0.043
Root MSE	0.998
F Value	2.79
Pr>F	0.0076***
R-square with avg_behav	0.143
Root MSE with avg_behav	0.946
F Value with avg_behav	9.69
Pr>F with avg_behav	<.0001***

Table 4.23. Parameter Estimates Table for Change in Principal Components on the Behavior Section (Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	0.313	0.3903	1.516	0.0002***
grade	0.038	0.1491	0.041	0.1048
sex	-0.111	0.4987	-0.049	0.7492
percent_urban_pre	0.014	0.0271**	0.014	0.0136**
park_visit	-0.375	0.0624*	-0.260	0.1758
travel_time	-0.016	0.0098***	-0.016	0.0064***
days_pre_p1	-0.013	0.0683*	-0.012	0.0842
sex*park_visit	0.390	0.0583*	0.259	0.1831
avg_behav			-0.359	<.0001***

4.5.3 Aspects of park visit that influence its impact on students

Some variables were only available for the treatment group, so regressions were estimated with data for just the students who visited the park (the treatment group). The change in percent correct answers to questions in the knowledge section was positively influenced by the teacher discussing the park before the visit. However, this effect was strongest for the youngest students and declined with age. Younger students evidently learned more from the park visit if the teachers discussed the park visit beforehand, while this made less of a difference for older students. Other factors, such as gender of teacher who brought students to park, and the particular guides who led the conservation education program, were insignificant in the model and excluded from the final regression. Urban students whose families own a car (likely the wealthiest students) gained less knowledge from the park visit.

Table 4.24. Data Summary and Fit Statistics Table for Change in Percent Correct on the Knowledge Section (Treatment Only)

Data Summary and Fit Statistics	
Number of Observations	214
Mean of change_per_know	0.083
R-square without private_school	0.129
Root MSE without private_school	0.205
F Value without private_school	8.41
Pr>F without private_school	<.0001***
R-square with private_school	0.142
Root MSE with private_school	0.204
F Value with private_school	7.70
Pr>F with private_school	<.0001***
R-square with percent_know	0.3618
Root MSE with percent_know	0.1763
F Value with percent_know	16.43
Pr>F with percent_know	<.0001***

Table 4.25. Parameter Estimates Table for Change in Percent Correct on the Knowledge Section (Treatment Only)

Parameter	Estimate	Pr >|t|	Estimate	Pr >|t|	Estimate	Pr >|t|
Intercept	-1.497	0.0003***	-1.203	0.0080***	-0.519	0.2353
age	0.108	<.0001***	0.092	0.0016***	0.062	0.0227**
sex	0.023	0.4328	0.018	0.5323	0.016	0.5259
zone	-0.012	0.8019	0.003	0.9563	0.025	0.5699
car	0.030	0.5112	0.029	0.5276	0.050	0.2132
teach_discuss_park	1.718	<.0001***	1.454	0.0012***	0.812	0.0597*
age*teach_discuss_park	-0.115	<.0001***	-0.100	0.0006***	-0.060	0.0277**
zone*car	-0.119	0.0463**	-0.115	0.0538*	-0.097	0.0643*
private_school			-0.084	0.1258	-0.020	0.6387
percent_know					-0.525	<.0001***

When all the missing values in the knowledge section were coded as incorrect, ‘if teacher discussed the park’ was still a significant predictor for change in percent correct when looking only at students that visited the park. Age still was a significant interaction with ‘if teacher discussed park visit’: as students increase in age the variable ‘if teachers discussed park’ has less of an influence on students’ change in performance between the two tests. Girls increased their percent correct answers between tests less than boys; which was most pronounced for young students.

Table 4.26. Data Summary and Fit Statistics Table for Change in Percent Correct on the Knowledge Section (Missing Values Coded as Incorrect) (Treatment Only)

Data Summary and Fit Statistics	
Number of Observations	216
Mean of change_per_know_9	0.120
R-square	0.133
Root MSE	0.200
F Value	8.42
Pr>F	<.0001***
R-square with percent_know_miss_incl	0.3479
Root MSE with percent_know_miss_incl	0.1738
F Value with percent_know_miss_incl	15.14
Pr>F with percent_know_miss_incl	<.0001***

Table 4.27. Parameter Estimates Table for Change in Percent Correct on the Knowledge Section (Missing Values Coded as Incorrect) (Treatment Only)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	-1.757	<.0001***	-0.845	0.0488**
age	0.128	<.0001***	0.084	0.0018***
sex	-0.332	0.0286**	-0.297	0.0374**
zone	0.167	0.3611	0.250	0.1481
teach_discuss_park	2.045	<.0001***	1.149	0.0054***
age*teach_discuss_park	-0.135	<.0001***	-0.081	0.0020***
age*zone	-0.017	0.1381	-0.018	0.0795*
age*sex	0.023	0.0134**	0.020	0.0193**
percent_know_miss_incl			-0.515	<.0001***

Turning to attitudes, students in classes with teachers that discussed the park visit beforehand expressed less change in attitudes than students whose teachers did not discuss the park. This may be because the students whose teachers had discussed the park started with more pro-environmental attitudes in the pre-test. Two of the guides had a significant positive influence on change in average attitude scores of students who visited the park. All three Cape Verdean guides were represented as dummy variables and I was the guide that

was not represented; therefore, two of the Cape Verdean guides had a significantly greater impact on student attitudes than I did. Urban students that were led by one of the guides had a significant increase in change in attitudes. As grade level increased the change in attitude increased, although this effect was smaller for students who had previously visited the park before this study. In general, students who had visited the park previously experienced a greater increase in pro-environmental attitudes, suggesting that multiple visits increased the impact of any one visit.

Table 4.28. Data Summary and Fit Statistics Table for Change in Average Attitude on the Attitude Section (Treatment Only)

Data Summary and Fit Statistics	
Number of Observations	213
Mean of change_avg_attitude	0.047
R-square	0.182
Root MSE	0.443
F Value	69.81
Pr>F	<.0001***
R-square with avg_attitude	0.5156
Root MSE with avg_attitude	0.3419
F Value with avg_attitude	119.67
Pr>F with avg_attitude	<.0001***

Table 4.29 Parameter Estimates Table for Change in Average Attitude on the Attitude Section (Treatment Only)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	-1.397	0.0510*	2.133	0.0002***
grade	0.206	0.0480**	0.106	0.0876*
sex	-0.558	0.0001***	-0.322	0.0218**
zone	0.107	0.2797	0.098	0.1486
prev_visit	0.717	0.0940*	0.307	0.2361
g1	-0.070	0.7970	-0.150	0.3120
g2	1.311	0.0183**	0.462	0.1536
g3	1.352	0.0031***	0.371	0.2603
teach_discuss_park	-0.551	0.0014***	-0.338	0.0139**
number_stud_at_park	-0.005	0.1787	-0.001	0.6328
grade*prev_visit	-0.081	0.0422**	-0.038	0.1333
zone*g3	0.437	0.0795*	0.655	0.0003***
sex*teach_discuss_park	0.479	0.0027***	0.273	0.0653*
avg_attitude			-0.601	<.0001***

Grade level, gender, and number of days between pre- and post-test were all significant predictors in the model of change in average behavior reported by students in the treatment group. As grade level increased there was a more positive change in behavior. Female students had a more positive change in behavior. As the number of days between the pre-test and post-test increased, there was less positive change in behavior.

Table 4.30. Data Summary and Fit Statistics Table for Change in Average Behavior on the Behavior Section (Treatment Only)

Data Summary and Fit Statistics	
Number of Observations	303
Mean of change_avg_behav	-0.014
R-square	0.054
Root MSE	0.969
F Value	4.41
Pr>F	0.0018***
R-square with avg_behav	0.3376
Root MSE with avg_behav	0.8121
F Value with avg_behav	24.79
Pr>F with avg_behav	<.0001***

Table 4.31. Parameter Estimates Table for Change in Average Behavior on the Behavior Section (Treatment Only)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	-0.359	0.1597	1.584	<.0001***
grade	0.067	0.0124**	0.073	0.0008***
sex	0.262	0.0216**	0.169	0.0795*
percent_urban_pre	-0.003	0.1444	-0.002	0.3196
days_pre_p1	-0.017	0.0144**	-0.013	0.0363**
avg_behav			-0.553	<.0001***

For comparison, a regression of the change in the first principal component of knowledge among students who visited the park was also estimated. This specification did not detect teacher discussing park to be significant but teacher gender was significant. The only significant predictors of change in principal components of knowledge (missing values included for all knowledge questions) were teacher gender and an interaction between grade level and gender. Students who had a female teacher displayed less change in knowledge. Also, the model suggested there may be a negative relationship with females showing less change in knowledge, but as they get older there is a larger increase in change in knowledge.

In another specification, the guides did have a significant impact on change in knowledge, but that model had a smaller R-square and guides were not significant if teacher gender was included.

Table 4.32. Data Summary and Fit Statistics Table for Change in Principal Components on the Knowledge Section (Missing Values Coded as Incorrect for All Knowledge Questions) (Treatment Only)

Data Summary and Fit Statistics	
Number of Observations	212
Mean of change_pcrecode	0.639
R-square	0.124
Root MSE	0.989
F Value	5.08
Pr>F	<.0001***
Number of Observations with percent_know_miss_incl	211
Mean of change_pcrecode with percent_know_miss_incl	0.629
R-square with percent_know_miss_incl	0.282
Root MSE with percent_know_miss_incl	0.890
F Value with percent_know_miss_incl	12.99
Pr>F with percent_know_miss_incl	<.0001***

Table 4.33. Parameter Estimates Table for Change in Principal Components on the Knowledge Section (Missing Values Coded as Incorrect for All Knowledge Questions) (Treatment Only)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	1.266	0.0064***	1.610	0.0004***
grade	-0.037	0.4384	-0.001	0.9791
sex	-0.941	0.1065	-1.096	0.0455**
zone	-0.286	0.2042	-0.197	0.3331
other_fam_visit	0.203	0.1534	0.243	0.0557*
teacher_gender	-0.435	0.0566*	-0.129	0.5572
grade*sex	0.110	0.0534*	0.128	0.0159**
percent_know_miss_incl			-2.263	<.0001***

Using the difference in the first principal component of attitude as the dependent variable, the same specification did not result in a statistically significance model. An alternative specification (with overall p=0.0512) suggested that age, gender, if teacher previously visited the park, if teacher discussed the park, and teacher education may have some influence on students' change in attitudes. However, these results were not presented because the coefficients are only significant at the 10% level except if teacher discussed park which is significant at the 5% level, and the overall model was only significant at the 10% level. Also, there were no significant models for average attitude principal components when treatment and control were combined. When principal components were used the conservation education program appears to have no effect on attitudes.

Turning to the change in the first principal component of behavior, an increase in pro-environmental behaviors was more likely among female students and students who had previously visited the park. Also, one particular guide influenced this outcome, although it is not clear why this would be the case because the guides provided very similar tours.

Table 4.34. Data Summary and Fit Statistics Table for Change in Principal Components on the Behavior Section (Treatment Only)

Data Summary and Fit Statistics	
Number of Observations	290
Mean of change_behave	-0.096
R-square	0.054
Root MSE	1.043
F Value	2.27
Pr>F	0.0288**
R-square with avg_behav	0.156
Root MSE with avg_behav	0.986
F Value with avg_behav	7.53
Pr>F with avg_behav	<.0001***

Table 4.35. Parameter Estimates Table for Change in Principal Components on the Behavior Section (Treatment Only)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	0.065	0.8528	1.499	0.0005***
grade	-0.005	0.8830	-0.003	0.9394
sex	0.256	0.0442**	0.181	0.1423
percent_urban_pre	-0.001	0.7469	0.000	0.9850
prev_visit	0.242	0.0812*	0.225	0.0885*
g1	-0.210	0.2714	-0.240	0.1923
g2	-0.424	0.0402**	-0.444	0.0291**
g3	-0.626	0.3508	-0.716	0.2600
avg_behav			-0.375	<.0001***

4.5.4 Modeling knowledge, attitudes, and behavior using pooled data

All of the previous models focused on the change in responses to the questionnaire. That has the advantage of "differencing out" idiosyncratic characteristics of individual students that may have affected their responses each time they answered the questionnaire. However, it could introduce additional error through the comparison of two responses. For example, although I matched students carefully by class and by name, it is still possible that there are some errors. Student responses may have been affected by idiosyncratic factors that varied across times that they took the test, e.g. quality of their writing instrument and whether they were tired or sick. Thus, I also estimated regression models of knowledge, attitudes, and behavior with pooled data, (i.e., with the pre-test data stacked on top of the post-test data as additional observations). For the estimations reported, the observations were clustered by student. In these models, I include a variable indicating how many times the student had previously completed the questionnaire (1, 2, or 3 times), and a separate variable for whether they had visited the park in the interim. The coefficient on park_visit represents the effect of

visiting the park and participating in the conservation education program. To develop the specifications, I tested interaction terms between park visit and the significant variables in each model.

The model of percent correct answers to knowledge questions (missing values not recorded) identifies multiple significant predictors. Having visited the park during the study was a significant factor in students' responses to the knowledge questions. However, if students were from an urban area or had another family member who had visited the park, then their visit to the park during the study had less of a positive influence on their knowledge. As grade level increased, so did students' percent correct on the knowledge section. The variable 'having previously visited the park' positively impacted students' responses (when the variable private_school was not included). Also, as distance from the park increased, students had slightly more correct responses. Private school students' responses were positively impacted by the visit to the park.

Table 4.36. Data Summary and Fit Statistics Table for Percent Correct on the Knowledge Section (Stacked Data) (Both Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	997
Mean of percent_know	0.443
Number of Clusters	621
R-square without private_school	0.277
Root MSE without private_school	0.197
F Value without private_school	33.58
Pr>F without private_school	<.0001***
R-square with private_school	0.293
Root MSE with private_school	0.195
F Value with private_school	32.03
Pr>F with private_school	<.0001***

Table 4.37. Parameter Estimates Table for Percent Correct on the Knowledge Section (Stacked Data) (Both Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	-0.076	0.0935*	-0.107	0.0184**
grade	0.031	<.0001***	0.034	<.0001***
sex	0.013	0.3824	0.015	0.2974
zone	0.030	0.3666	0.036	0.2770
prev_visit	0.033	0.0901*	0.028	0.1386
other_fam_visit	0.086	0.0004***	0.087	0.0003***
number_tests	-0.017	0.2657	0.006	0.7032
park_visit	0.158	0.0008***	0.152	0.0010***
travel_time	0.001	0.0044***	0.001	0.0609*
zone*park_visit	-0.099	0.0122**	-0.110	0.0051***
other_fam_visit*park_visit	-0.072	0.0152**	-0.077	0.0092***
park_visit*travel_time	0.001	0.0153**	0.001	0.0594**
private_school			0.132	0.0002***

When all the missing values in the knowledge section were coded as incorrect responses, visiting the park during the time of the study did not appear to influence responses. However, students who visited the park with clubs were more likely to gain

knowledge from the park visit. Students with family members who had previously visited the park generally got more of the questions correct, but the park visit had less of an impact on their knowledge. Also, there was a positive interaction between distance from the park and park visit. If students visited the park then the distance from the park had a larger positive effect on percent correct. This model was estimated with and without the variables for private school and school club because they represent such a small fraction of the students who participated in the study (6% private school and 5% school club). Being from a private school had a positive impact on students' responses. As grade level increased so did percent correct, and as percent of students from an urban area increased the percent correct decreased. After controlling for all of these variables, the number of times students responded to the questionnaire did not influence their responses when private school was included in the model. However, when private school was excluded, percent correct decreased, the more times students responded to the questionnaire.

Table 4.38. Data Summary and Fit Statistics Table for Percent Correct on the Knowledge Section (Missing Values Coded as Incorrect) (Stacked Data) (Both Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	1042
Mean of percent_know_miss_incl	0.389
Number of Clusters	638
R-square without private_school/club	0.323
Root MSE without private_school/club	0.187
F Value without private_school/club	46.67
Pr>F without private_school/club	<.0001***
R-square with private_school/club	0.346
Root MSE with private_school/club	0.184
F Value with private_school/club	40.00
Pr>F with private_school/club	<.0001***

Table 4.39. Parameter Estimates Table for Percent Correct on the Knowledge Section (Missing Values Coded as Incorrect) (Stacked Data) (Both Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	0.011	0.8034	-0.014	0.7528
grade	0.025	<.0001***	0.028	<.0001***
sex	0.011	0.4167	0.010	0.4290
percent_urban_pre	-0.002	0.0002***	-0.002	0.0017***
prev_visit	-0.113	0.0759*	-0.095	0.1336
other_fam_visit	0.070	0.0010***	0.071	0.0008***
number_tests	-0.027	0.0707*	0.007	0.6229
park_visit	0.036	0.3797	0.003	0.9538
travel_time	0.002	<.0001***	0.002	0.0007***
other_fam_visit*park_visit	-0.051	0.0529*	-0.057	0.0280**
park_visit*travel_time	0.002	<.0001***	0.001	0.0014***
grade*prev_visit	0.016	0.0211**	0.014	0.0416**
private_school			0.137	<.0001***
club			-0.072	0.0661*
park_visit*club			0.203	0.0003***

Visiting the park was a significant factor in students' responses to the attitude statements, and students who visited the park expressed more positive attitudes. As percent urban increased, visiting the park had slightly less positive effect on students' attitudes. Female students had more positive attitudes, but if they visited the park during the study their attitudes were less positive. As grade level increased, attitudes became more positive. Being in a private school had a positive influence on attitudes while responding to the questionnaire as an individual class instead of a mixed group of students that are not all in the same class had a negative influence on attitudes. Students from mixed groups might have been more excited about the park because they might not have thought of it as a school related trip.

Table 4.40. Data Summary and Fit Statistics Table for Average Attitude on the Attitude Section (Stacked Data) (Both Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	880
Mean of avg_attitude	4.530
Number of Clusters	456
R-square without private_school/ind_class	0.222
Root MSE without private_school/ind_class	0.450
F Value without private_school/ind_class	19.82
Pr>F without private_school/ind_class	<.0001***
R-square with private_school/ind_class	0.236
Root MSE with private_school/ind_class	0.447
F Value with private_school/ind_class	16.84
Pr>F with private_school/ind_class	<.0001***

Table 4.41. Parameter Estimates Table for Average Attitude on the Attitude Section (Stacked Data) (Both Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	-2.810	0.2948	-3.531	0.1920
grade	0.073	<.0001***	0.079	<.0001***
sex	0.221	0.0005***	0.219	0.0006***
percent_urban_pre	0.072	0.0120**	0.077	0.0073***
number_tests	-0.058	0.2880	0.072	0.3222
park_visit	6.549	0.0140**	7.101	0.0081***
days_pre_p1	0.002	0.5753	0.004	0.1895
sex*park_visit	-0.167	0.0296**	-0.179	0.0204**
percent_urban_pre*park_visit	-0.069	0.0160**	-0.076	0.0085***
private_school			0.247	0.0073***
ind_class			-0.171	0.0133**

As with the models of differences, the model of reported average behavior estimated with pooled data had much lower explanatory power (R^2=0.06) than models of knowledge. Visiting the park did not significantly influence students' responses to the behavior statements. As students increased in age their behaviors became more positive, but if they

visited the park then the positive increase based on age was weaker. The number of times the students completed the questionnaire affected their responses to the behavior statements, with average behavior becoming more negative the more times the questionnaire was completed. Urban students responded more negatively to the behavior statements; although that was less true if they had visited the park. As the number of days increased between the pre- and post-test, the responses became more negative, but if students visited the park the responses were more negative as the number of days between tests increased.

Table 4.42. Data Summary and Fit Statistics Table for Average Behavior on the Behavior Section (Stacked Data) (Both Treatment and Control)

Data Summary and Fit Statistics	
Number of Observations	841
Mean of avg_behav	3.745
Number of Clusters	452
R-square without club	0.057
Root MSE without club	0.923
F Value without club	3.50
Pr>F without club	0.0001***
R-square with club	0.060
Root MSE with club	0.922
F Value with club	3.70
Pr>F with club	<.0001***

Table 4.43. Parameter Estimates Table for Average Behavior on the Behavior Section (Stacked Data) (Both Treatment and Control)

Parameter	Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept	2.503	0.0112**	2.481	0.0121**
age	0.228	<.0001***	0.228	<.0001***
sex	0.063	0.4264	0.048	0.5423
zone	-0.456	0.0324**	-0.457	0.0320**
car	0.127	0.1138	0.133	0.0980*
number_tests	-0.259	0.0523**	-0.245	0.0683*
park_visit	0.899	0.3734	0.890	0.3785
days_pre_p1	-0.063	0.0059***	-0.063	0.0063***
travel_time	0.004	0.0786*	0.004	0.0921*
age*park_visit	-0.179	0.0027***	-0.179	0.0028***
park_visit*days_pre_p1	0.055	0.0221**	0.053	0.0269**
zone*park_visit	0.347	0.1492	0.367	0.1271
club			0.378	0.0205**

4.6 Discussion

Students that participated in the conservation education program at Serra Malagueta Natural Park appeared to learn about the park, biodiversity, and local plant and animal species. Average attitude scores did not show a large change for students who visited the park, but some specific attitudes were still positively impacted. Even though students only had several hours to experience the park they still demonstrated some knowledge gain. Although there was no positive change in reported behavior, it is understandable that several hours in the park would not strongly influence students' behavior, and it is also possible that students were more aware of their behavior and report it more accurately after the park visit.

Using paired (both principal components and standard) data to calculate changes in knowledge, the estimation results suggested that students' knowledge increased by visiting the park. The only other consistently significant variable affecting change in knowledge was

private school. However, because relatively few students were from private schools, it is difficult to know if it is being from a private school or some other factors particular to those few students that impacts change in knowledge. The private school students began with high scores, so it was difficult for them to greatly improve their scores. When stacked data were used, private school had a positive impact on students' responses to the knowledge questions. When all the missing values in the knowledge section were coded as incorrect, female students showed less gain in knowledge while urban students showed more gain in knowledge, all else equal. However, this result is not robust, as it is not found in models of change in knowledge when missing values are left blank.

Another way to identify factors that influence the change in knowledge was to estimate models for the treatment groups only (both principal components and non-principal components), including characteristics of their visit to the park. In models of change in percent correct answers (with missing values left blank or missing values counted as incorrect), the variable 'if the teacher discussed the park before the visit,' positively influenced students' change in knowledge. Younger students appeared to learn more from the park visit if their teacher had discussed the park before they arrived. However, the variable 'if teacher discussed the park' was not significant in the model of the change in the first principal component of knowledge.

When the data from the pre- and post- test were pooled (stacked rather than paired), visiting the park did not have a significant impact on students' responses to the knowledge questions. However, it did have a significant interaction with both other family member visited the park and distance from the park. Having another family member who had visited

the park had a positive significant influence on students' responses, but when the student visited the park too, the effect was weakened. Students who came to visit the park from further away (school at greater distance from park) gave more correct answers to the knowledge questions. Students from private schools correctly answer more of the questions.

Visiting the park does not appear to change attitudes. No significant models were found when principal components were used for combined treatment and control groups and just the treatment group. Park visit was not significant in the change in attitude model using the average Likert scale response to the attitude questions. Some estimation results suggest that grade level and gender could influence change in attitudes. However, the parameter estimates were not consistently positive or negative when looking at combined treatment and control, just treatment, or the stacked data.

Reported pro-environmental behavior seems to be negatively affected by visiting the park. The decrease in the environmental behavior score becomes greater with the number of days between completing the questionnaires. Gender was the only variable significant in both the treatment group models of change in behavior. Female students that visited the park displayed a positive change in behavior.

In sum, the results of this study show that the park does increase students' knowledge of the park and biodiversity conservation. However, this is a short-term impact, based on students' responses to a survey one week after their visit to the park. Turning to attitudes, students generally have positive environmental attitudes prior to their park visit, but because of the preexisting positive attitudes there is no strong evidence that the park program increases positive environmental attitudes. Finally, there is no evidence that the park visit

increases reported pro-environmental behavior. In fact, boys reported less pro-environmental behavior after the park visit. However, overall, reported behavior was difficult to explain and did not change much between pre- and post- tests. Future research should consider other methods – such as observations – for measuring impacts on behaviors.

4.7 Caveats

It is difficult to evaluate a field trip to SMNP because school and the field trip can be integrated (Bitgood, 1989). There are multiple limitations with these analyses. Ideally, all students who participated in the conservation education program and this study would have completed the questionnaire three times, and all students in the control group would have completed the questionnaire twice, but this did not occur because of timing and scheduling conflicts. The sample size was not very large and there are lots of variations among the students who participated in the program. It would have been ideal to have a sample with normally distributed age and grade level. Some of the independent variables have small sample sizes because of variation in the different student groups.

One issue with looking at change in knowledge, attitudes, and behavior could be students are starting with a high level of knowledge, attitudes and/or behavior. Therefore, pre-test levels will be included in future analyses to test if high starting levels are impacting the lack of change in knowledge, attitudes, and behavior.

5 LONG-TERM IMPACT (RESULTS AND ANALYSIS)

5.1 Stability of environmental knowledge, attitudes, and behavior

This chapter examines how students' environmental knowledge, attitudes, and behavior change in the month after they visit SMNP and participate in the conservation education program. While students' knowledge, attitudes, and reported behavior may be influenced soon after their visit to the park, it is important to know whether these impacts are lasting. I examine whether students retain information learned during the park visit and how their attitudes and reported behavior change in the month after they visit the park, using data from the second and third rounds of the questionnaire with students who had visited the park.

The third round, or second post-test, was designed to evaluate whether students still remember what they learned about a month after their visit to the park and whether their attitudes and reported behaviors remained constant or evolved over that time period. It is possible that after one week, students still have the information from the park memorized, but they do not retain this information in long-term memory. Likewise, one week after the park visit, students may have still been enthusiastic about the park and had more positive attitudes and reported more pro-environmental behaviors. Alternatively, as found in chapter 2, the teachers who take their students to the park may adjust their class plans to focus more on the issues raised during the park visit. Nevertheless, I hypothesize that students' knowledge, attitude, and behavior scores decrease from post-1 to post-2, which would suggest that the conservation education program only has short-term impacts.

5.2 Description of Sub-Sample of Students

In this case, I use data from park visitors only (the treatment group). One hundred sixteen students took the questionnaire three times, a pre-test and two post-tests. The second post-test was given to students between 26 and 47 days after the pre-test, and the number of days between post-1 and post-2 ranges from 19 to 40.

The sample of 116 students includes 2 groups with approximately 7 classrooms. Table 5.1 compares socio-demographic characteristics of this sub-sample to the full sample of students who visited the park. In general, the socio-demographic characteristics of the sub-sample are very similar to the full sample of students who visited the park. The average grade level and age is slightly higher for the sub-sample, but the sub-sample is composed of students in the lowest and highest grades with none of the middle grade levels represented. The sub-sample has a higher percent of students whose families own a car, 69% compared to 60%. Percent female, percent urban, and percent of students that had previously visited the park are very similar between the two samples. However, of the students who had previously visited the park the full sample has a higher percent of students that had a guided tour (71% compared to 58%). The full sample has a higher percent of students who have another family member that has visited the park (58% compared to 53%).

Table 5.1. Socio-Demographic Characteristics of the Sub-Sample and the Full Sample

Variable	Sub-Sample Mean	St dev	N	Full-Sample Mean	St dev	N
grade	9.517	3.147	116	8.766	2.416	688
grade_cycle	8.672	2.936	116	8.131	2.476	688
age	15.713	3.595	115	14.931	2.661	677
sex	0.554	0.499	112	0.531	0.499	655
zone	0.664	0.475	110	0.678	0.468	633
prev_visit	0.190	0.394	116	0.214	0.41	682
if_yes_guide	0.579	0.507	19	0.711	0.455	135
other_fam_ visit	0.532	0.501	111	0.576	0.495	665
car	0.687	0.466	115	0.601	0.49	682

5.3 Results

The percent correct for both post-1 and post-2 are similar for most questions. Students could be retaining the information they learned from the conservation education program, but it is also possible that teachers are still covering the information in their classrooms after the park visit. Knowing the definition of biodiversity and whether the plant species lantuna and lingua-de-vaca are introduced, endemic, or invasive are the only three questions that showed a decrease in percent correct between post-1 and post-2 (not statistically tested). There is a large number of missing values for the pre-test in the knowledge section.

Table 5.2. Percent Correct for Pre, Post-1, and Post-2 Knowledge Questions

Variable	Pre-test	Post-test 1	Post-test 2
def_end mean	0.658	0.718	0.746
def_end st. dev.	0.477	0.452	0.437
def_end N	79	110	114
def_intr mean	0.606	0.716	0.732
def_intr st. dev.	0.491	0.453	0.445
def_intr N	99	109	112
why_park mean	0.243	0.352	0.377
why_park st. dev.	0.431	0.480	0.487
why_park N	103	108	114
soil_ero mean	0.337	0.330	0.351
soil_ero st. dev.	0.475	0.473	0.480
soil_ero N	98	106	111
monk mean	0.424	0.509	0.509
monk st. dev.	0.497	0.502	0.502
monk N	99	112	112
lant mean	0.464	0.693	0.591
lant st. dev.	0.501	0.463	0.494
lant N	97	114	115
ling mean	0.674	0.658	0.584
ling st. dev.	0.471	0.477	0.495
ling N	95	114	113
kalip mean	0.333	0.330	0.377
kalip st. dev.	0.474	0.472	0.487
kalip N	93	115	114
biodiv mean	0.620	0.726	0.692
biodiv st. dev.	0.489	0.449	0.465
biodiv N	71	84	78

When looking at Table 5.3 and the mean Likert scores for the attitude statements (Table 5.5) from the pre- and two post-tests, the scores between the two post-tests were very similar. There are no large changes between post-1 and post-2, and the attitudes appear to remain stable.

Table 5.3. Mean Likert Score for Pre, Post-1, and Post-2 Attitude Statements

Variable	Pre-test	Post-test 1	Post-test 2
loose_goats_pos mean	5.036	5.351	5.391
loose_goats_pos st. dev.	1.228	0.959	1.101
loose_goats_pos N	111	114	110
park_rich_pos mean	4.832	5.175	5.286
park_rich_pos st. dev.	1.575	1.384	1.189
park_rich_pos N	113	114	112
remove mean	3.170	3.530	3.514
remove st. dev.	1.489	1.477	1.495
remove N	106	115	111
no_preserv_pos mean	4.838	4.465	4.709
no_preserv_pos st. dev.	1.411	1.581	1.176
no_preserv_pos N	111	114	110
lots_nat_pos mean	2.606	2.614	2.645
lots_nat_pos st. dev.	1.247	1.392	1.398
lots_nat_pos N	109	114	110
too_big_pos mean	3.245	2.921	2.973
too_big_pos st. dev.	1.447	1.476	1.468
too_big_pos N	110	114	111
future_vis mean	5.107	5.289	5.252
future_vis st. dev.	1.448	1.111	1.179
future_vis N	112	114	111
camp mean	5.406	5.348	5.312
camp st. dev.	1.128	0.917	0.950
camp N	106	112	109
know_nat mean	5.128	5.274	5.200
know_nat st. dev.	1.348	1.104	1.065
know_nat N	109	113	110
good_prot mean	5.152	5.491	5.351
good_prot st. dev.	1.409	0.885	1.041
good_prot N	112	114	111
refor mean	4.519	4.712	4.791
refor st. dev.	1.274	1.224	1.050
refor N	106	111	110
ero_prob mean	4.375	4.354	4.450
ero_prob st. dev.	1.566	1.349	1.380
ero_prob N	112	113	111

The mean Likert score for all three behaviors slightly decreases from the first post-test to the second post-test (not tested statistically) (Table 5.5).

Table 5.4. Mean Behavior Likert Scores for Pre, Post-1, and Post-2 Behavior Statements

Variable	Pre-test	Post-test 1	Post-test 2
trash mean	3.853	4.322	4.134
trash st. dev.	1.948	1.755	1.711
trash N	116	115	112
learn_an mean	4.088	3.870	3.770
learn_an st. dev.	1.509	1.484	1.576
learn_an N	113	115	113
hike mean	3.106	3.043	2.965
hike st. dev.	1.520	1.495	1.558
hike N	113	115	113

Figures 1 and 2 show an increase in mean percent correct from the pre-test to the two post-tests, but there was no difference between the two post-tests. The average attitude scores do not appear to have much variation through time. The average behavior score does decline from the first post-test to the second post-test.

Table 5.5. Overall Mean Percent Correct Knowledge Scores and Mean Attitude and Behavior Likert Scores for Pre, Post-1, and Post-2 Tests

Variable	Pre-test	Post-test 1	Post-test 2
percent_know mean	0.446	0.549	0.541
percent_know st. dev.	0.225	0.208	0.225
percent_know N	115	116	116
percent_know_miss_incl mean	0.383	0.517	0.514
percent_know_miss_incl st. dev.	0.224	0.213	0.231
percent_know_miss_incl N	115	116	116
avg_attitude mean	4.440	4.537	4.569
avg_attitude st. dev.	0.627	0.471	0.502
avg_attitude N	114	115	112
avg_behav mean	3.638	3.745	3.622
avg_behav st. dev.	1.011	0.939	1.034
avg_behav N	116	115	113

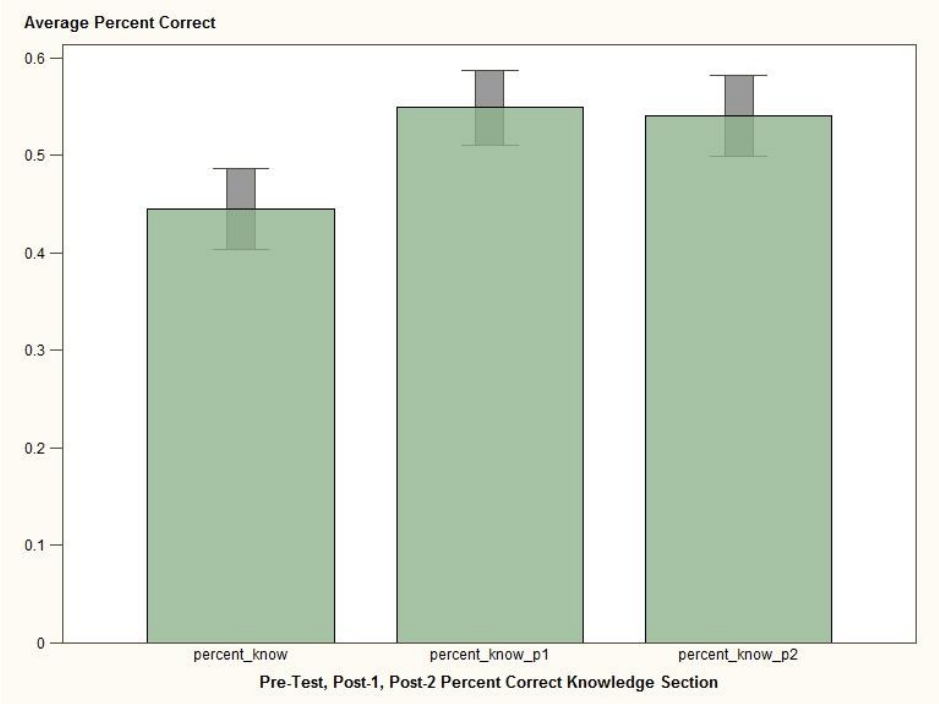

Figure 5.1. Overall percent correct on the knowledge section for pre-test, post-1, and post-2.

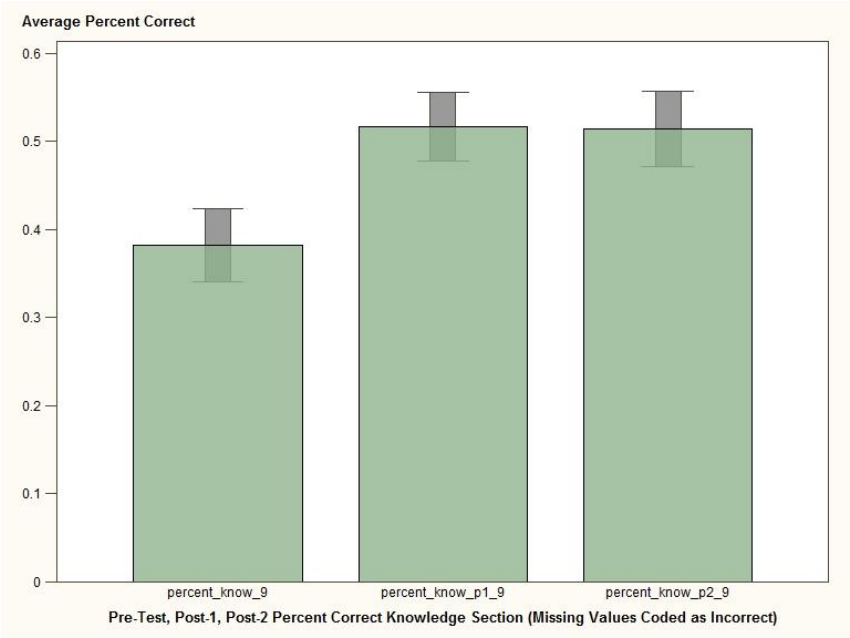

Figure 5.2. Overall percent correct on the knowledge section (missing values coded as incorrect) for pre-test, post-1, and post-2.

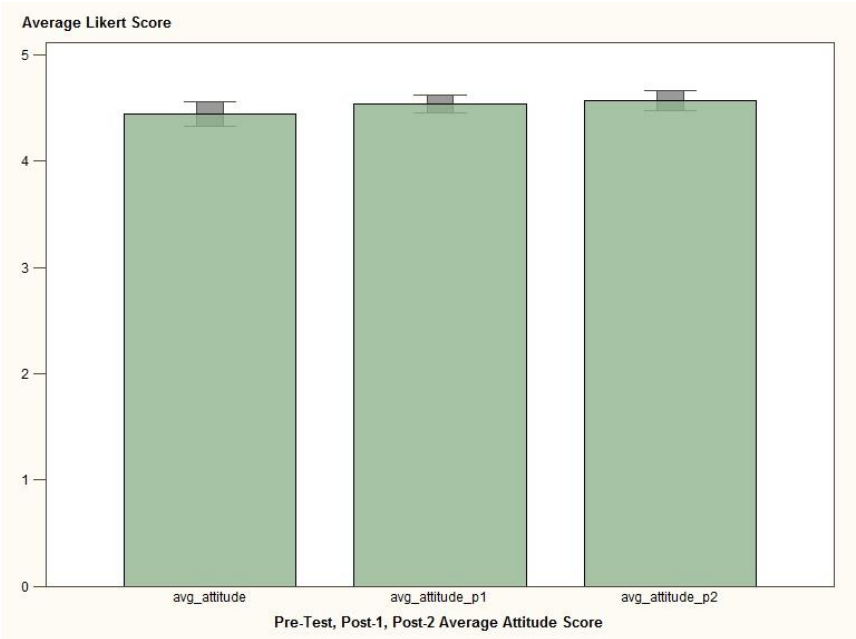

Figure 5.3. Average Likert score for the attitude section for pre-test, post-1, and post-2.

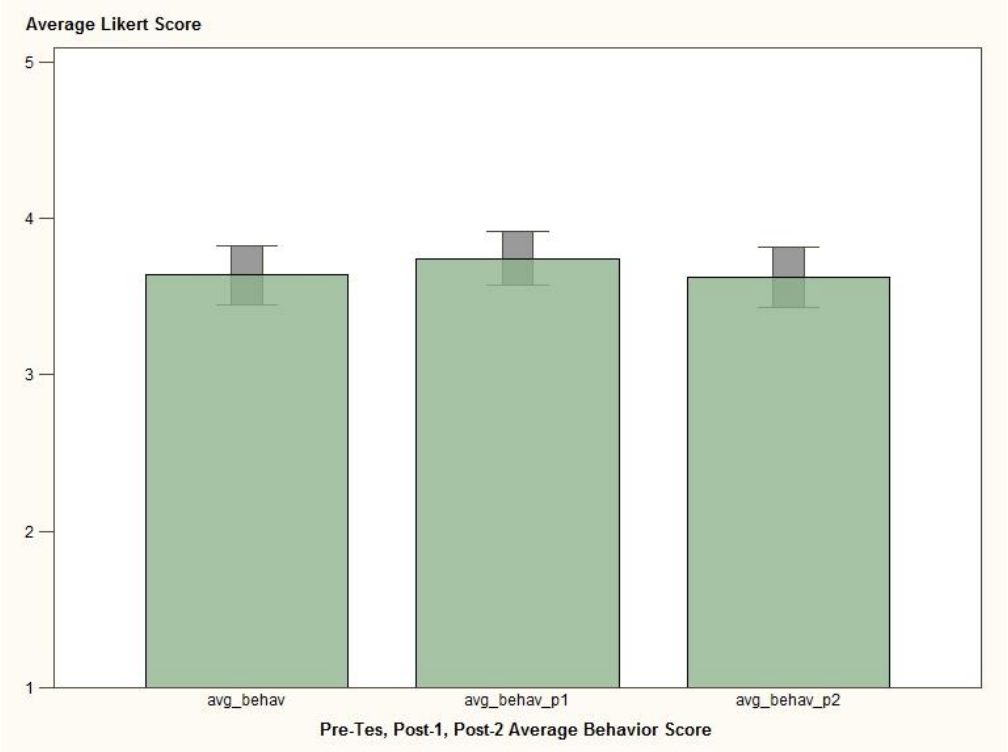

Figure 5.4. Average Likert score for the behavior section for pre-test, post-1, and post-2.

Table 5.6. Wilcoxon Signed Rank Tests Comparing Post-1 and Post-2 Average Scores

Variable	Change in Score	Statistic	Pr ≥ |S|	N
change_percent_know_p2_p1	-0.009	-132.5	0.6502	116
change_percent_know_miss_incl_p2_p1	-0.003	-37.5	0.8734	116
change_avg_attitude_p2_p1	0.012	62.5	0.8381	112
change_behav_attitude_p2_p1	-0.133	-409.5	0.0819*	113

Wilcoxon signed rank tests were used to test for significant change between post-1 and post-2 scores of overall knowledge, attitudes, and behaviors. Neither the change in average attitude scores nor the change in mean percent correct for the knowledge section was significant. The change in average behavior between the two post-tests was significant at the

0.10 level. Because this change in overall behavior was significant, the variation in behavior across students could have changed significantly between the pre- and second post-tests. To assess this, I estimate ordinary least squares regressions to identify factors that influence the change in behavior from pre-test to post-2. Both change in average behavior score between pre-test and post-2 and change in principal components for behavior between pre-test and post-2 were used as dependent variables, with the same specifications as used in the previous chapter. None of the models were significant: change in reported behaviors between pre-test and the second post-test among students who visited the park did not appear to be related to student, school, or visit characteristics.

5.4 Discussion

In sum, students' environmental knowledge and attitudes remain stable in the month after their participation in SMNP's conservation education program. It is notable that students' knowledge increases after the park visit and then remains stable over the following month. Thus, the conservation education program may be having a long-term impact on understanding and knowledge of biodiversity conservation issues. Conversely, attitudes do not change much, and students report more pro-environmental behavior soon after the park visit, with declining reports a month later.

5.5 Caveats

There are multiple limitations with these analyses. Ideally, all students who participated in the conservation education program and this study would have completed the

questionnaire three times, but this did not occur because of timing and scheduling conflicts. The sample size is only 116 students and consists of only two visiting groups. Therefore, there is not enough variation in some of the independent variables to include them in the regression models. There were also issues with multicollinearity, as indicated by high variance inflation factors, so certain variables could not be combined in the same model.

While an index of environmental knowledge (percent of knowledge questions answered correctly) holds steady between the first and second post-test, this does not mean that students are retaining information from the program. Competing hypotheses that I cannot rule out are that (1) students are learning how to take the test, and (2) teachers are covering material related to protected areas, biodiversity, and conservation in the classroom, as a follow-up to the park visit.

Reported pro-environmental behaviors are not stable, but decreasing. Perhaps students report more environmental behaviors soon after their park visit because they recently learned about local plants and animals and got to experience a natural area. However, a month after their visit, the effect of the park has worn off and students no longer report the same pro-environmental behaviors, which suggest a potential concern with measuring reported behaviors: students may have a desire to act but may not have the opportunities to display pro-environmental behaviors. For example, students from rural areas may not have the option of throwing trash somewhere other than the ground. Students from urban areas might not have the opportunity to go hiking outside of school trips. Students may not have access to resources to learn about local plants and animals. More research is

needed to understand students' environmental behaviors and whether and how they are affected by participation in the park's conservation education program.

6 CONCLUSION

6.1 Summary of Key Findings

When looking at the responses to the pre-tests none of the questions had more than a 50% correct response rate. In particular students struggled with fully comprehending why Serra Malagueta is a natural park. Thus, all of the question topics would be worth including in conservation education programs in Cape Verde. In general, student attitudes towards conservation, biodiversity, and natural parks are positive, but students on average did not express a pro-environmental opinion in response to several statements. The park could focus on the need for invasive species removal, why large areas are needed for conservation, and how limited natural ecosystems are on Cape Verde. Students do express an interest in learning about local plants and animals.

It is important to understand what factors influence students' knowledge, attitudes, and behavior prior to visiting the park. Age and grade level influence students' prior knowledge, attitudes, and behavior. Older/higher grade level students start with more environmental knowledge and pro-environmental attitudes. Whether students had previously visited SMNP did not have a significant effect on their responses to most of the individual questions about environmental knowledge, attitudes, and behavior. However, students who have previously visited the park do answer a higher mean percentage of the knowledge questions correctly. In general females have more environmentally positive attitudes, but males hike more. Students who live in urban (rather than rural) areas generally have more knowledge of environmental concepts and more positive attitudes towards the environment.

Urban students are more likely to avoid throwing trash on the ground, while rural students try to learn more about local plants and animals and hike more frequently. Students' socioeconomic status, as proxied by whether their family owns a car, does not influence their responses to the questionnaire.

Visiting the park positively influences change in knowledge gain. However, visiting the park does not seem to be a significant factor influencing students' environmental attitudes. As the number of days between the pre-test and post-test increase, the change in behavior decreases. It is not a surprise that student behaviors did not express large changes. Short experiences typically do not change behavior (Knapp, 1996).

Based on the subsample that completed the questionnaire three times, attitudes and knowledge remain stable from the first-post-test to the second post-test. Students are not forgetting the information and their pro-environmental attitudes are not decreasing approximately a month after their visit to the park. However, reported behaviors are not remaining stable, but are decreasing.

A possible reason for a lack of change in attitudes could be the 'ceiling effect' where the participants started off with positive environmental attitudes (Beaumont, 2001; Gough et al., 2007 (these studies involved tourists)). The visiting students already had positive environmental attitudes before they participated in the conservation education program. Maybe because students had a guided tour they did not experience large changes in attitudes. In one study, Australian students learned more when a reef experience was combined with a classroom presentation. However, attitudes and ecological intention to act experienced the largest positive change when students had a reef experience only and did not have a

classroom lecture (Stepath, 2007). Stronck (1983) also found similar results. Students visiting a museum, who had a docent leading them (more structured tour) showed higher levels of learning compared to students that had their teacher leading them (unstructured tour) (note that knowledge section did not have a pre-test). The opposite was true with attitudes toward the museum; the students with unstructured tours expressed more positive attitudes.

6.2 Study Recommendations

More research is needed to further understand the conservation education program and park visits' impact on visiting students. It would be ideal to have more participants with an even distribution of grade levels. Also, it would be ideal to for all visiting students throughout the whole school year to participate and complete the questionnaire three times and all control groups complete it twice. However, grade level and when classes visit the park is uncontrollable, but based on which classes visit the park and when they decide to come. It could be possible to change the questionnaire and focus on primary school students, that way long term retention could be tested. Most of the visiting groups are primary schools. Primary school students are likely to stay in the same class as they advance to the next grade. This would not be feasible for sixth graders but could work for other primary grades.

A more user friendly and shorter questionnaire could be developed. Younger students typically had more difficulty filling out the questionnaire and had to ask more questions. A limitation of the study could be students did not fill out the socio-demographics

questions correctly. Some socio-demographic questions varied between the pre-test and post-tests.

If other instructional formats are developed for the conservation education program the park could test to see which style has the greatest impact on students' environmental knowledge, attitudes, and behaviors.

6.3 Conclusion: Possible Improvements and Future Work

It will be important for SMNP to continue to evaluate and try and improve their conservation education program. For future evaluation work, SMNP staff could implement direct evaluation. Nowak (1984) describes how direct evaluation is an important evaluation tool for environmental education or interpretation programs, and involves asking exactly what you want to know about the effectiveness of your program, such as what are the strengths or weakness. This could be used by SMNP staff to help their program, and only requires asking the specific questions that you want answered, and does not require much money or time.

Other future work could involve evaluating the information and displays in the exhibition room. Bettinger et al. (2010) showed that images/pictures can have a large impact on the message received by students, so it is important the correct message be clearly understood. Quality of exhibits was an important factor in a zoo study (Wagner et al., 2009). However, signs at state nature preserves were not seen as effective interpretation tools in one study (Olson et al., 1984).

Research from Wagner et al. (2009) suggests that seeing rare animals is an important factor in conservation motivation. Tisdell and Wilson (2005) found similar results at a conservation park in Australia; the variable 'whether or not marine turtles were seen' had an impact on tourists intended conservation behavior. The SMNP guides could try and focus more on looking for wildlife to show the students. One of the questions students typically asked was "What animals are in the park?" The visitors to SMNP want to see animals, but there are not the large species that visitors want to see, and it is difficult to locate and actually view the species that are present. It is possible that direct viewing of animals could impact attitudes and behaviors.

Lindemann-Matthies and Kamer (2006) noted that a touch table (a ranger was with the touch table to explain things) can influence visitors' knowledge at a Swiss zoo. A group of student visitors to a museum expressed interest in touching and feeling things at a museum (Stronck, 1983). SMNP has an exhibition room that has locally made products that students can touch and look at. The addition of a touch table with plant and animal materials might assist students in developing a better understanding of the different species and lead to improved learning. Currently, the park only has a few pictures of the local animals and plants with brief information about them. An interactive table could improve learning and interest since most visitors do not have the opportunity to see the animals in SMNP.

Knapp (2005) recommends that interpretive programs partner together particularly with schools. Schools should be able to incorporate SMNP into its environmental education, thereby increasing the likelihood of the program being more effective. SMNP could partner with other agencies (i.e. environmental groups, centers, etc.) and the schools to help students

have a better understanding of the environment, leading to more attitude and behavior changes. Also, the park could provide the teachers with appropriate materials for the classroom.

Dettman-Easler and Pease (1999) recommend pre- and post-visit activities to strengthen material learned from the program. SMNP conservation education program could become more effective if the material is reinforced in the classroom. Finson and Enochs (1987) found that pre-visit activities, in-visit activities, post-visit activities, or combinations of these to be an important part of students' attitudes in their science-technology museum study because the visiting students without the activities had lower attitude scores than students who did not visit the museum. Pre-visit lesson(s) can be influential in helping students to achieve the learning objectives (Bitgood, 1989). It is important for students to learn about the environment before they arrive so they can focus on learning the material at site. It can be challenging for students to learn new material in a new environment because it is easy for them to focus on the new environment itself instead of the teaching (Bitgood, 1989). For many of the SMNP students, it was the first time they had ever been to the park or maybe even a forested area.

Improving teachers' conservation knowledge can help foster positive attitudes in young students (de White & Jacobson 1994). Based on the de White and Jacobson (1994) study, just a visit to the zoo or visit and audiovisual did not seem to have much impact. It appears to be important to have involved, informed teachers and systematic classroom preparation with the visit. Knapp (2000) looked at elementary age students that visited a city park that included a large forest and nature preserve (small sample size). The author

recommends that the information needs to be repeated, and teachers accomplish this goal through exercises emphasizing information provided on the field trip. Knapp (2000) did find that results from both tests yielded positive responses toward wanting to learn more about the subject matter and an interest in returning to the field trip site. SMNP students have the desire to return to the park and have a positive view of the park. Therefore, repetition in the classroom of what they learned in the park could improve knowledge retention. Kuhar et al. (2010) suggested that the reason students performed better on pre-tests after the 1st year of pre-tests could be that teachers are gaining knowledge and skills to be able to use in their classroom and students are more knowledgeable when they visit the forest reserve. When teachers continually visit SMNP they could be gaining knowledge and confidence that would allow them to improve their teaching about the park in their classrooms.

Another tool that could be used would be to give interpretation sheets (provide information about the park and the biodiversity) to the students. Interpretive sheets were successfully used with tourists at a rainforest walk in Australia; those with interpretation sheets learned more and believed they learned more (Gough et al., 2007). This could help with large classes where it might be difficult to hear everything the guide is saying. The challenge would be funding for printing the sheets to give to the students. The park has several brochures but none of them go into detail about conservation or the parks' biodiversity. Brochures could be created giving detailed information about biodiversity, conservation, and applications visitors can take to help conserve the environment.

Instead of focusing mainly on the environmental issues in the park, the guides could emphasize actions the students can take to help solve and prevent the environmental

problems and issues. It is important for students to not only be familiar with environmental problems, but they need to understand the different sides of the issues and the ways they can help (Newhouse, 1990). Jordan, Hungerford, and Tomera (1986) conducted a study of students that participated in residential environmental programs (6 day programs) at a nature environmental center. The treatment groups received information on awareness and action strategies of environmental issues while the control groups only received information on awareness of environmental issues. The treatment group showed an increase in knowledge of environmental actions and reported participating in more environmental behaviors, while the control group did not show an increase in environmental action knowledge and did not report participating in significantly more environmental behaviors. By informing students of action strategies, SMNP can motivate students to change their behavior.

Camps have been effective in creating knowledge gain and positive change in attitudes and behavior (Bogner, 1998). SMNP could look into creating an environmental camp experience. Students demonstrated a strong interest in attending a camp based on their response to the questionnaire used in this study.

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APPENDICES

Appendix 1. Student Questionnaire - Portuguese

QUESTIONÁRIO

Ao completar este questionário significa que concorda em participar voluntariamente e entende os seus objectivos.

Nome: _____

Número ou código da classe: _____

Escolaridade:_____

Idade:_____ anos

Sexo: M☐ F☐

Você vive numa área: Urbana ☐ Rural ☐

Você já visitou o Parque Natural de Serra Malagueta antes?
Sim ☐ Não ☐

→ Caso sim, você teve uma visita guiada?
Sim ☐ Não ☐

Alguma outra pessoa de sua família já visitou o parque?
Sim ☐ Não ☐

Você tem familiares emigrantes?
Sim ☐ Não ☐

A sua família possui um carro?
Sim ☐ Não ☐

<u>De entre as respostas apenas uma está correcta.</u> Escolha entre **a**, **b**, **c**, ou **d**.

1. O que significa "*espécie endêmica*"?
a. Uma espécie que está ameaçada (em vias de extinção)
b. Uma espécie que existe em muitos lugares (ou seja, países)

c. Uma espécie que não existia num determinado lugar mas que foi levada por pessoas
d. Uma espécie que se encontra num determinado lugar, e não é encontrada em nenhum outro lugar do mundo.
e. Eu nunca ouvi falar desse termo/palavra antes

2. O que significa uma "*planta introduzida*"?
a. Uma planta que é semeada por pessoas
b. Uma planta que sempre esteve presente num determinado lugar, mas também é encontrada noutros lugares
c. Uma planta que não existia num determinado lugar mas que foi levada por pessoas
d. Uma espécie que se encontra num determinado lugar, e não é encontrada em nenhum outro lugar do mundo.
e. Eu nunca ouvi falar desse termo/palavra antes

3. Porque é que a Serra Malagueta é considerada como *"Parque Natural"*?
a. Tem um elevado nível de biodiversidade
b. Existem plantas e animais em vias de extinção
c. Tem cultura tradicional
d. Todas as opções acima estão correctas
e. Eu nunca ouvi falar desse termo/palavra antes

4. Qual é uma das causas principais de *"erosão do solo"*?
a. Construir terraços com paredes de pedra
b. Retirar a vegetação
c. Plantar árvores que obtêm nutrientes do solo
d. Não colocar adubo ou estrume no solo
e. Eu nunca ouvi falar desse termo/palavra antes

5. Preencha o espaço vazio com "endêmica", "introduzida", ou "invasora":
(Ajuda: Você utilizará todas as opções pelo menos uma vez)

O macaco é uma espécie _____.

A lantuna é uma espécie _____.

A lingua-de-vaca é uma espécie _____.

O eucalipto (kalipi) é uma espécie _____.

6. Qual é o termo/palavra que significa "*variedade de todos os series vivos*"?

_____

Dê um número (de 1 a 6) para cada uma das afirmações de acordo com a tua opinião.
6 = concordo totalmente, 5 = concordo, 4 = concordo um pouco,
3 = discordo um pouco, 2 = discordo, 1 = discordo totalmente

1. Deveria ser permitido às pessoas pastar as suas cabras soltas na Serra Malagueta /_____
2. Parques Naturais são para pessoas ricas e turistas estrangeiros /_____
3. Determinadas plantas devem ser removidas dos Parques Naturais/_____
4. Não há necessidade de preservar as areas naturais que não tenham floresta /_____
5. Existem ainda muitas áreas naturais na Ilha de Santiago /_____
6. O Parque Natural da Serra Malagueta é grande demais /_____
7. Gostaria de visitar a Serra Malagueta no futuro /_____
8. Se a Serra Malagueta oferecer serviços de acampamento ambiental, gostaria de participar /____
9. É importante conhecer as áreas naturais ou protegidas /_____
10. É bom que a Serra Malagueta seja protegida como um Parque /_____
11. É importante fazer plantação com plantas nativas no Parque/_____
12. A erosão do solo na Ilha de Santiago é um grande problema /_____

Dê um número (de 1 a 6) para cada uma das afirmações de acordo com seu comportamento ultimamente.
6 = sempre, 5 = quase sempre, 4 = bastantes vezes,
3 = algumas vezes, 2 = quase nunca, 1 = nunca

13. Evito jogar lixo no chão /_____
14. Tento aprender sobre as plantas e os animais locais /_____
15. Faço caminhadas em áreas naturais /_____

Appendix 2. Translated Student Questionnaire – English

Questionnaire

Completing this survey means that you agree to voluntarily participate and you understand its objectives.

Name: _____

Class ID number: _____

Grade:_____

Age:_____

Sex: M ☐ F ☐

What type of area do you live: Urban ☐ Rural ☐

Have you visited the park before?
Yes ☐ No ☐

If yes, did you have a guide?
Yes ☐ No ☐

Has anyone in your family visited the park before?
Yes ☐ No ☐

Do you have family members that are emigrants overseas?
Yes ☐ No ☐

Does your family own a car?
Yes ☐ No ☐

One of the following answer choices is correct. Choose between **a**, **b**, **c**, or **d**.

1. What does *"endemic specie"* mean?
a. A species that is threatened (endangered)

b. A species that exists in a lot of places (that is countries)
c. A species that didn't exist in a certain place but was brought by people
d. A species that is found in a certain place and is not found anywhere else in the world
e. I have never heard of this term before

2. What does "*introduced plant*" mean?
a. A plant that is sown by people
b. A plant that has always been present in a certain place, but is also found in other places
c. A plant that didn't exist in a certain place but was brought by people
d. A species that is found in a certain place and is not found anywhere else in the world
e. I have never heard of this term before

3. Why is Serra Malagueta considered a *"Natural Park "*?
a. Has a high level of biodiversity
b. Has endangered plants and animals
c. Has traditional culture
d. All of the above options are correct
e. I have never heard of this term before

4. Which is the main cause of *"soil erosion"*?
a. Building terraces with rock walls
b. Removing vegetation
c. Planting trees that obtain nutrients from the soil
d. Not putting fertilizer or manure in the soil
e. I have never heard of this term before

5. Fill in the blank with "endemic", "introduced", or "invasive":
(Hint: You will use all of the options at least once.)

Monkey is an _____specie.

Lantuna is an _____specie.

Lingua-de-vaca is an _____specie.

Eucalyptus is an _____specie.

6. What word means *"the variety of all living things"*? _____

For each of the sentences choose a number from (1-6) based on your opinion of agreement.
6 = strongly agree, 5 = agree, 4 = somewhat agree,
3 = somewhat disagree, 2 = disagree, 1 = strongly disagree

1. People should be allowed to let their goats graze freely in Serra Malagueta /_____
2. Natural Parks are for rich people and foreign tourists /_____
3. Determined plants should be removed from natural parks/_____
4. It is not necessary to preserve natural areas that don't have forests /_____
5. There are still lots of natural areas on Santiago Island /_____
6. Serra Malagueta Natural Park is too large/_____
7. I would like to visit Serra Malagueta in the future/_____
8. If Serra Malagueta offered services for an environmental camp, I would like to participate /____
9. It is important to know/visit natural or protected areas /_____
10. It is good that Serra Malagueta is protected as a Park /_____
11. It is important to reforest the Park with native plants /_____
12. Soil erosion on Santiago Island is a big problem /_____

For each of the actions choose a number from (1-6) that agrees with your recent behavior.
6 = always, 5 = almost always, 4 = many/sufficient times,
3 = sometimes, 2 = almost never, 1 = never

13. I avoid throwing trash on the ground /_____
14. I try to learn about local plants and animals /_____
15. I go hiking in natural areas /_____

Appendix 3. Teacher Questionnaire (Treatment School Groups) - Portuguese

QUESTIONÁRIO PARA PROFESSORES
ID #: _____

M / F: Sexo
Com quantos alunos no total trabalha este ano? _____

Quantos vêm regularmente às aulas, na maioria das semanas? _____

Você já foi ao parque antes?_____
Se sim, você trouxe seus alunos para uma caminhada guiada?_____
Se sim, quando foi a última vez que você visitou?_____

Há quantos anos você é professor? _____

Há quantos anos você ensina nesta escola?_____

Qual é a sua formação escolar?_____
Que curso que você estudou?_____

Você tem falado com seus alunos sobre o parque antes de sua visita? Se sim, descreva.
_____
_____
_____

Dê um número (de 1 a 6) para cada uma das afirmações de acordo com a tua opinião.
6 = concordo totalmente, 5 = concordo, 4 = concordo um pouco,
3 = discordo um pouco, 2 = discordo, 1 = discordo totalmente

1. Deveria ser permitido às pessoas pastar as suas cabras soltas na Serra Malagueta /_____
2. Parques Naturais são para pessoas ricas e turistas estrangeiros /_____
3. Determinadas plantas devem ser removidas dos Parques Naturais/_____
4. Não há necessidade de preservar as areas naturais que não tenham floresta /_____
5. Existem ainda muitas áreas naturais na Ilha de Santiago /_____
6. O Parque Natural da Serra Malagueta é grande demais /_____
7. Gostaria de visitar a Serra Malagueta no futuro /_____

8. Se a Serra Malagueta oferecer serviços de acampamento ambiental, gostaria de participar /____
9. É importante conhecer as áreas naturais ou protegidas /_____
10. É bom que a Serra Malagueta seja protegida como um Parque /_____
11. É importante fazer plantação com plantas nativas no Parque/_____
12. A erosão do solo na Ilha de Santiago é um grande problema /_____

Appendix 4. Teacher Questionnaire (Control School Groups) - Portuguese

QUESTIONÁRIO PARA PROFESSORES
ID #: _____

M / F: Sexo
Com quantos alunos no total trabalha este ano? _____

Quantos vêm regularmente às aulas, na maioria das semanas? _____

Você já foi ao parque?_____
Se sim, você trouxe seus alunos para uma caminhada guiada?_____
Se sim, quando foi a última vez que você visitou?_____

Há quantos anos você é professor? _____

Há quantos anos você ensina nesta escola?_____

Qual é a sua formação escolar?_____

Que curso que você estudou?_____

Você ensinou seus alunos sobre o parque? Se sim, descreva.

_____
_____

Dê um número (de 1 a 6) para cada uma das afirmações de acordo com a tua opinião.
6 = concordo totalmente, 5 = concordo, 4 = concordo um pouco,
3 = discordo um pouco, 2 = discordo, 1 = discordo totalmente

1. Deveria ser permitido às pessoas pastar as suas cabras soltas na Serra Malagueta /_____
2. Parques Naturais são para pessoas ricas e turistas estrangeiros /_____
3. Determinadas plantas devem ser removidas dos Parques Naturais/_____
4. Não há necessidade de preservar as areas naturais que não tenham floresta /_____
5. Existem ainda muitas áreas naturais na Ilha de Santiago /_____
6. O Parque Natural da Serra Malagueta é grande demais /_____
7. Gostaria de visitar a Serra Malagueta no futuro /_____

8. Se a Serra Malagueta oferecer serviços de acampamento ambiental, gostaria de participar /____
9. É importante conhecer as áreas naturais ou protegidas /_____
10. É bom que a Serra Malagueta seja protegida como um Parque /_____
11. É importante fazer plantação com plantas nativas no Parque/_____
12. A erosão do solo na Ilha de Santiago é um grande problema /_____

Appendix 5. Translated Teacher Questionnaire (Treatment) – English

TEACHER QUESTIONNAIRE
ID #: _____

M / F: Sex
How many students do you have this year (total)? _____

How many regularly come to class most weeks? _____

Have you been to the park before?_____
If yes, did you bring your students for a guided hike?_____
If yes, when was the last time you visited?_____

How many years have you been a teacher? _____

How many years have you taught at this school?_____

What is your education background?_____
What course did you study?_____

Did you talk with your students about the park before your visit? If yes, describe.
_____
_____

For each of the sentences choose a number from (1-6) based on your opinion of agreement.
6 = strongly agree, 5 = agree, 4 = somewhat agree,
3 = somewhat disagree, 2 = disagree, 1 = strongly disagree

1. People should be allowed to let their goats graze freely in Serra Malagueta /_____
2. Natural Parks are for rich people and foreign tourists /_____
3. Determined plants should be removed from natural parks/_____
4. It is not necessary to preserve natural areas that don't have forests /_____
5. There are still lots of natural areas on Santiago Island /_____
6. Serra Malagueta Natural Park is too large/_____
7. I would like to visit Serra Malagueta in the future/_____
8. If Serra Malagueta offered services for an environmental camp, I would like to participate /____

9. It is important to know/visit natural or protected areas /_____
10. It is good that Serra Malagueta is protected as a Park /_____
11. It is important to reforest the Park with native plants /_____
12. Soil erosion on Santiago Island is a big problem /_____

Appendix 6. Translated Teacher Questionnaire (Control) - English

TEACHER QUESTIONNAIRE
ID #: _____

M / F: Sex
How many students do you have this year (total)? _____

How many regularly come to class most weeks? _____

Have you been to the park before?_____
If yes, did you bring your students for a guided hike?_____
If yes, when was the last time you visited?_____

How many years have you been a teacher? _____

How many years have you taught at this school?_____

What is your education background?_____
What course did you study?_____

Did you teach your students about the park? If yes, describe.
_____
_____
_____

For each of the sentences choose a number from (1-6) based on your opinion of agreement.

6 = strongly agree, 5 = agree, 4 = somewhat agree,
3 = somewhat disagree, 2 = disagree, 1 = strongly disagree

1. People should be allowed to let their goats graze freely in Serra Malagueta /_____
2. Natural Parks are for rich people and foreign tourists /_____
3. Determined plants should be removed from natural parks/_____
4. It is not necessary to preserve natural areas that don't have forests /_____
5. There are still lots of natural areas on Santiago Island /_____
6. Serra Malagueta Natural Park is too large/_____
7. I would like to visit Serra Malagueta in the future/_____

8. If Serra Malagueta offered services for an environmental camp, I would like to participate /____
9. It is important to know/visit natural or protected areas /_____
10. It is good that Serra Malagueta is protected as a Park /_____
11. It is important to reforest the Park with native plants /_____
12. Soil erosion on Santiago Island is a big problem /_____

Appendix 7. Variable Descriptions and Summary Statistics

Table A. 1. Variable Descriptions and Summary Statistics

Variables	Variable Description	Mean	St Dev	N
grade	Grade the student is currently studying	8.766	2.416	688
age	Age of the student at the time of the questionnaire	14.931	2.661	677
sex	Male or female; Female=1	0.531	0.499	655
zone	Live in a rural or urban area; Urban=1	0.678	0.468	633
prev_visit	Had the student previously visited the park; Yes=1	0.214	0.41	682
other_fam_visit	Had another family member previously visited the park; Yes=1	0.576	0.495	665
car	Does the student's family own a car (Used as a measure of wealth); Yes=1	0.601	0.49	682
old_test	Did the student take the original version or modified version; Original version=1	0.266	0.442	688
number_tests	How many times was the questionnaire filled out	1.843	0.686	688
saturday	Was the park visited on a Saturday ; Yes=1	0.29	0.454	366
park_visit	Did the student visit the park; Yes=1	0.532	0.499	688
days_pre_p1	Number of days between the pre-test and first post-test	17.584	11.029	464
hours_at_park	Number of hours spent at the park during the visit	2.202	0.618	321
number_stud_at_park	Number of students in the group that visited park	54.292	25.26	366
travel_time	Distance in minutes between the school and park	73.837	32.727	662
private_school	Was the school group from a private school; Yes=1	0.057	0.231	688
club	Was the group a school club; Yes=1	0.047	0.211	688

Table A.1. Continued

ind_class	Was the group an individual class or mixed group of students from different classes; Individual class=1	0.852	0.356	688
cheat	Was the group's answers influenced by the teacher; Yes=1	0.028	0.164	688
percent_urban_pre	Percent of students at the school who said they were from an urban area on the pre-test (1st test for control group)	67.142	31.801	688
g1	Did students have Park Guide #1; yes=1	0.719	0.45	366
g2	Did students have Park Guide #2; yes=1	0.199	0.4	366
g3	Did students have Park Guide #3; yes=1	0.038	0.192	366
cool	The temperature was cool; yes=1	0.144	0.352	278
cool-warm	The temperature was cool/warm; yes=1	0.263	0.441	278
warm	The temperature was warm; yes=1	0.381	0.487	278
warm-hot	The temperature was warm/hot; yes=1	0.191	0.394	278
teacher_gender	Male or female teacher; Female=1	0.712	0.453	431
teach_prev_visit	Had the teacher previously visited the park; Yes=1	0.742	0.438	431
teacher_prev_students	Had the teacher previously visited the park with their students; Yes=1	0.367	0.483	341
teach_discuss_park	Did the teacher discuss the park and environmental topics with the students before the park visit; Yes=1	0.564	0.496	431
teach_educ	Does the teacher have a bachelor's degree; Yes=1	0.848	0.359	415

Appendix 8. Summary Measures of Environmental Knowledge, Attitudes, and Behavior

Table A 2. Description of Summary Measures of Environmental Knowledge, Attitudes, and Behavior

Variable	Definition
percent_know	Total number of questions in the knowledge section answered correctly divided by the number of questions answered
percent_know_miss_incl	Total number of questions in the knowledge section answered correctly divided by the number of knowledge questions (9)
avg_attitude	Sum of Likert scale responses in the attitude section divided by the number of student's responses in the attitude section
avg_behav	Sum of Likert scale responses in the attitude section divided by the number of student's responses in the behavior section