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Impacts of the conservation education program in Serra Malagueta Natural Park, Cape Verde

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Environmental and conservation education programs are commonly offered in the rapidly expanding network of protected areas in developing countries. There have been few evaluations of these programs and their impacts on participants. At Serra Malagueta Natural Park in Cape Verde, we assessed changes in environmental knowledge, opinions, and behaviors among visiting school children and a comparison group that did not visit the park. Participation in the park's conservation education program has a positive impact on environmental knowledge after the visit. The program may also contribute to student knowledge by influencing classroom teaching in anticipation of the park visit.

Keywords: conservation education; Cape Verde; park visitation; impact evaluation; conservation knowledge

Introduction

Parks and other protected areas around the world offer education and interpretation programs to increase visitors' knowledge and encourage positive attitudes and supportive behaviors towards conservation. In tropical developing countries, protected area networks are expanding rapidly, and with them conservation education programs. However, relatively little is known about the effectiveness of these programs. Program evaluation is important for environmental and conservation education, because it allows program facilitators to know what is working and what can be improved (Bennett 1989; Jacobson 1987b; Thomas 1990).

Researchers have evaluated interpretation programs in parks, environmental education programs in zoos, environmentally oriented camp programs, and other 'out-of-classroom' environmental education programs (Kruse and Card 2004; Kuhar et al. 2010; Leeming et al. 1993; Munro, Morrison-Saunders, and Hughes 2008; Wagner et al. 2009; Zelezny 1999). Some evaluations rely on self-reported knowledge gain while others employ test-style questions (multiple choice or true/false). Likert scale questions are commonly used to measure attitudes (Dettmann-Easler and Pease 1999; Kruse and Card 2004; Stepath 2007; Tubb 2003). Typically, behavior is self-reported rather than observed, so researchers actually measure the intention to act (Beaumont 2001; Gough, Woodland, and Hill 2007; Orams 1997; Stepath 2007; Tisdell and Wilson 2005). In most studies, the respondents are the participants

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themselves (e.g. the students who receive environmental education), although Finson and Enochs (1987) also had teachers complete a questionnaire about their planned use of a visit to a science-technology museum, and Stevenson et al. (2013) assessed 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) for students' environmental literacy.

Reviews of the published literature evaluating environmental education programs have reached mixed conclusions. For example, Munro, Morrison-Saunders, and Hughes (2008) determined that 19 out of 21 interpretive programs (both non-personal and interpersonal) had been judged successful or partially successful in accomplishing management objectives. The most commonly evaluated outcomes were knowledge gain and attitude change, with only a few studies considering changes in behavior. Leeming et al. (1993) reviewed 34 evaluations of environmental education programs that sought to quantify effects on knowledge, attitudes, and behavior. Of the seventeen studies that considered out-of-class interventions, most did not detect any positive impacts. In a meta-analysis, Zelezny (1999) noted that four out of nine evaluations of out-of-classroom programs reported improved environmental behavior, while all nine evaluations of classroom programs demonstrated improved behavior.

Most of these reviews criticized the methodologies typically used in evaluations, arguing that methodological weaknesses make it difficult to attribute impacts to programs (Leeming et al. 1993; Zelezny 1999). For example, Munro, Morrison-Saunders, and Hughes (2008) did not detect any evaluations of interpretative programs that met all of their criteria: statistically valid sample size, paired pre- and post-testing, use of a control group, and a follow-up test after at least three months. In the broader environmental education literature, there are a few studies that use control groups as recommended by both Munro, Morrison-Saunders, and Hughes (2008) and Jacobson (1987b). For example, Dettman-Easler and Pease (1999) surveyed students in a residential environmental education program and other students in the same geographic area who received only in-class environmental education, having both groups complete pre- and post- questionnaires about attitudes towards wildlife.

While there is a large and growing literature evaluating environmental education and interpretive programs in developed countries (Carleton-Hug and Hug 2010; Collado, Staats, and Corraliza 2013; Skibins, Powell, and Stern 2012), there are relatively few such studies in the developing tropics. In one of the few studies in Africa, Kuhar et al. (2010) detected long-term (two years) knowledge retention by students who participated in an environmental education program at a forest reserve in Uganda. However, in an evaluation of a nature learning experience for students in South Africa, Ferreira (2012) noted little impact on their environmental knowledge or behavior, although she did detect evidence of a positive impact on pro-environmental attitudes. Norris and Jacobson (1998) performed a content analysis of 56 reports of tropical conservation education programs and concluded that fewer than half of the programs were successful in completing at least half of their objectives, based on the evidence available in those reports.

We evaluate the impacts of visiting a park and participating in its conservation education program in Cape Verde, a small island developing state (SIDS) in the Sahel region of Africa. Specifically, we use a rigorous evaluation design to determine whether participation in the park's conservation education program increases biodiversity conservation knowledge; fosters more positive opinions towards conservation; and encourages behaviors that contribute to conservation.

With support from the United Nations Development Programme and Global Environment Facility, in 2003 Cape Verde created a system of protected areas to conserve terrestrial and marine areas and their biodiversity. Like many SIDS, Cape Verde has endemic species threatened by high human population density and intense pressure on natural resources. Of the 47 protected areas in Cape Verde's system, nine are 'natural parks', (park staff, personal communication, 14 March 2013) which are natural areas with high levels of biodiversity, where local people are allowed to live and use natural resources for traditional practices (Gomes et al. 2003).

Serra Malagueta Natural Park (SMNP) is located in the northern interior part of Santiago Island. According to Duarte and Moreira (as cited in Duarte, Rego, and Moreira 2005), human influences have left Santiago Island with almost no remaining areas of natural ecosystems. SMNP aims to preserve the remaining biodiversity, promote the sustainable development of communities living in and around the park[1], and educate the people of Cape Verde about biodiversity conservation. The park staff spend significant time on environmental education for visitors, especially school children on field trips.

In the three years prior to this study, a total of 1980, 2053, and 2203 students visited the park, in 2008, 2009, and 2010, respectively (Park Statistics).[2] Most of the students were from primary and secondary schools throughout Santiago Island. All of the student visitors participated in a conservation education program that focuses on biodiversity and protected areas. When school groups visit, one of the guides meets the students at the park headquarters to give a presentation about park history, conservation, and biodiversity. Afterwards, the guide invites the students to explore the exhibition room, which has local handicrafts and pictures of plants and animals found in the park. The guide then takes the students and teachers to the endemic plant nursery where they observe and learn about some of the endemic plants. After the nursery visit, most school groups follow their guide up one of the park trails. The distance hiked varies, but most groups spend a few hours in the park. During the hike, the guide talks with the students and points out different features of the park. The number of students in these school groups varies from 15 to 100 students.

Methods: data collection

To evaluate the conservation education program at SMNP, we surveyed students and teachers from fifth through twelfth grades about their environmental knowledge, opinions, and self-reported behaviors, using a self-administered questionnaire.[3] The sample included a 'park visit' group and a 'control' group. The 'park visit' group consisted of students (in 10 groups made up of approximately 16 classes from 10 schools) who visited the park and participated in the conservation education program between March and July 2011. These students completed a questionnaire just *before* they participated in the conservation education program (the 'pre-test', completed at the park) and about a week *after* they participated (the 'post-test', completed in their school classrooms).[4]

The 'control' group consisted of students in similar grades and schools. During the same time frame of March–July 2011, 12 groups from 7 schools completed the questionnaire at least once. Of those, 5 groups from 2 schools completed the questionnaire twice. These are also labeled 'pre-tests' (first time taking the test) and 'post-tests' (second time taking the test). All students in the sample completed the questionnaire, with no refusals.

The student questionnaire was designed to measure the intended outcomes of the conservation education program through questions about knowledge, opinions, and behaviors.[5] The questionnaire had 4 parts. The first part elicited information on socio-demographic characteristics (mostly yes/no questions). The second part had 4 multiple choice questions that assessed biodiversity conservation knowledge (for example, the reason that Serra Malagueta is a natural park); 4 questions that asked respondents to identify plant or animal species as endemic, introduced, or invasive; and one fill-in-the-blank question to determine whether students knew the term 'biodiversity' by presenting the definition and asking for the term. These questions assessed student knowledge of the main topics covered by the park staff who led the conservation education program. The third part elicited students' opinions about the park and biodiversity conservation by presenting 12 statements (e.g. people should be allowed to let their goats graze freely in Serra Malagueta) and asking students how much they agreed (6) or disagreed (1) with each statement in a Likert scale.[6] 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 in 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 signify more pro-environmental opinions, and the average score of the opinion statements serves as an index of environmental opinions. The fourth part of the questionnaire asked students to self-report behaviors relevant to the environment, focusing on actions that park staff consistently mention and that the students control and could change in a relatively short time period, e.g. 'I avoid throwing trash on the ground'. Students were asked how frequently they had performed each action recently on a Likert scale ranging from 1 (never) to 6 (always).

The questionnaire design was informed by the literature. For example, Stepath (2007) determined that many students answered 'no opinion' or chose the middle of the Likert scale in his pilot test. We used a 6-point scale to prevent students from choosing the neutral midpoint as a way to avoid stating what they guess is the less socially acceptable (i.e. less environmentally friendly) response. Opinions were elicited about statements framed as both pro- and anti-environmental, reflecting lessons learned from Jaus (1984), who noted that his results could have been biased by the fact that all of the statements in his questionnaire were presented as pro-environmental. The frequency scale for pro-environmental self-reported behavior employed in this study is based on Beaumont's (2001) survey of ecotourists at a national park in Australia. Some of the questions about environmental opinions and demographics were based on the questionnaire used by Jacobson (1987a). Further insight was obtained from the questionnaires employed by Tubb (2003), Wagner et al. (2009), and Shepard and Speelman (1986). The questionnaire was pilot tested in schools on Santiago Island with students at different grade levels in classes that had and had not visited the park. Based on the questions asked by students during the pilot test and their responses to the survey, the questionnaire was edited for clarity and to ensure that it would be understood by students at all target grade levels.

The teacher questionnaire elicited information on gender, education level, whether the teacher had previously visited and brought students to SMNP, and whether s(he) had recently taught students about the park in the classroom. In the park visit group, 12 teachers completed the questionnaire when their students took the pre-test.[7] In the control group, 6 out of 10 teachers completed the questionnaire.

Based on the student survey responses, we constructed summary measures of biodiversity conservation knowledge (percent of correct answers in the knowledge section), opinions (average opinion score), and self-reported behaviors (average behavior score), excluding missing answers in all cases. For our primary measure of knowledge, we calculated the percent of correct answers out of all questions attempted. As a robustness check, we also constructed three other measures of knowledge: (1) the percent of correct answers with all missing answers counted as incorrect, as if the questionnaire were graded as a test, and (2) the percent of correct answers excluding missing answers except for the biodiversity definition question, which was counted as incorrect if left blank[8]; and (3) the first principal component of correct vs. incorrect answers to the questions in the knowledge section, with all missing answers counted as incorrect. The first principal component was calculated from stacked pre-test and post-test data, using the polychoric PCA package in STATA (Kolenikov and Angeles 2009). The first principal component is the linear combination that captures the most variation.

Methods: data analysis

We used a differences-in-differences (DID) approach to test for impacts of the park visit and conservation education program. First, we compared the responses of (1) participants (the park visit group) before and after the program, and (2) participants and non-participants (the control group) after the educational program. To obtain more credible impact estimates, we then compared (3) pre–post-test differences between the park visit and control group (DID). We used Wilcoxon signed-rank tests to evaluate differences between pre- and post-tests and Wilcoxon two-sample test statistics to evaluate differences between park visit and control groups. DID controls for variation in intrinsic characteristics of students that influence their knowledge, opinions, or self-reported behavior because those influence both the pre- and post-tests and are therefore swept out when considering changes. Also, DID helps rule out differences between park visitors and the control group as a potential explanation for the apparent impact of the conservation education program on student knowledge observed in the comparison of participants and non-participants. However, some characteristics may influence not only students' knowledge, but also their ability to acquire new knowledge. Thus, to further control for any differences in the park visit and control samples, we estimate multivariate ordinary least squares regression models of changes in knowledge between the pre- and post-tests as a function of park visit (treatment status), controlling for characteristics of the students, their classes, and their schools.

Based on the literature and first-hand knowledge of Cape Verde, we selected as student characteristics: gender, urban vs rural residence, whether a student had previously visited the park, whether another family member had visited the park, whether the student's family owned a car, and initial level of knowledge in the pre-test; and class and school characteristics: grade level, distance of school from the park, and private vs. public school. We used chi-square tests and Wilcoxon two-sample tests to test the null hypotheses of no differences in these characteristics – including environmental knowledge – across the park visit and control groups the first time they completed the questionnaire. We characterized the park visit based on whether it was with a school club, individual class, or mixed group of students. Regressions also included a control for number of days between pre- and post-test.

Results

In total, 688 students participated in the study. The park visit group consisted of 392 students from 10 different schools. Of the 392 students, 54 only took the pre-test. The control group included 296 students from 7 different schools. Of the 296 students, 170 students filled out the questionnaire only once.

We first examined the effectiveness of the conservation education program at SMNP in changing students' knowledge, opinions, and self-reported behavior by (1) comparing responses of park visitors before and after the educational program (Table 1), and (2) comparing responses of the control group and park visitors after the educational program (Table 2). Participants in the educational program at SMNP significantly increased their biodiversity conservation knowledge ($p \leq .0001$) and their opinions ($p = 0.0589$) became significantly (at the 10% level) more pro-environmental, while their self-reported behavior did not change ($p = 0.6547$) (Table 1). The average student who participated in the program answered one more question correctly on the post-test compared to the pre-test, increasing the percent correct by 9%. Comparing the post-test results from the two groups, park visitors had significantly greater knowledge ($p = 0.0023$) but less pro-environmental opinions ($p = 0.0017$) and no different self-reported behavior from the control group (Table 2). Thus, the two approaches both suggest the program increases knowledge and has no impact on self-reported behavior, but suggest opposite effects on opinions. Supporting the comparison of the park visit and control groups, we noted they have similar observable characteristics, except for a higher percentage of rural students in the park visit group (Table 3).

To control for potential unobserved differences across the groups and for potential learning from completing the same questionnaire more than once, we examined DID of knowledge, opinions, and self-reported behavior (Table 4). We determined

Table 1. Wilcoxon signed ranks tests comparing paired pre- and post-test average scores (park visit group).

Variable	Mean score pre-test	Mean score post-test	Change in score	Signed rank S	Pr ≥ |*S*|	*N*
Percent correct	42%	51%	9.0%	10,174	<.0001	332
Average opinion	4.43	4.49	0.062	2924	0.0589	323
Average behavior	3.75	3.74	−0.009	−509	0.6547	325

Table 2. Comparison between park visit and control post-tests.

Variable	Post-test score (Park visit vs. control)	Wilcoxon two-sample test statistic	Pr ≥ |*Z*|	*N* (Park visit vs. control)
Percent correct	52% vs. 45%	24,798	0.0023	332 vs. 125
Average opinion	4.49 vs. 4.66	31914.5	0.0017	323 vs. 125
Average behavior	3.74 vs. 3.65	26,733	0.3396	325 vs. 124

Table 3. Summary statistics for variables in linear regression model.

	Mean (park visit)	St. dev. (park visit)	*N* (park visit)	Mean (control)	St dev (control)	*N* (control)	Wilcoxon two-sample test
Grade	8.691	2.597	392	8.865	2.154	296	0.8750
Gender/ female	0.516	0.500	366	0.550	0.498	289	0.3902
Urban area	0.591	0.492	359	0.792	0.407	274	<.0001
Park visit	0.934	0.249	392	0.000	0.000	296	–
Private school	0.099	0.300	392	0.000	0.000	296	–
% correct on first test	0.418	0.234	385	0.355	0.220	293	0.0006

Table 4. Wilcoxon two-sample tests- differences between change in scores for park visit and control.

Variable	Change in score (park visit vs. control)	Wilcoxon two-sample test statistic	Pr ≥ |*Z*|	*N* (park visit vs. control)
Percent correct	9.0% vs. 2.7%	24,919	0.0032	332 vs. 125
Average opinion	0.062 vs. 0.003	27,071	0.4198	323 vs. 125
Average behavior	−0.009 vs. −0.188	25975.5	0.1147	325 vs. 124

that participation in the conservation education program had a statistically significant impact on biodiversity conservation knowledge ($p = 0.0032$), although smaller than implied by Tables 1 and 2. The average opinion score became slightly more pro-environmental in the park visit group, while the average remained the same in the control group, reflecting very small changes in the average responses to most of the opinion statements. This difference was not statistically significant ($p = 0.4198$), which may be partly because responses were already generally pro-environmental in the pre-test. The average self-reported behavior score did not change in the park visit group, while the control group on average expressed more negative self-reported behavior in the post-test; this difference was not significantly different ($p = 0.1147$).

To confirm the effect of the program on biodiversity conservation knowledge, we controlled for student characteristics (including initial knowledge) by including them as covariates in a multivariate regression on changes in knowledge (Table 5). On average, the park visit and control groups were similar on most of these characteristics, except that students in the control group demonstrated less environmental knowledge in the pre-test and were more likely to live in urban areas. We specify a model that has good overall explanatory power and informative coefficient estimates.

We confirmed that regression results were robust to the specific summary measure of knowledge by re-estimating the model with change in percent correct with missing values coded as incorrect, change in percent correct with missing values excluded except biodiversity question coded as incorrect, and change in the first principal component (calculated with missing values coded as incorrect). Regardless of the specific summary measure of knowledge, visiting the park has a positive and statistically significant impact ($p \leq 0.0001$) (Table 5). Grade level ($p = 0.008$) and

Table 5. Linear regression estimate for change in percent correct (missing values excluded).

Parameter	Estimate	St. error	t value	Pr > |t|
Intercept	0.0673	0.062133	1.08	0.2794
Grade	0.0178	0.006662	2.67	0.0080
Female	0.0146	0.017842	0.82	0.4124
Urban area	0.0937	0.088956	1.05	0.2928
Park visit	0.0954	0.021535	4.43	<.0001
Grade*urban area	−0.0088	0.009193	−0.96	0.3370
Private school	−0.0010	0.035765	−0.03	0.9780
% correct on first test	−0.5556	0.044511	−12.48	<.0001

Note: The mean of change in percent correct is 0.0732.

Table 6. Linear regression estimates for change in percent correct.

Parameter	% correct (missing excluded)	% correct (missing = incorrect)	Principal Component (missing = incorrect)	% correct (biodiv missing = incorrect)
R-square	0.32	0.20	0.15	0.27
N	412	412	413	412
Mean	0.07	0.11	0.56	0.08
Intercept				
Grade	+++	++	++	+++
Female				
Urban area		+	++	
Park visit	+++	+++	+++	+++
Grade*urban area		-	–	
Private school				
% correct on pre test	—	—	—	—

Notes: +++ Positive predictor at the 0.01 level; ++ Positive predictor at the 0.05 level; + Positive predictor at the 0.10 level.
— Negative predictor at the 0.01 level; – Negative predictor at the 0.05 level; - Negative predictor at the 0.10 level.

initial knowledge ($p \leq 0.0001$) were also important determinants of knowledge (Table 5). Initial knowledge had a negative effect on the change in knowledge (Table 5) and was systematically higher in the park visit group (Table 3). When missing answers were treated as incorrect, we determined that rural students in younger grades had significantly lower knowledge scores (Table 6).

Discussion

Students who participate in the conservation education program at SMNP appear to be learning about the park and biodiversity. Even though students only spend a few hours at the park, they gain knowledge about biodiversity, regardless of how knowledge items are scored (percent correct or first principal component, with missing excluded or counted as incorrect) and how the impact of the conservation program is assessed (by comparing ‘before and after’ or ‘with and without’ the park visit, or combining those into DID with or without additional controls). Based on the most rigorous approach to attributing impact, participation in the program increased student knowledge of the topics covered in the questionnaire by ~9.5% (Table 5).

In contrast, we detected no evidence that participation in the conservation program influenced self-reported behavior. Although spending time outdoors in educational contexts promote environmentally friendly behaviors even when it does not impact attitudes or knowledge levels (Cheng and Monroe 2010; Stevenson et al. 2013), our results are consistent with the SMNP program's focus on conveying knowledge about biodiversity, rather than explicitly connecting everyday behaviors to biodiversity knowledge. In some ways, our results bode well for education efforts at SMNP because they are succeeding in areas where outdoor education efforts typically do not (content knowledge) and need improvement in areas where outdoor nature-based education has proven successful (e.g. attitudes and behavior) (Cheng and Monroe 2010). While different evaluation designs suggest different effects on opinions, our preferred approach shows that participation in the program has no impact on student opinions, perhaps because pre-test opinions were quite pro-environmental prior to the visit, leaving little room for positive change. Changing the program to explicitly focus on connections between knowledge about biodiversity and personal behaviors could help SMNP have an impact on those behaviors, if program administrators decide that is a priority.

Biodiversity conservation knowledge gain was influenced by grade level and initial knowledge. Students in higher grades gained more knowledge than students in younger grades. Other studies have determined that younger students learn faster (Stevenson et al. 2013). Our results may indicate that the conservation education program at SMNP is more appropriate for students in higher grades. Alternatively, it could indicate that the youngest students in Cape Verde have not yet learned test-taking skills, such as always filling in answers to multiple choice questions. This explanation for differences between our results in SMNP and results from similar studies in more developed nations seems intuitive because high-stakes multiple-choice testing for all ages of students is common in most developed nations (Nichols and Berliner 2007) but rare in Cape Verde.

Higher initial knowledge among park visitors than among the control group could indicate either that better students (studying in better schools or classrooms) are more likely to get a chance to visit the park, or that students learn in anticipation of the park visit. The latter explanation is consistent with responses to the teacher questionnaire. Of the 12 teachers who accompanied groups of students on park visits and who completed the questionnaire, 9 had taught their students about the park before the visit. Eight of the 12 teachers said they had been to the park before, and 6 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 1 of them had brought their students, and only 2 out of the 6 control group teachers said they had taught their students about the park.

If greater initial biodiversity conservation knowledge is the result of preparation for the park visit, then our estimate of a 9.5% gain in knowledge is a lower bound, because it does not capture the impact channel associated with anticipatory learning (cf. Bitgood 1989). Bogner (1998) also reported that students who participated in a program had a more pro-environmental orientation before the program and suggested that teachers may have 'presensitized' the students (deliberately or not). Similarly, the time students had spent outdoors as part of formal science education in North Carolina predicted pre-test scores on environmental knowledge, attitudes, and behaviors (Stevenson et al. 2013). Smith-Sebasto and Cavern (2006) determined that students exposed to both pre-trip and post-trip activities in the classroom were more likely to acquire more pro-environmental attitudes from participation in a residential environmental education program in New Jersey. Future studies could capture anticipatory learning by conducting earlier pre-tests on baseline knowledge, attitudes, and behaviors, before students and teachers begin discussing field trips. Alternatively, researchers could use classrooms planning to visit the park in the future as controls, administering both the pre-test and post-test before students visit the park. That would control for any systematic differences in the lesson plans of teachers who take their students to the park, although it might not control for other contemporaneous influences on the students, such as television or radio programs.

In conclusion, visiting SMNP and participating in the conservation education program increased students' biodiversity conservation knowledge, as measured about a week after the visit. The impact on knowledge was larger for students in higher grades, but the park program appeared to be about equally effective for boys and girls from private or public schools (Tables 5 and 6). Methodologically, we demonstrated the value of a rigorous evaluation design (DID), which confirmed the impact on knowledge but showed the change in opinions evident in a comparison of responses before and after the visit was not actually attributable to the park visit. However, we identified a caveat of DID, which is that park visits may impact students even before they arrive via classroom preparation. Evaluations should account for this potentially important impact channel. More research is needed to assess the permanence of biodiversity conservation knowledge gains (beyond the first week) and whether this eventually influences opinions and behaviors. Future evaluation studies should survey students longer after their park visit, although this would be challenging in the case of SMNP because most groups visit at the end of the school year. While the long-term impacts on conservation and support for Cape Verde's system of protected areas are unknown, we believe that SMNP is effectively educating student visitors about biodiversity and conservation.

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Notes

1. There are approximately 265 people living in four traditional communities inside the park (Park staff, personal communication, February 11, 2013).
2. The total number of students listed includes university students. The total number of national and foreign tourists also increased yearly from 2008 to 2010. There were 1763 national tourists and 686 foreign tourists in 2010.
3. The survey protocol and instruments were reviewed and approved by the NCSU IRB (#1894). The survey instruments were written in Portuguese.
4. The objective was to have the students complete two post-tests, to evaluate retention of knowledge, evolution of opinions, and changes in self-reported behaviors over time (cf. Kruse and Card 2004; Kuhar et al. 2010). However, only two groups completed a second post-test, due to logistical constraints related to the school calendar. Thus, we only include results from the first post-test in the analyses reported here.
5. The intended outcomes of the program were assessed through close observation of the program during the 12 months prior to the survey, while the lead author was a Peace Corps volunteer posted with SMNP.

6. The 12 statements reflect the topics discussed by park staff who lead the conservation education programs. Translated to English, they are as follows: (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) SMNP 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.
7. In two of the groups who visited the park, the teachers did not complete the questionnaire. In one group of three classes, only one teacher filled out the questionnaire.
8. This measure was developed because the biodiversity question had the highest non-response rate, probably because it was the only fill-in-the-blank question in the knowledge section. The other knowledge questions had answer choices and students were likely to answer them whether or not they knew the answer, because they could simply select one of the choices, i.e. they could guess at the answer. Conversely, if they left them blank, they may have simply forgotten to go back and select one of the choices; that is, skipping these questions seems more likely to be a mistake in completing the questionnaire and less likely an indication of lack of knowledge.

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