



Museum Visitor Studies, Evaluation & Audience Research

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Summative Evaluation: Citizen Science Program

Prepared for the
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TABLE OF CONTENTS

LIST OF TABLES iv

EXECUTIVE SUMMARY v

Introduction.....	v
Description of Sample.....	v
Program Experience and Engagement	vi
Scientific Method and Rigor.....	vi
Pride and Ownership of the Reserve	vii
Recognition of Research’s Application and Value	vii
Additional Program Impacts	vii
Case Study Summaries.....	viii

DISCUSSION x

Introduction.....	x
Scientific Method and Rigor.....	x
Pride and Ownership of the Reserve	xii
Recognition of Research’s Application and Value	xii
Conclusion	xiii
References	xiv

INTRODUCTION I

Methodology.....	1
Data Analysis	2
Reporting.....	3

PRINCIPAL FINDINGS: STANDARDIZED QUESTIONNAIRE 4

Introduction.....	4
Participant Demographics and Background Information.....	4
Program Participation.....	8
Motivations for Participating in Citizen Science	10
Program Experiences	11
Self-Reported Program Impacts	15

PRINCIPAL FINDINGS: IN-DEPTH INTERVIEWS 20

Introduction..... 20

Motivation for Participation..... 20

Most Engaging Aspects..... 21

Most Challenging Aspects 22

Perceived Program Role and Value of Participation 23

Perceived Value of the Trust and Hacienda..... 24

Understanding of Research Goals and Their Role 25

Self-Reported Program Impacts 27

PRINCIPAL FINDINGS: CASE STUDIES 29

Introduction..... 29

Case Study A: Shoreline Program..... 29

Case Study B: Birds Program 32

Case Study C: Crabs Program 37

APPENDICESSOME REMOVED FOR PROPRIETARY PURPOSES

LIST OF TABLES

TABLE 1:	Demographic Characteristics	4
TABLE 2:	Education Characteristics	5
TABLE 3:	Residence.....	5
TABLE 4:	Science-and Conservation-Related Background	6
TABLE 5:	Participation History	7
TABLE 6:	Trust Membership	7
TABLE 7:	Program and Program Type.....	8
TABLE 8:	Participation Characteristics	9
TABLE 9:	Program Participated in That Day by Visiting in a Group with Children	9
TABLE 10:	How Respondents Heard about Citizen Science Program	10
TABLE 11:	Participation Reason.....	10
TABLE 12:	Participation Reason by Visiting in a Group with Children	11
TABLE 13:	Participation Reason by Age	11
TABLE 14:	Phrases That Best Describe the Program Experience	12
TABLE 15:	Word That Best Describes Perceived Role in Program	12
TABLE 16:	Ratings of Program Logistics.....	13
TABLE 17:	Ratings of Program Experiences	13
TABLE 18:	Ratings of Experiences Today by Gender	14
TABLE 19:	Ratings of Experiences Today by Group Size	14
TABLE 20:	Ratings of Experiences Today by Program	15
TABLE 21:	Effect on Knowledge and Skills	15
TABLE 22:	Ratings of Knowledge and Skills by Amigo Membership.....	16
TABLE 23:	Ratings of Knowledge and Skills by Animal Interaction.....	16
TABLE 24:	Interest in Being a Scientist.....	17
TABLE 25:	Interest in Being a Scientist by Program Type	17
TABLE 26:	Interest in Being a Scientist by Group Size	18
TABLE 27:	Interest in Being a Scientist by Age of Respondent.....	18
TABLE 28:	Behaviors Affected by Participation (Repeat Participants)	19
TABLE 29:	Effects on Behavior by Gender (Repeat Participants).....	19

EXECUTIVE SUMMARY

INTRODUCTION

The Conservation Trust of Puerto Rico (Fideicomiso) contracted Randi Korn & Associates, Inc. (RK&A) to conduct a summative evaluation of their Citizen Science program. Prior to this evaluation, RK&A had partnered with the Trust in 2009 to conduct a formative evaluation of the program. Both evaluations were funded by the National Science Foundation. The following summary presents findings thematically by program impact; additionally, this summary presents findings that contextualize the study sample and participants' overall experiences and engagement.

The findings presented here are among the most salient. Please read the body of the report for a more comprehensive presentation of findings.

DESCRIPTION OF SAMPLE

Three methodologies were employed to study participants' experiences in the Citizen Science program: standardized questionnaires, in-depth telephone interviews, and case studies.

QUESTIONNAIRE RESPONDENTS

Questionnaires were completed by 343 participants (12 years and older).

- ◆ Slightly more than one-half of respondents are female.
- ◆ About one-third of respondents are youth (12 to 17 years), and another approximately one-third are young adults (18 to 34 years); respondents' median age is 20 years.
- ◆ Three-quarters of respondents are first-time participants.
- ◆ Slightly less than one-half attended the program in social groups, and slightly more than one-half were visiting in a group with children.
- ◆ The majority of respondents are not employed in a science-related profession.
- ◆ About one-third have been or are currently active in a conservation organization and/or volunteered for other activities similar to Citizen Science.

TELEPHONE INTERVIEWEES

Interviews were conducted with 39 participants (14 years and older).

- ◆ Slightly more than one-half of interviewees are female.
- ◆ Interviewees range in age from 14 to 69 years; the median age of interviewees is 30.
- ◆ Two-thirds of interviewees are first-time participants.
- ◆ About one-half of interviewees were visiting with a group of children.

CASE STUDIES

Case studies were conducted with three participants who have a high level of program involvement; each case study included multiple interviews and an observation over the course of about one year.

PROGRAM EXPERIENCE AND ENGAGEMENT

These findings speak to participants' overall experience and engagement.

- ◆ Questionnaire respondents rated logistical aspects of the program highly, with the availability of materials/tools used rated highest (mean = 6.8).
- ◆ On the scale from 1, “dull experience” to 7, “stimulating experience,” questionnaire respondents rated their experience as stimulating (mean = 6.1).
- ◆ Questionnaire findings indicate that those participating in smaller groups (10 or fewer participants) rated their program experiences higher on the following 7-point scales:
 - ❖ Did not require my active participation (1)/Required my active participation (7) (mean = 6.2 versus mean = 5.3)
 - ❖ Very little camaraderie between me and other participants (1) / Great deal of camaraderie between me and other participants (7) (mean = 6.1 versus mean = 5.1)
- ◆ About one-half of interviewees said they most enjoyed learning something new about an existing personal interest; one-third most enjoyed a new or different experience (e.g., animal interaction).
- ◆ About one-third of interviewees described logistical and/or experiential barriers they encountered during participation (e.g., lack of preparedness).

SCIENTIFIC METHOD AND RIGOR

Impact: Citizen Science participants will experience and develop an understanding of the scientific method and the purpose of rigor in scientific research.

- ◆ More than one-third of questionnaire respondents indicated that “conducting scientific investigations” best described their experience.
- ◆ Questionnaire findings indicate that respondents had moderate gains in their confidence as it relates to scientific knowledge and skills. The two areas in which respondents rated their confidence highest are as follows:
 - ❖ Respondents indicated the greatest effect in their ability to communicate to others about the things they discovered (mean = 5.7).
 - ❖ Respondents also highly rated their confidence in their ability to generate new questions about the topics they explored (mean = 5.7).
- ◆ Questionnaire findings indicate that those participating in programs with animal interaction rated their confidence significantly higher in their ability to do the following:
 - ❖ Ability to identify characteristics of local habitats, plants or animals (mean = 5.8 versus mean = 5.0).
 - ❖ Ability to communicate to others about the things they discovered (mean = 6.3 versus mean = 5.4).
 - ❖ Ability to generate new questions about the topics they explored (mean = 6.2 versus mean = 5.5).
- ◆ About one-half of interviewees recalled in detail many scientific research tasks in which they were involved and had a clear understanding of why they performed these tasks.

- ◆ About one-quarter of interviewees said they realized the importance of process and rigor when collecting data.
- ◆ About one-quarter of interviewees reported learning specific techniques for collecting data (e.g., measuring crabs) and/or how to interpret data (e.g., comparing graphs of sediment samples).

PRIDE AND OWNERSHIP OF THE RESERVE

Impact: Citizen Science participants will develop a sense of pride and ownership over the reserve.

- ◆ When rating their program experiences, questionnaire respondents were least certain about whether the experience was relevant to their community (mean = 5.4 on the scale from 1, “not relevant to my community,” to 7, “very relevant to my community”).
- ◆ Interviewees described less of a connection between the Hacienda and their *own* community; however, they saw broad relevance to Puerto Rico or Puerto Ricans in general.
- ◆ About two-thirds of interviewees described the Reserve’s value as a recreational and educational resource for them and other Puerto Ricans.
- ◆ About three-quarters of interviewees also expressed some ownership over the Reserve when describing their program role:
 - ❖ About one-half described their role as a collaborator in the research studies of Trust scientists.
 - ❖ About one-quarter described their contribution as helping others realize the importance of preserving Puerto Rico’s cultural and natural resources.

RECOGNITION OF RESEARCH’S APPLICATION AND VALUE

Impact: Citizen Science participants will understand that the research they do in the program will have real application and direct impact on decisions made about the nature reserve.

- ◆ Slightly less than one-half of questionnaire respondents indicated their reason for participating in the program was “to contribute to scientific research and/or conservation efforts.”
- ◆ When describing their program experience, about one-quarter of questionnaire respondents indicated that “applying science to land management” best described their experience; about one-fifth indicated that “conserving the environment” best described their experience.
- ◆ When rating program experiences, questionnaire respondents indicated that their experience did contribute to protecting the Reserve (mean = 6.2 on the scale from 1, “Did not contribute to the protection of the Reserve,” to 7, “Contributed to the protection of the Reserve”).
- ◆ About one-half of interviewees described a clear understanding of the research goals; for example, they discussed how the Trust’s research on bats helps scientists understand the species’ role in reforestation.

ADDITIONAL PROGRAM IMPACTS

Participants self-reported other effects of the program on their awareness, interests, attitudes, and behaviors.

- ◆ Questionnaire respondents rated their interest in being a scientist on the scale from 1, “I am not interest in being a scientist” to 7, “I am interest in being a scientist;” respondents indicated a moderate interest in being a scientist (mean = 5.4).
- ◆ There were significant differences in questionnaire respondents’ ratings of their interest in being a scientist:
 - ❖ Those participating in programs with animal interaction rated their interest higher (mean = 5.9 versus mean = 5.1).
 - ❖ Those participating in smaller groups (10 or fewer participants) rated their interest higher (mean = 5.7 versus mean = 4.6).
- ◆ Questionnaire respondents’ who were repeat participants were asked to indicate what (if any) behaviors they feel have been affected by their participation in Citizen Science.
 - ❖ About one-third indicated they watch and/or listen to more science-related programming than before.
 - ❖ About one-quarter each indicated they started collecting natural specimens or watching wildlife, use materials and tools provided by the program, and/or have become active in conservation efforts in their community.
- ◆ About three-quarters of interviewees said the program had, in some way, affected their awareness, attitude, interest, and/or behavior as it relates to the environment and/or science.
 - ❖ About one-half of interviewees discussed an increased awareness of the value or role of nature or animals (e.g., bats).
 - ❖ Slightly less than one-quarter expressed a more heightened awareness that has led to specific attitude or behavior changes (e.g., adopting conservation behaviors).

CASE STUDY SUMMARIES

Trust staff purposefully selected three case study participants, all of whom have a high level of commitment to the Citizen Science program. These case studies represent a best-case-scenario for program engagement. The case study participants are not representative of the average Citizen Science participant, thus summaries of key findings are presented separately in this section.

- ◆ Interviews and observations indicate that Case Study A is interested in the field of physical geography. As a hands-on extension of that interest, he is committed to and enthusiastic about his work with the Citizen Science program. Over the course of interviews, Case Study A’s enthusiasm deepened. He came to realize his strengths and firmly decided to pursue a future course of study in the field of physical geography.
- ◆ Interviews and observations indicate that Case Study B is deeply committed to working with the Birds program and derives a great deal of personal satisfaction from her volunteer involvement. She is primarily interested in learning about birds and not pursuing a career in the field. However, she finds direct connections between her use of the scientific method in Citizen Science and her professional and academic work. She also enjoys working with other people through the program, especially her sister. Over the course of interviews, Case Study B’s confidence, knowledge, and abilities in the Birds program significantly increased.

- ◆ Interviews and observations indicate that Case Study C is very committed to the Crabs program and uses nearly every opening in his busy schedule to volunteer. He is extremely knowledgeable about crabs and has pursued independent work to take his research and contributions to great heights. Over time, Case Study C assumed a significant leadership role within the program.

DISCUSSION

INTRODUCTION

The Conservation Trust of Puerto Rico is one of many non-profit organizations that have developed Citizen Science programs (a.k.a, Public Participation in Scientific Research). Citizen Science programs involve the public in scientific research studies; citizens' contributions vary by project, and Bonney et al. (2009) recently defined three project categories based on the depth of public participation: contributory projects, collaborative projects, and co-created projects.¹ What Bonney et al. (2009) clarifies is that one project can assume the title of more than one category depending on how the public chooses to engage. For example, the majority of the Trust's Citizen Science programs are contributory in nature; participants come for the day and assist scientists with data collection. However, repeat participants have the opportunity to work on additional aspects of a project such as data analysis, which might transition the project into a collaborative one. In a few cases (e.g., the case study participants in this report), co-created projects emerged based on participants' curiosity and questions that arose during program experiences.

Bonney et al.'s (2009a) review of Citizen Science projects found that very few have formally assessed the impact of participants' experiences. This discussion seeks to contribute to knowledge in this area by exploring study findings through the lens of program impacts. The Citizen Science program strives for participants to: use and understand the scientific method; experience and understand the purpose of scientific rigor; develop a sense of ownership for the Reserve; and realize that the research in which they participate has wide application to decisions made about conserving the Reserve's flora and fauna.

SCIENTIFIC METHOD AND RIGOR

Study findings demonstrate moderate gains in participants' use and understanding of the scientific method and the importance of scientific rigor. Questionnaire findings show that respondents indicated the greatest increase in their confidence level when rating their ability to "communicate to others about the things [they] discovered" and "generate new questions about the topics [they] explored," both of which are aspects of the scientific process. Respondents indicated the least increase in their confidence level when rating their ability to "analyze and interpret the information [they] collected" and "identify characteristics of local habitats, plants, or animals." Interview findings also suggest moderate understandings in these areas; about one-half of interviewees recalled in detail the scientific research tasks in which they were involved and had a clear understanding of why they performed these tasks (see the quotation below).

¹ Contributory projects are those where the public primarily collects data for a research project independently designed by scientists; collaborative projects involve the public in a few extra steps of the research process, including data analysis and dissemination of findings; and co-created projects are those where the public is involved in designing the research project along with scientists and take part in all aspects of the research process (Bonney et al., 2009).

We took measurements of the beaches at the Hacienda . . . and the salinity of the water as well. (And how did you take the measurements and the salinity?) To take measurements, we went to three fixed points from the vegetation line, and we put markers down from there to the water line, and then used a big pole, which basically acted as a ruler, to measure the distance from the fixed points to the waterline, as well as the height of the sand level of the beach. . . . (And, why did you do those things?) To know the status of the beach is very important. If we know at what rate, for example, the beach is eroding, we know what we can [and] can't do, whether we can build a lot, or whether we should try to protect [or] improve it. The salinity content can sometimes become dangerous as well in a place that has [a] content that isn't right. . . . It [the salinity] can kill off many species, so to know that is very useful. [male, 14, first-time participant]

Yet, when asked to discuss any learning or discoveries that resulted from participation, only about one-quarter realized the importance of process and rigor when conducting scientific research. Similarly, only about one-quarter said they learned specific techniques for collecting data and/or how to interpret data. These findings are not unlike those found in other studies of Citizen Science programs. For example, Brossard et al. (2005) found no difference between control and treatment groups' understanding of the scientific process when they explored participants' experiences in The Birdhouse Network. Instead, they found gains in participants' knowledge of bird biology and behavior (i.e., facts/content knowledge). Interviews from the Trust's project show a similar trend, as many discussed knowledge or facts they had gained about animals, plants, and/or habitats that are native to the Hacienda. What is more evident in these findings are effects on the way participants see the environment or species; about three-quarters of interviewees discussed ways in which program participation had reinforced or increased their awareness, interests, and positive attitudes about conservation and the environment (see the quotation below). These gains are similar to those found in other Citizen Science programs (Bonney et al., 2009a; Evans et al., 2005; Overdevest et al., 2004).

My daughter, who was able to capture [a bat] that was female and pregnant, [had] a very good experience; it was very positive because she lost her dread of bats, and she learned that rather than being little animals that you have to fear, you have to respect them. And, [she learned] that they can [play an important role] in the [development] of new plants that emerge in the area, that is new flowering patterns in the Hacienda. [female, 48, repeat participant]

While only moderate gains in understanding of the scientific method and the importance of scientific rigor may seem discouraging, one must consider participants' previous knowledge and interests in these areas and the typical length of program exposure. Both questionnaires and interviews demonstrate that participants have an existing interest in science and/or the environment. For example, the top three reasons selected by questionnaire respondents for participating in the Program are: personal interest in/to learn about conservation science, to contribute to scientific research and/or conservation efforts, and to spend time in nature/outdoors. Likewise, about two-thirds of interviewees described a pre-existing interest in science and/or environmental conservation that motivated them to participate. Thus, participants probably have some prior experience conducting scientific investigations and are more science-oriented than average citizens. As Bell et al. (2009) suggest, this may contribute to a ceiling effect where participants' prior interest and knowledge lessens a program's potential to facilitate significant learning gains.

Case study findings further support this notion of a ceiling effect, as the two case study participants who had a great deal of prior knowledge relating to the scientific research process did not report significant learning in this area; however, the case study participant without much prior knowledge did. Important to note is the repeated exposure of case study participants to program activities versus questionnaire respondents and interviewees, the majority of whom were first-time participants. Thus, repeated

exposure that is holistic in nature (i.e., involves participation in multiple facets of the research process) may be one key to achieving a more significant impact on participants' learning (Bonney et al., 2009a). Interestingly, questionnaire findings suggest another possible factor that might contribute to learning: those who had participated in a program that involved live animal interaction (the majority of Bats and Crabs programs) rated their increase in confidence higher than those who had not. Additionally, those who had participated in a program that involved live animal interaction also rated their interest in being a scientist higher than those who had not. It is not entirely clear why this happened; however, some interviewees described the new and different experience of interacting with animals as what they most enjoyed about their program experience; and, zoos and aquariums have long touted that interaction with exotic animals has great potential as a hook for engaging visitors in learning and conservation (Clayton et al., 2009; Falk et al., 2007).

PRIDE IN AND OWNERSHIP OF THE RESERVE

Findings demonstrate that participants see the Reserve as valuable: about two-thirds of interviewees described the Reserve as relevant and valuable to them and Puerto Rico. They described its value as a place of respite where one can connect with nature and an educational resource for citizens and schools; interviewees further described the value of the Reserve as conserving important flora and fauna. About three-quarters of interviewees also expressed some ownership over the Reserve when describing their program role; about one-half described their role as a collaborator in the research studies of Trust scientists, and about one-quarter described their contribution as helping others realize the importance of preserving Puerto Rico's cultural and natural resources. Interestingly, the connection interviewees made between the Reserve and their *own* community tended to be less clear. Likewise, questionnaire findings also show that respondents indicated the least certainty about whether their program experience was relevant to *their* community.

One possible explanation for participants' characterization of the Reserve's value to Puerto Rico rather than their community is the nature of the Trust's Citizen Science programs. Programs emphasize engaging citizens in real scientific research projects that have direct implications for managing flora and fauna native to the Hacienda; heavy emphasis is not placed on connecting participants' experiences at the Hacienda with their everyday environmental experiences or conservation issues in their community. Further, participants' recognition of the Reserve as a unique entity for them to enjoy may contribute to any gaps they see between it and their local environment. Citizen Science programs that tie research goals to the communities in which participants live have documented the sense of ownership participants feel for their local environment (e.g., their own backyard) (Bonney et al., 2009a; Evans et al., 2005). Thus, where it naturally aligns with the research process in which participants are already engaged, the Trust might consider arming participants with knowledge and skills that have direct application to conservation actions they can take in their own community and allocating resources that will aid participants in these efforts. Yet, it is important to note that the primary goal of the Trust's Citizen Science programs is to develop and/or hone a sense of pride and ownership for the Reserve itself, and in this, the Trust was quite successful.

RECOGNITION OF THE RESEARCH'S APPLICATION AND VALUE

Questionnaire and interview findings demonstrate that participants have a broad understanding of the value and application of the research in which they participated. When rating their program experience that day, respondents indicated that they "did contribute to the protection of the Reserve." Further, when describing their program experience on the day of participation, about one-quarter of respondents

indicated that “applying science to land management” best described their experience and about one-fifth indicated that “conserving the environment” best described their experience. Yet, the most respondents chose “exploring nature” and “conducting scientific investigations” as the best descriptors of their experience. Thus, these findings suggest a broad rather than specific understanding of the research purpose, as more respondents described the experience in terms of what they did instead of the *result* of what they did; interviews further support this notion. About one-half of interviewees had a clear understanding of the research purpose; several also connected the individual research goals to the Trust’s larger purpose of developing a management plan for the Hacienda’s flora and fauna. Yet, the remaining one-half of interviewees struggled to make as clear of a connection.

As mentioned previously, the nature of many participants’ experiences in the Trust’s Citizen Science programs is contributory; that is, participants primarily collect data, or, if they contribute to data analysis as a first-time participant, it is usually as an isolated experience from data collection. (In the case of repeat participants, there are opportunities to bridge the two experiences.) It is therefore essential for the program to help participants see how their contributions fit into the greater research process and purpose. Findings suggest that some participants are making these connections, while others are not; and, these connections are not a factor of being a first-time versus repeat participant. Brossard et al. (2005) discuss the need to explicitly communicate what participants are experiencing, including the research’s purpose and the different aspects of the scientific process. This is not unlike the importance of explicitly presenting a museum exhibition’s message *throughout* the exhibition, as opposed to just the beginning or end (Serrell, 1996). Further, in the case of Trust programs, participants may need opportunities to bridge their experiences with other aspects of the research project they are not able to experience. Other Citizen Science programs have online databases where participants have access to data collected for the study and can perform simple analyses to answer their own curiosities and questions. Participants also have opportunities to ask additional questions of scientists (Bonney et al., 2009b).

While the Trust offers face-to-face interaction between participants and scientists, capitalizing on these in-person interactions may deepen the effects of program participation (Evans et al., 2005). For example, findings show that those participating in small groups (10 or fewer participants) rated their integration into the research process and camaraderie with other participants higher than those in large groups (20 or more participants). Level of integration and camaraderie may in turn affect participants’ learning; although questionnaire respondents’ self-reported gains in knowledge and skills were not significantly different by group size. Because the questionnaire is limited in its ability to detect nuanced differences in learning, it would be worthwhile to use rubric-scored interviews to explore any differences in participants’ experiences and learning by a range of factors.² RK&A has found rubrics to be an authentic measure of the nuanced kinds of learning that happen in informal environments (RK&A, 2009; RK&A, 2007).

CONCLUSION

In all areas where the Trust hoped to achieve impact with participants, gains were made. Findings show that participants self-reported moderate gains in their knowledge and awareness of flora and fauna and scientific processes. Some also acknowledged attitude and behavior changes as a result of program participation. Findings further demonstrate that a majority of participants felt the Reserve is relevant and valuable to them and Puerto Rico, honing and developing their sense of pride and ownership.

² Because rubrics convert qualitative into quantitative data by scoring interviews on a continuum, the samples must be large (i.e., 150 to 200 interviews) and the interview guide should be standardized. The interviews in this study did not meet those criteria, but a future study could employ this methodology.

Finally, some participants also recognized the application and value of the research in which they participated. This discussion also raised some potential barriers to achieving impact, such as the average participants' brief, often isolated exposure to a specific research project. As Trust staff reflect on findings, they might consider how to engage participants in a more holistic, long-term experience that could deepen the program's impacts.

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INTRODUCTION

This report presents findings from a summative evaluation of the Citizen Science program conducted by Randi Korn & Associates, Inc. (RK&A) for the Conservation Trust of Puerto Rico (the Trust). The program and evaluation are supported by funding from the National Science Foundation. Data were collected from October 2009 to August 2010.

The objectives are to evaluate the program's intended impacts:

- ◆ Citizen Science participants will use and develop an understanding of the scientific method, including: planning investigations, hypothesizing, observation, data collection, data analysis, and interpretation;
- ◆ Citizen Science participants will experience and understand the purpose of rigor utilized in scientific research;
- ◆ Citizen Science participants will develop a sense of pride and ownership over the reserve; and
- ◆ Citizen Science participants will understand that the research they do in the program will have real application and direct impact on decisions made about the nature reserve (e.g. contribute to the land management plan).

METHODOLOGY

RK&A selected three methodologies to capture participants' experiences in the Citizen Science program: standardized questionnaires, in-depth telephone interviews, and case studies. These methodologies produce quantitative and qualitative data. Below is a detailed description of each methodology.

STANDARDIZED QUESTIONNAIRES

Questionnaires were used because they collect standardized information from a large sample of visitors. Further, questionnaire data can be compared using various statistical analyses. For this study, standardized questionnaires were used to collect data about participants' program experiences, learning, and demographics.

RK&A designed the study to collect approximately 400 *post*-program questionnaires from Citizen Science participants. Since reaching quotas was a concern, we surveyed all eligible participants (12 years and older) on data collection days, thereby reaching participants from about 75 percent of all scheduled programs. At the end of each program activity, specially-trained data collectors and Trust staff asked all participants to complete a questionnaire about their experience (see Appendix A and B). Participants were screened to ensure they had not yet completed a questionnaire.

If a participant declined to participate, the data collector logged the participant's gender, estimated age, description of the visit group, whether they were first-time/repeat, the program attended, and reason for refusal. If the participant agreed, the data collector gave them a questionnaire to complete on his or her own, collected questionnaires, and checked for completeness.

IN-DEPTH INTERVIEWS

RK&A used in-depth telephone interviews to collect data about participants' experiences in the program. Interviews capture participants' thoughts, feelings, and attitudes and compliment questionnaires since they capture the language participants use to discuss their experiences.

Following each program (on data collection days), RK&A-trained data collectors asked all participants (12 years and older) if they would be willing to participate in a telephone interview about their experience. If the participant declined, the data collector logged the participant's gender, estimated age, description of the visit group, whether they were first-time/repeat, program participated in, and reason for refusal. If the participant agreed, the data collector captured the participants' contact information to schedule a phone interview. Interviewees were then randomly selected from the complete list of willing participants.

The interview was conducted using an open-ended interview guide (see Appendix C and D). All interviews were audio-recorded (in Spanish) with interviewees' permission and transcribed to English to facilitate analysis. At the end of each interview, the data collector captured relevant demographic information.

CASE STUDIES

Case studies were used to examine the program at the micro level. Case studies typically examine the interplay of variables to provide as complete an understanding of one event or situation as possible. Case studies do not produce generalizable information.

For this study, one case study was defined as one program participant. Trust staff selected three case studies from three different programs who demonstrated a high level of commitment to the program. Data were collected using participant observations and interviews between October 2009 and September 2010. One observation was conducted for context at some point during participant's program experience. Participant interviews—which concentrated on participants' reflections of their program experience over time—were conducted in Fall 2009, Winter 2010, and Spring/Summer 2010; interviews were audio-recorded (in Spanish) and transcribed into English to facilitate analysis. Additionally, audio-recorded interviews with scientists, staff, and family/friends were conducted in Spring/Summer 2010 to provide a more holistic picture of each case study's experience (see Appendices E to H for the guides). All interviews were conducted via telephone (in Spanish) and transcribed to English to facilitate analysis.

DATA ANALYSIS

QUANTITATIVE DATA

Questionnaires produce quantitative data. Data were analyzed using SPSS 12.0.1 for Windows, a statistical package for personal computers. Analyses included descriptive and inferential methods. See Appendix I for a listing of all statistical analyses.

Frequency distributions were calculated for all categorical variables. Summary statistics, including the mean (average) and standard deviation (spread of scores: “±” in tables), were calculated for rating scale variables.

To examine the relationship between two categorical variables, cross-tabulation tables were computed to show the joint frequency distribution of the variables, and the chi-square statistic (X^2) was used to test the significance of the relationship. For example, “program” was tested against “age group” to determine whether the two variables are related.

To test for differences in the mean *ratings* of two or more groups, an analysis of variance (ANOVA) was performed and the F-statistic was used to test the significance of the difference. For example, rating scale scores were compared by “age group” to determine whether ratings are age-related.

For all statistical tests, a 0.01 level of significance was used to preclude findings of little practical significance.³ Only statistically significant findings are presented in the body of the report.

QUALITATIVE DATA

In-depth telephone interviews and case studies produce qualitative data, meaning that results are descriptive. When analyzing qualitative data, the evaluator studies verbatim transcripts and observations for meaningful patterns, and, as patterns emerge, groups similar responses and behaviors, eliciting trends in the data.

REPORTING

QUANTITATIVE DATA

This report presents quantitative data in tables. Percentages within tables may not always equal 100 owing to rounding. Findings within each topic are presented in descending order, starting with the most-frequently occurring.

QUALITATIVE DATA

Trends and themes within the data are presented in thematic sections, and, within each section, findings are reported in descending order starting with the most-frequently occurring.

This report uses verbatim quotations from interviews (edited for clarity) to give the reader the flavor of participants’ experiences, and to illustrate their ideas as fully as possible. Within quotations, the interviewer’s comments appear in parentheses. For telephone interviews, gender, age, and whether the interviewee is a first-time or repeat participant appears in brackets following the quotations. For case study interviews, the number of the participant interview (e.g., Interview 1) or type of supplementary interview (e.g., Scientist Interview) appears in brackets following the quotations.

SECTIONS OF THE REPORT:

1. Principal Findings: Standardized Questionnaires
2. Principal Findings: In-depth Interviews
3. Principal Findings: Case Studies

³ When the level of significance is set to $p = 0.01$, any finding that exists at a probability (p -value) ≤ 0.01 is “significant.” When a finding (such as a relationship between two variables or a difference in rating scores) has a p -value of 0.01, there is a 99 percent probability that the finding exists; that is, in 99 out of 100 cases, the finding is correct. Conversely, there is a 1 percent probability that the finding would not exist; in other words, in 1 out of 100 cases, the finding appears by chance.

PRINCIPAL FINDINGS: STANDARDIZED QUESTIONNAIRES

INTRODUCTION

RK&A designed the study to collect approximately 400 *post*-program questionnaires from Citizen Science participants. Eligible participants were those 12 years and older who had participated in at least one program activity and not yet completed a questionnaire. Questionnaires were administered to eligible participants at Hacienda la Esperanza between October 2009 and May 2010 immediately following a program experience. Since reaching quotas was a concern, we surveyed all eligible participants on data collection days, thereby reaching eligible participants from about 75 percent of all scheduled programs. Data collectors solicited 349 program participants and invited them to complete the questionnaire. A total of 343⁴ participants agreed and six declined, for a participation rate of 98 percent.

PARTICIPANT DEMOGRAPHICS AND BACKGROUND INFORMATION

DEMOGRAPHICS

Slightly more than one-half of respondents are female (56 percent) (see Table 1). About one-third of respondents are 12 to 17 years (37 percent), and another approximately one-third are young adults (18 to 34 years) (33 percent); respondents' median age is 20 years. Spanish is the primary language spoken by most respondents (95 percent).

TABLE 1
DEMOGRAPHIC CHARACTERISTICS

GENDER (n = 336)	%
Female	56
Male	44
AGE¹ (IN YEARS, n = 332)	%
12 – 17	37
18 – 24	22
25 – 34	11
35 – 44	11
45 – 54	11
55 – 64	6
65 or older	1
PRIMARY LANGUAGE (n = 313)	%
Spanish	95
English	5

¹Age: range = 12 – 73; median age = 20; mean age = 27.2 (± 15.27 years)

⁴ Before analysis, one survey was removed from the 343 collected since the participant was not eligible.

The level of formal schooling completed by respondents varies as those 12 years and older were eligible to participate. One-quarter are currently university students (25 percent), and the majority of those are undergraduate students (72 percent) (see Table 2).

TABLE 2

EDUCATION CHARACTERISTICS

EDUCATION LEVEL (n = 406)	%
Did not/have not yet completed high school ¹	37
High school degree	6
Some college/Associate's degree	22
College graduate/Bachelor's degree	11
Some graduate work	7
Graduate/professional degree	18
CURRENTLY A UNIVERSITY STUDENT (n = 334)	%
No	75
Yes	25
TYPE OF UNIVERSITY STUDENT (n = 81)	%
Undergraduate	72
Graduate or Professional	28

¹Students still in primary or high school fall in this category as well as any adults who did not complete their high school degree.

Not surprisingly, most respondents live in Puerto Rico (see Table 3). The questionnaire asked in which municipality and barrio participants live.⁵ Table 3 lists those municipalities where 20 or more respondents live. Please see Appendix J for a complete list of municipalities where respondents live.

TABLE 3

RESIDENCE

RESIDENT OF PUERTO RICO (n = 328)	%
Yes	98
No	2
MUNICIPALITY (n = 295)	%¹
San Juan	13
Manati	12
Vega Baja	12
Bayamon	7
Arecibo	7

¹Percentages do not equal 100 because municipalities with an n<20 are not listed. Please see Appendix J for a complete list of municipalities where respondents live.

⁵ The barrios in which respondents live are not listed, as this question was misinterpreted or left blank by many respondents.

SCIENCE AND CONSERVATION BACKGROUND

Respondents were asked for information about their background as it relates to science and conservation behaviors. The majority of respondents are not employed in a science-related profession (85 percent) (see Table 4). About one-third have been or are currently active in a conservation organization and/or volunteered for other activities similar to Citizen Science (31 percent and 28 percent, respectively).

TABLE 4
SCIENCE- AND CONSERVATION-RELATED BACKGROUND

EMPLOYED IN A SCIENCE-RELATED PROFESSION (<i>n</i> = 333)	%
No	85
Yes	15
EVER AN ACTIVE MEMBER OF A CONSERVATION ORGANIZATION (<i>n</i> = 332)	%
No	58
Yes	31
Unsure	11
EVER VOLUNTEERED FOR SIMILAR ACTIVITIES TO CITIZEN SCIENCE (<i>n</i> = 332)	%
No	65
Yes	28
Unsure	7

CITIZEN SCIENCE BACKGROUND

Three-quarters of respondents were first-time participants (74 percent) (see Table 5, next page). Of repeat participants, slightly less than two-thirds participated two to three times previously (61 percent). Of the six Citizen Science programs offered by the Trust, the Crabs and Botany programs had the most repeat participants (43 percent and 42 percent, respectively).

TABLE 5**PARTICIPATION HISTORY**

FIRST-TIME OR REPEAT PARTICIPANT (n = 336)	%
First-time participant	74
Repeat participant	26
IF A REPEAT PARTICIPANT... NOT INCLUDING TODAY, HOW MANY TIMES HAVE YOU PARTICIPATED IN CITIZEN SCIENCE PROGRAMS? (n = 74)	%¹
Once	19
2 – 3 times	61
4 or more times	20
IF A REPEAT PARTICIPANT... NOT INCLUDING TODAY, WHICH CITIZEN SCIENCE PROGRAMS HAVE YOU PARTICIPATED IN? (n = 88)	%
Crabs	43
Botany	42
Bats	31
Shoreline	28
Birds	14
Archaeology	9

¹Percentages do not total 100 because participants marked all that apply.

About one-quarter of respondents are Red Amigo members (subscribe to the Trust’s e-mail list) (26 percent), and less than one-fifth are Amigo members (paid members) (17 percent) (see Table 6).

TABLE 6**TRUST MEMBERSHIP**

AMIGO MEMBER (n = 333)	%
No	68
Yes	17
Unsure	14
RED AMIGO MEMBER (n = 316)	%
No	56
Yes	26
Unsure	18

Members were compared to non-members by gender, age, and description of visit group. There were no significant differences.

PROGRAM PARTICIPATION

Respondents participated in a range of programs, with approximately one-quarter participating in the Bats program (24 percent), followed by one-fifth each participating in the Botany and Shoreline programs (21 percent and 19 percent, respectively) (see Table 7). About one-third participated in programs where they had the opportunity to interact with live animals (30 percent).

TABLE 7
PROGRAM AND PROGRAM TYPE

PROGRAM (n = 336)	%
Bats	24
Botany	21
Shoreline	19
Birds	13
Crabs	13
Archaeology	10
PROGRAM WITH ANIMAL INTERACTION¹ (n = 336)	%
No	70
Yes	30

¹This includes all Crab programs and 70 percent of Bats programs.

About two-thirds of respondents participated in weekend programs (Saturday and Sunday) (65 percent) (see Table 8, next page). Likewise, about two-thirds participated in morning programs (70 percent).⁶ Slightly more than one-third of respondents participated in a program with 10 or fewer participants (39 percent), and another approximately one-third participated in a program with 11 to 19 participants (38 percent). Slightly less than one-half attended the program in social groups (43 percent), and slightly more than one-half were visiting in a group with children (54 percent).

⁶ The majority of Citizen Science programs are scheduled on weekends and during daytime hours.

TABLE 8**PARTICIPATION CHARACTERISTICS**

DAY (n = 336)	%
Weekend day	65
Weekday	35
TIME OF DAY (n = 336)	%
Morning	70
Afternoon/Evening	30
DESCRIPTION OF VISIT GROUP (n = 333)	%
Organized group with adults and children	34
Social group with adults only	23
Social group with adults and children	20
Alone	12
Organized group with adults only	10
NUMBER OF PARTICIPANTS IN PROGRAM ACTIVITY¹ (n = 314)	%
10 or fewer	39
11 to 19	38
20 or more	24

¹Range = 2 – 24 participants; median = 13 participants; mean = 13.65 (± 6.65 participants)

PARTICIPANT CHARACTERISTICS ASSOCIATED WITH PROGRAM PARTICIPATION

RK&A tested whether respondents differed in their participation that day by gender, age, and description of visit group. There is one difference by visit group:

- ◆ Those visiting in groups *with* children are more likely to participate in the Shoreline program than are those *without* children (see Table 9).

TABLE 9**PROGRAM PARTICIPATED IN THAT DAY BY VISITING IN A GROUP WITH CHILDREN**

	GROUP WITH CHILDREN		
	YES	NO	TOTAL
PROGRAM¹ (n = 333)	%	%	%
Bats	25	23	24
Shoreline	28	9	19
Archaeology	6	15	10
Birds	11	15	13
Botany	20	22	21
Crabs	10	17	13

¹ $\chi^2 = 26.916$; $df = 5$; $p = .000$

MOTIVATIONS FOR PARTICIPATING IN CITIZEN SCIENCE

HOW RESPONDENTS HEARD ABOUT THE CITIZEN SCIENCE PROGRAM

Slightly less than one-half of respondents heard about the Citizen Science Program from their school/other organization and/or a friend, family member, or co-worker (42 percent each) (see Table 10). About one-quarter heard about the program through advertisements (26 percent).

TABLE 10
HOW RESPONDENTS HEARD ABOUT CITIZEN SCIENCE PROGRAM

METHOD (<i>n</i> = 334)	% ¹
School or other organization	42
Friend, family member, or co-worker	42
Advertisements (e.g., TV, newspaper, radio, Internet)	26
Through other communications/activities with the Trust (e.g., Amigos membership)	19
Always known about it/live nearby	3
Other ²	2

¹Respondents marked up to two responses; thus, percentages total more than 100 percent.

²Other: not reported (*n* = 4); while visiting the Hacienda for work/recreation (*n* = 2); Internet research (*n* = 1).

PARTICIPATION REASON

Respondents were asked to identify their top two reasons for participating in Citizen Science. Almost one-half identified their participation reason as a personal interest in or to learn more about conservation science; and/or to contribute to scientific research and/or conservation efforts (46 percent and 44 percent, respectively) (see Table 11). About one-third indicated their reason for participating was to spend time in nature/outdoors (33 percent).

TABLE 11
PARTICIPATION REASON

REASON (<i>n</i> = 326)	% ¹
Personal interest in/to learn more about conservation science	46
To contribute to scientific research and/or conservation efforts	44
To spend time in nature/outdoors	33
School assignment/community service requirement	23
To see Hacienda la Esperanza	19
To expose my children to learning opportunities	11
Social outing with family/friends	10
Other ²	2

¹Respondents marked their top two reasons; thus, percentages total more than 100 percent.

²Other: not reported (*n* = 5); to learn about the endemic birds of Puerto Rico (*n* = 1).

PARTICIPANT CHARACTERISTICS ASSOCIATED WITH PARTICIPATION REASON

Participants' reasons for participating in the program were compared by gender, age, and description of visit group. There are a couple significant differences by visit group (see Table 12):

- ◆ Participants in a visit group *without* children are more likely to participate because of a personal interest in or to learn more about conservation science than are those visiting in a group *with* children.
- ◆ Participants in a visit group *without* children are more likely to participate to contribute to scientific research and/or conservation efforts than are those visiting in a group *with* children.

TABLE 12
PARTICIPATION REASON BY VISITING IN A GROUP WITH CHILDREN

REASON (n = 323)	VISITING WITH CHILDREN		TOTAL
	YES	NO	
	%	%	%
Personal interest in/to learn more about conservation science ¹	34	58	45
To contribute to scientific research and/or conservation efforts ²	36	53	44

¹ $\chi^2 = 19.421$; $df = 1$; $p = .000$

² $\chi^2 = 9.866$; $df = 1$; $p = .002$

There is one significant difference by age of respondent (see Table 13):

- ◆ Young adult participants (18 to 34 years) and middle-aged participants (35 to 54 years) are more likely to participate to contribute to scientific research and/or conservation efforts than are youth participants (17 years and younger).

TABLE 13
PARTICIPATION REASON BY AGE

REASON (n = 322)	AGE OF PARTICIPANT (YEARS)				TOTAL
	12 – 17	18 – 34	35 – 54	55+	
	%	%	%	%	%
To contribute to scientific research and/or conservation efforts ¹	23	61	56	35	44

¹ $\chi^2 = 37.710$; $df = 3$; $p = .000$

PROGRAM EXPERIENCES

This section of the report focuses on respondents’ experiences in the Program on the day they were surveyed.

DESCRIPTIONS OF RESPONDENTS’ EXPERIENCE AND PROGRAM ROLE

Respondents were asked to choose the top two phrases that best describe their experience on the day they were surveyed. Slightly more than one-half of respondents indicated that “exploring nature” best described their experience that day (58 percent), and about one-third each indicated that “conducting scientific investigations” and “collecting data” best described their experience (40 percent, and 33 percent, respectively) (see Table 14, next page).

TABLE 14**PHRASES THAT BEST DESCRIBE THE PROGRAM EXPERIENCE**

DESCRIPTION OF EXPERIENCE (<i>n</i> = 332)	%¹
Exploring nature	58
Conducting scientific investigations	40
Collecting data	33
Applying science to land management	23
Conserving the environment	16
Engaging in a recreational activity	12
Interpreting data	8
Conducting environmental science	2

¹Respondents marked the top two phrases that best described their experience; thus, percentages total more than 100 percent.

Respondents were asked to choose the one word that best describes what they perceived their role to be in the Program the day they were surveyed. About one-half of respondents indicated that “volunteer” best described their role (51 percent), while about one-third indicated that “learner/student” best described their role (32 percent) (see Table 15). Few respondents indicated that “scientist” best described what they perceived their role to be that day (2 percent).

TABLE 15**WORD THAT BEST DESCRIBES PERCEIVED ROLE IN PROGRAM**

ROLE (<i>n</i> = 327)	%
Volunteer	51
Learner/student	32
Research assistant	15
Scientist	2

How respondents described their experience and role was compared by gender, age, and description of visit group. There were no significant differences.

RATINGS OF PROGRAM LOGISTICS

Respondents were asked to rate their experiences with program logistics on a scale from 1 (“Poor”) to 7 (“Excellent”). Overall, respondents rated logistical aspects of the program highly, with the availability of materials/tools used rated highest (mean rating = 6.8) and preparation information rated lowest (mean rating = 6.4) (see Table 16, next page).

TABLE 16**RATINGS OF PROGRAM LOGISTICS**

7-POINT SCALE: POOR (1) / EXCELLENT (7)	<i>n</i>	MEAN	±
Availability of materials/tools used	311	6.76	.80
Condition of materials/tools used	299	6.65	.91
Instructions/training for activity	330	6.61	.97
Process of signing up for the program	307	6.43	1.09
Preparation information (e.g., weather, dress, etc.)	332	6.42	1.19

Respondents' ratings were compared by a range of variables (see Appendix I). There were no significant differences.

RATINGS OF PROGRAM EXPERIENCES

Respondents rated their experiences in the program that day on eight different 7-point scales⁷. Ratings varied; respondents indicated that the experience “did contribute to the protection of the Reserve” (mean = 6.2) and was a “stimulating experience” (mean = 6.1) (see Table 17). Respondents were least certain about whether the experience was relevant to their community (mean = 5.4).

TABLE 17**RATINGS OF PROGRAM EXPERIENCES**

7-POINT RATING SCALES	<i>n</i>	MEAN	±
Did not contribute to the protection of the Reserve (1)/Contributed to the protection of the Reserve (7)	306	6.16	1.63
Dull experience (1)/Stimulating experience (7)	305	6.14	1.56
Did not contribute to scientific research (1)/Contributed to scientific research (7)	303	5.80	1.92
Not relevant to my personal interests (1)/Relevant to my personal interests (7)	311	5.79	1.85
Did not require my active participation (1)/Required my active participation (7)	307	5.69	1.85
Very little camaraderie between me and other participants (1)/Great deal of camaraderie between me and other participants (7)	305	5.69	1.83
Not relevant to my community (1)/Very relevant to my community (7)	299	5.41	1.89

⁷ Four of the rating scale items were inverted on the questionnaire to help ensure respondents carefully read each item; respondents' ratings for these items were recoded during analysis for more straightforward reporting of the data; please see Appendix A and B for the questionnaire.

PARTICIPANT CHARACTERISTICS ASSOCIATED WITH RATINGS OF PROGRAM EXPERIENCES

Respondents’ ratings of program experiences were compared by a range of variables (see Appendix I).

There is one significant difference by gender (see Table 18):

- ◆ Female participants are more likely to rate their experiences higher on the scale from 1 (“Not relevant to my community”) to 7 (“Very relevant to my community”) than are male participants.

TABLE 18
RATINGS OF EXPERIENCES TODAY BY GENDER

7-POINT RATING SCALES (<i>n</i> = 299)	GENDER		
	MALE	FEMALE	TOTAL
	MEAN	MEAN	MEAN
Not relevant to my community (1)/Very relevant to my community (7) ¹	5.02	5.72	5.41

¹F = 10.550; *df* = 1; *p* = .001

There are a few significant differences by group size (see Table 19). Those participating in smaller groups (10 or fewer participants) rated their experiences higher on three of the seven scales compared to those participating in larger groups (20 or more participants) as follows:

- ◆ Not relevant to my personal interests (1) / Relevant to my personal interests (7)
- ◆ Did not require my active participation (1) / Required my active participation (7)
- ◆ Very little camaraderie between me and other participants (1) / Great deal of camaraderie between me and other participants (7)

TABLE 19
RATINGS OF EXPERIENCES TODAY BY GROUP SIZE

7-POINT RATING SCALES	<i>n</i>	GROUP SIZE			TOTAL
		1 – 10	11-19	20+	MEAN
		MEAN	MEAN	MEAN	MEAN
Not relevant to my personal interests (1)/Relevant to my personal interests (7) ¹	290	6.32	5.73	5.07	5.81
Very little camaraderie between me and other participants (1)/Great deal of camaraderie between me and other participants (7) ³	286	6.10	5.53	5.14	5.66
Did not require my active participation (1)/Required my active participation (7) ²	289	6.23	5.27	5.28	5.65

¹F = 11.834; *df* = 2; *p* = .000

²F = 9.583; *df* = 2; *p* = .000

³F = 6.578; *df* = 2; *p* = .002

There is one significant difference by program (see Table 20):

- ◆ Participants in the Crabs program are more likely to rate their experiences higher on the scale from 1 (“Did not require my active participation”) to 7 (“Required my active participation”) than are participants in the Birds program.

TABLE 20
RATINGS OF EXPERIENCES TODAY BY PROGRAM

7-POINT RATING SCALES (<i>n</i> = 307)	PROGRAM						
	CRABS	BATS	BOTANY	SHORELINE	ARCHAEOLOGY	BIRDS	TOTAL
	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
Did not require my active participation (1)/ Required my active participation (7) ¹	6.37	6.03	5.79	5.44	5.43	4.63	5.69

¹F = 4.508; *df* = 5; *p* = .001

SELF-REPORTED PROGRAM IMPACTS

This section of the report focuses on any self-reported effects of the program on participants’ knowledge, skills, interests, and behaviors.

KNOWLEDGE AND SKILLS

On a scale from 1 (“Just as confident”) to 7 (“Much more confident”), respondents rated their ability to understand concepts or perform skills emphasized in the programs. Overall, respondents indicated a moderate increase in their confidence level as it relates to certain knowledge or skills (see Table 21). Respondents indicated the most increase in their confidence level as it relates to their ability to “communicate to others about the things [they] discovered” (mean = 5.7) and the lowest increase in their confidence level as it relates to their ability to “identify local habitats, plants, or animals” (mean = 5.3).

TABLE 21
EFFECT ON KNOWLEDGE AND SKILLS

7-POINT SCALE: JUST AS CONFIDENT (1) / MUCH MORE CONFIDENT (7)	<i>n</i>	MEAN	±
My ability to communicate to others about the things I have discovered	328	5.67	1.76
My ability to generate new questions about the topics we explored	325	5.66	1.65
My ability to use data collection tools/instruments to get information	325	5.50	1.82
My ability to analyze and interpret the information we collected	326	5.48	1.67
My ability to identify characteristics of local habitats, plants or animals	328	5.25	1.82

PARTICIPANT CHARACTERISTICS ASSOCIATED WITH RATINGS OF KNOWLEDGE AND SKILLS

Respondents’ ratings of their knowledge and skills were compared by a range of variables (see Appendix I).

There is one significant difference by membership (see Table 22):

- ◆ Amigo members are more likely to rate their confidence in their ability to “generate new questions about the topics [they] explored” higher on the scale from 1 (“Just as confident”) to 7 (“Much more confident”) than are non-Amigo members.

TABLE 22
RATINGS OF KNOWLEDGE AND SKILLS BY AMIGO MEMBERSHIP

7-POINT SCALE: JUST AS CONFIDENT (1) / MUCH MORE CONFIDENT (7) (n = 280)	AMIGO MEMBER		
	YES	NO	TOTAL
	MEAN	MEAN	MEAN
My ability to generate new questions about the topics we explored ¹	6.23	5.48	5.63

¹F = 9.305; df = 1; p = .003

There are a few significant differences by whether programs included animal interaction (see Table 23). Those participating in programs with animal interaction rated their confidence higher in their ability to do the following:

- ◆ Ability to identify characteristics of local habitats, plants or animals.
- ◆ Ability to communicate to others about the things they discovered.
- ◆ Ability to generate new questions about the topics they explored.

TABLE 23
RATINGS OF KNOWLEDGE AND SKILLS BY ANIMAL INTERACTION

7-POINT SCALE: JUST AS CONFIDENT (1) / MUCH MORE CONFIDENT (7)	n	ANIMAL INTERACTION		
		YES	NO	TOTAL
		MEAN	MEAN	MEAN
My ability to identify characteristics of local habitats, plants or animals ¹	328	5.82	5.00	5.25
My ability to communicate to others about the things I have discovered ²	328	6.32	5.40	5.67
My ability to generate new questions about the topics we explored ³	325	6.15	5.45	5.66

¹F = 14.436; df = 1; p = .000

²F = 19.709; df = 1; p = .000

³F = 12.929; df = 1; p = .000

INTEREST IN BEING A SCIENTIST

Respondents were asked to rate their interest in being a scientist on a scale from 1 (“I am not interested in being a scientist”) to 7 (“I am interested in being a scientist”). Respondents indicated a moderate interest in being a scientist (mean = 5.4) (see Table 24).

TABLE 24
INTEREST IN BEING A SCIENTIST

7-POINT SCALE	<i>n</i>	MEAN	±
I am not interested in being a scientist (1)/I am interested in being a scientist (7)	323	5.36	2.00

PARTICIPANT CHARACTERISTICS ASSOCIATED WITH INTEREST IN BEING A SCIENTIST

Respondents’ ratings of interest in being a scientist were compared by a range of variables (see Appendix I).

There is a significant difference by program type (see Table 25):

- ◆ Those participating in the programs with animal interaction are more likely to rate their interest in being a scientist higher on the scale from 1 (“I am not interested in being a scientist”) to 7 (“I am interested in being a scientist”) than are those who did not participate in programs with interaction.

TABLE 25
INTEREST IN BEING A SCIENTIST BY PROGRAM TYPE

7-POINT RATING SCALES (<i>n</i> = 323)	ANIMAL INTERACTION		TOTAL
	YES	NO	
	MEAN	MEAN	MEAN
I am not interested in being a scientist (1)/I am interested in being a scientist (7) ¹	5.87	5.14	5.36

¹F = 9.316; *df* = 1; *p* = .002

There is a significant difference by group size (see Table 26, next page):

- ◆ Those participating in smaller groups (10 or fewer participants) are more likely to rate their interest in being a scientist higher on the scale from 1 (“I am not interested in being a scientist”) to 7 (“I am interested in being a scientist”) than are those participating in larger groups (20 or more participants).

TABLE 26**INTEREST IN BEING A SCIENTIST BY GROUP SIZE**

7-POINT SCALE (n = 301)	GROUP SIZE			
	1 - 10	11-19	20+	TOTAL
	MEAN	MEAN	MEAN	MEAN
I am not interested in being a scientist (1)/I am interested in being a scientist (7) ¹	5.71	5.32	4.56	5.29

¹F = 11.834; df = 2; p = .000

There is a significant difference by age of respondent (see Table 27):

- ◆ Young adult participants (18 to 34 years) and middle-age adult participants (35 to 54 years) are more likely to rate their interest in being a scientist higher on the scale from 1 (“I am not interested in being a scientist”) to 7 (“I am interested in being a scientist”) than are youth participants (17 years and younger).

TABLE 27**INTEREST IN BEING A SCIENTIST BY AGE OF RESPONDENT**

7-POINT SCALE (n = 320)	AGE OF PARTICIPANT (YEARS)				TOTAL MEAN
	12 - 17	18 - 34	35 - 54	55+	
	MEAN	MEAN	MEAN	MEAN	
I am not interested in being a scientist (1)/I am interested in being a scientist (7) ¹	4.62	5.92	6.03	4.64	5.37

¹F = 13.224; df = 3; p = .000

BEHAVIORS

Respondents who are repeat participants were asked to indicate what (if any) behaviors they feel have been affected by their participation in Citizen Science. About one-third of repeat participants indicated they watch and/or listen to more science-related programming than before (34 percent), and about one-quarter each indicated they started collecting natural specimens or watching wildlife (28 percent), use the materials and tools provided by the program (26 percent), and have become active in conservation efforts in their community (26 percent) (see Table 28, next page). Another approximately one-quarter indicated that their behavior has not changed as a result of program participation (28 percent).

TABLE 28**BEHAVIORS AFFECTED BY PARTICIPATION (REPEAT PARTICIPANTS)**

BEHAVIOR (<i>n</i> = 89)	%¹
I watch and/or listen to more science-related programming than before	34
I started collecting natural specimens or watching birds or other wildlife	28
My behavior has not been affected (i.e., none of the above)	28
I use the materials and tools provided to me by Citizen Science	26
I have become active in conservation efforts in my community or elsewhere	26
I read more science-related books and/or articles than before	18
Other ²	3
I joined/donated money to one or more conservation organizations	2

¹Respondents marked all that apply (except in the case where they selected “none of the above”); thus, percentages total more than 100 percent.

²Other: not reported (*n* = 2); increased collaboration with others (*n* = 1).

PARTICIPANT CHARACTERISTICS ASSOCIATED WITH BEHAVIORS

Effects on behavior of respondents who are repeat participants were compared by gender, age, and description of visit group. There is one significant difference by gender (see Table 29):

- ◆ Female participants are more likely than male participants to indicate they watch and/or listen to more science-related programming than before.

TABLE 29**EFFECTS ON BEHAVIOR BY GENDER (REPEAT PARTICIPANTS)**

BEHAVIOR (<i>n</i> = 89)	GENDER		
	MALE	FEMALE	TOTAL
	%	%	%
I watch and/or listen to more science-related programming than before ¹	21	47	34

¹ $\chi^2 = 6.840$; *df* = 1; *p* = .009

PRINCIPAL FINDINGS: IN-DEPTH INTERVIEWS

INTRODUCTION

RK&A interviewed 39 participants (14 years and older) approximately one to two weeks after program participation. Slightly more than one-half of interviewees are female. Interviewees range in age from 14 to 69 years; the median age of interviewees is 30. Two-thirds are first-time participants; the remaining one-third that are repeat participants have participated a median of three times. About one-half of interviewees were visiting with a group of children. Interviewees from a range of programs are represented: Bats ($n = 11$); Birds ($n = 7$); Crabs ($n = 7$); Shoreline ($n = 6$); Archaeology ($n = 6$); and Botany ($n = 4$). Data were collected from October 2009 to May 2010.

MOTIVATION FOR PARTICIPATION

When asked their primary reason for participating in Citizen Science programs, about two-thirds of interviewees described a pre-existing interest in science, conservation, the environment, animals, etc. that motivated them to participate (see the first quotation below); more specifically, several are university students currently studying science who wanted more experience and/or knowledge in their area of study (see the second quotation). For many of these interviewees, participation was self-motivated (i.e., they heard about the programs and initiated contact) (see the third quotation). For several others, the impetus for participating was being part of an organized group, for a school assignment, or because a friend invited them (see the fourth quotation).

(What was your main reason for participating?) [Someone from] my university went to the Trust Fund in San Juan, and they gave [that person] flyers that said that they had a Hacienda where they conducted research projects and it caught my attention and I went. (Was there something in particular that attracted your attention about the Hacienda, something that stood out, perhaps?) I like birds and I saw on the Internet that there were spaces available, so I participated in that activity. [female, 18, first-time participant]

(What is the main reason why you've participated in the Citizen Science programs?) Well, I have many reasons. One is that I am a dedicated advocate for the environment. And, I want to keep up-to-date. I advocate for the environment and for animals. That's why I want to keep up with everything related to them. In addition, my college degree is in general science, and in the future, I'd like to get a master's in biology. And, I think that participating in the Citizen Science [programs] can earn me experience as a biologist. [female, 34, repeat participant]

(What was your main motivation for participating in Citizen Science?) My interest in preserving natural resources, and also learning more about ecosystems and the flora and fauna of Puerto Rico. Basically, my main reason for participating in the program is my interest in the environment. . . . When I was young, [a local bank] had a program for these special accounts and, I became a "Friend" of the Trust through that bank account. I was always interested in those types of programs, so when I saw [the] commercial, I quickly called. I thought, 'Look, here's my chance.' [male, 19, first-time participant]

(What was your primary reason for participating in Citizen Science?) I've always had an interest in the geography of Puerto Rico, and also, we got the opportunity to come here through the National Junior Honor Society, and so I took the opportunity to come. [male, 14, first-time participant]

The remaining one-third of interviewees were motivated to participate because of their children's pre-existing interest in science, animals, etc. and/or a desire to expose their children or students to scientific research and environmental conservation. While most of these interviewees were self-motivated and initiated participation (see the first quotation below), the impetus for a few to participate was their child's school assignment or community service requirement (see the second quotation).

My interest in offering my support to create consciousness about the protection of the environment and natural resources [was the primary reason]. Also, I have a ten-year-old daughter and I would like to create that consciousness in her. [male, 42, first-time participant]

The main reason was a [school] project that the girl [my granddaughter] had. . . . I mentioned to her [one of the scientists] about the project that the girl had, and since she is a specialist in shorelines, she told me that we could go and visit and participate in the Hacienda, in the project that they had. [female, 60, first-time participant]

MOST ENGAGING ASPECTS

When asked what they have most enjoyed about participating in Citizen Science programs, about one-half of participants said they most enjoyed learning something new (knowledge, skills, appreciation, etc.) about something in which they have an existing personal interest (see the first quotation below). For several of these interviewees (especially university students), the gain in knowledge or skills was appreciated as contributing toward their future career in science (see the second quotation). About one-third of interviewees most enjoyed experiencing something new or different, including animal interaction and/or being out in nature (and away from the city) (see the third quotation). Several most enjoyed feeling that they had contributed to scientific research that would help the environment (see the fourth quotation); several most enjoyed watching their children gain knowledge or skills (see the fifth quotation); and several most enjoyed the camaraderie of participating with those with similar interests (see the sixth quotation).

(What have you most enjoyed about participating in Citizen Science?) The experience is very educational, it's always very interesting, [and] we learned a whole lot of things. We had an archaeologist who explained the whole procedure, and the [staff assistant] explained the procedures, what they look for, [and] what they see. They gave us the opportunity to learn the technical knowledge that they have, [including] what they intend to gain with the cleaning of those artifacts [and] with the identification of pieces. To be involved in that type of activity, which is not one that [I] work in, is always very enriching. (And, why do you like that?) It's always very good to learn about nature, about our ancestors; if we learn the history, we can try to define what's going to happen in the future with us; history is always good. [male, 35, first-time participant]

(What did you like most about Citizen Science?) The opportunity they offer to participate in scientific activities. (Why is that?) Because I'm on a path toward the sciences. In addition, I like nature; I like biology. One of my goals is to study medical technology, specifically to help and discover. [The program] helps me make discoveries within the sciences. It helped me to acquire knowledge. [female, 37, first-time participant]

(What did you like most about participating in Citizen Science?) Frankly, I liked everything from beginning to end, honestly, because it was very different. I'd never had an experience like that. . . I was also very surprised, during the time we were waiting to be able to catch the crabs, at night, because there's so little light, you can see the stars very clearly. That left us very impressed, because sometimes . . . because of the rush of life and light pollution, you do not [have the chance to] see. And, we were able to take advantage of the waiting time in the activity to enjoy that. [female, 30, first-time participant]

(What have you enjoyed the most, what has been a highlight of these activities?) Obviously learning from the research project leaders. I'm also motivated by the fact that the findings will be used to act for the well-being of the birds' habitats. I hope to see the results from the work that we've been doing. I'm oriented towards the results. [female, 32, first-time participant]

Overall, I enjoyed the fact that the students that came—I also brought along my daughters and nephews—had the experience of being part of a research investigation that, as the interpreter told them, was something that they did everyday at certain times. [female, 35, first-time participant]

(What did you enjoy the most?) I value the opportunity to learn about things that are interesting to [me] with people who are also interested. In general, I like these kinds of things because I work in a totally different field and, usually, you get to meet people who are just very enthusiastic [about] their work. [female, 56, repeat participant]

MOST CHALLENGING ASPECTS

When asked to describe what has been most difficult or challenging about participating in Citizen Science programs, about two-thirds of interviewees said nothing was difficult or challenging other than those challenges they typically expect from such activities (inclement weather, getting dirty, physical exertion, time lags, etc.) or that they feel are out of the Program's control (distance they have to travel, time to participate given other life priorities, etc.). Many of these interviewees said the experience is worth participating in and/or engaging despite these barriers (see the quotations below).

(What has been the most difficult or challenging aspect of your participation with Citizen Science?) Knowing that you can't control nature and there are some good days and some not-so-good days. There are days when you can see the birds or whatever we're looking for and days where you can't. But we can't really control that, it's just nature. [female, 32, first-time participant]

The most difficult thing? I really don't know, I really haven't found . . . they've been factors outside of the Trust's [control] . . . for example, for us, many times we've had problems with the municipality's buses, but it has nothing to do with [the Trust]. But in terms of the investigations, no, we haven't faced any type of difficulty. So the only difficulty has been that logistics part of getting there. . . . Thank God that the people at the Trust were very kind and they waited for us

before beginning the activity; we got there an hour and a half late. So even in that process, working with the Trust has been excellent. [female, 48, repeat participant]

Another almost one-third described logistical and/or experiential barriers that they encounter(ed) during participation. Several described challenges that suggested a lack of preparedness and/or misalignment with expectations of program tasks (e.g., required clothing for the activity, outdoor conditions, etc.) (see the first quotation below). Several others expressed a desire to be more fully integrated into the activity or feel as though they are contributing in a more meaningful way (see the second quotation).

(What has been most difficult/challenging about participating in Citizen Science?) The walk on the beach due to the harshness of the sun. (Anything else?) The profiles activity because it's tiring. (Why is that)? Staying and doing that, the setting up and everything. [male, 14, repeat participant]

Regarding the census, I'd have to say just knowing more about the birds so that one can be a more effective volunteer. Because, obviously, [there were] those who already knew more, I mean, I knew about some of the birds, but not as much as these other two guys, who knew immediately this or that birdsong. I'd like to know more so that I can contribute more next time in the group. Although, I was the one in charge of recording the data . . . because I told myself, let me be as helpful as possible, in whatever. If I know little about birds, then I can at least write the information down. [female, 46, first-time participant]

PERCEIVED PROGRAM ROLE AND VALUE OF PARTICIPATION

Interviewees were asked to describe their role in the Program and their perceived contribution and/or the result of their participation. Responses varied and overlapped, as interviewees often characterized the value or result of their participation in more than one way. About one-half of interviewees described their role as a collaborator in the research studies of Trust scientists (only one interviewee used the word scientist to describe his or her role); these interviewees described their participation as quite valuable, with several going as far as to say the research would not be possible without their help (see the first quotation below). Some of interviewees also described a give-and-take relationship between them, as the participant, and the Program, explaining that they receive new knowledge, experiences, and skills and scientists receive the benefits of their physical and intellectual assistance (see the second quotation). About one-quarter described part of their role and contribution as that of a promoter, explaining that they help others realize the importance of the Program in preserving Puerto Rico's cultural and natural resources (see the third quotation). About one-quarter of interviewees described their program role as more cursory and were less certain of how much (or if) they contributed to any larger purpose or goal; these interviewees described their role as logistical, helping to defray costs by completing tasks that would enable the research to continue (see the fourth quotation).

Taking into consideration the purpose of the project, the contribution of every participant is crucial. You're helping collect data that will eventually be used for scientific purposes. Insofar as you participate in that process, you contribute so that the project will be successful and that it will really be beneficial to create [awareness of] natural and environmental resources. In addition, it helps motivate other people. The way I understand it, each person, however little or much they contribute to the project, is important because the citizen's involvement, in and of itself, is an achievement, in addition to the fact that they spread the word. [male, 42, first-time participant]

(Overall, how would you characterize what you do in Citizen Science?) As a very educational experience that is very useful for my future, and also, something that's not only educational, but, it also takes you out of your everyday routine. (And how would you describe your role in the program?) As a student. (What, if anything, do you feel that you contribute by participating?) I am contributing to research, and it makes me feel important . . . maybe with the help I provided, for example putting up a trap, I was able to capture a crab, and that way the scientist can get a crab to be able to obtain her information, and in that manner I feel useful.

[female, 14, first-time participant]

(What, if anything, do you feel that you contribute by participating?) By participating, I contribute, in addition to helping the scientists, [to] spread the word, so that other people find out about the program that [the Trust] has so they can get over there and enjoy it, just like I have. [female, 35, repeat participant]

(What, if anything, do you feel that you contribute by participating?) I think that it's voluntary work, and in that sense you contribute economically to defray the costs of such a study. (Is there anything else that you contribute by participating?) It depends on each person, both the biologist [who] gives us information, as well as us, with our questions and comments. I imagine that the biologist can receive that input on what things people see or find interesting about the investigations that they do. (What do you see as the result of what you do?) Honestly, I don't know what the final result of the study would be, as I mentioned, it was only a one night experience, and it would be good to see later on what would be the findings or conclusions they reach. [male, 48, first-time participant]

PERCEIVED VALUE OF THE TRUST AND HACIENDA

When asked whether the Hacienda is relevant to them and their community, slightly less than two-thirds described a broad relevance or value. For instance, some described the Hacienda as a resource for the surrounding community and Puerto Rico; they described it is a place of respite and recreation, as well as an educational resource about the environment and science for schools and citizens (see the first quotation below). Others described the Trust's value as conserving Puerto Rico's natural resources for them and other Puerto Ricans (see the second quotation). Interviewees described less of a connection between the Hacienda and their *own* community (because of the distance between the two); however, they saw broad relevance to Puerto Rico or Puerto Ricans in general (see the third quotation).

I live in San Juan, twenty minutes from the beach, Isla Verde, and the fact that there are beach grape trees there, just like in the beach near me, and that there are certain types of vegetation that only exist in shoreline areas, well that can be related, not to my community, but to something close to where I live. (How, if at all, does it factor into your everyday life?) Anywhere where I can avoid commotion, it's relevant. Over there at the Hacienda, it's tranquil, there's a lot of vegetation . . . you have the beach close by, the air you breathe is more pure, so I don't know if it really relates to the area where I live. . . . I mean Puerto Rico is so small that I think everything is relevant. [female, 60, first-time participant]

I don't live near the area, but it [the Hacienda] is part of my island. Insofar as those lands are conserved, they have a daily impact on my life [and] the quality of the environment. It [the Hacienda] has an impact on my emotional and psychological health because to the extent that I can see more natural resources and trees . . . I really feel a lot better knowing that these terrains are being protected and that these institutions and organizations exist [and] that have this protective goal. It fills me with satisfaction and pride. It motivates me to keep working, to keep protecting the environment and spreading the word about the urgency of protecting the environment. [male, 42, first-time participant]

It [the Hacienda] doesn't relate so much to my community directly because it's not nearby. However, for the people who live nearby, they have the Reserve; it's a peaceful area, away from everyday contaminants; it's like a lung. It's also helping to preserve other species in the community, for example birds. I guess it doesn't affect me directly, but it contributes quite a bit to that area. [male, 19, first-time participant]

The remaining one-third did not see or could not articulate any relevance between the Hacienda and their community (see the quotation below).

I don't see that it [the Hacienda] relates in any direct way because I don't live close to the Reserve, and I don't talk about it or anything. (So, you go and participate, but you don't see any relation with you or your community?) No, not really. (And, how, if at all, does it factor into your everyday life? Is there any relevance?) No, I don't see any relevance. [female, 23, repeat participant]

UNDERSTANDING OF RESEARCH GOALS AND THEIR ROLE

UNDERSTANDING OF RESEARCH GOALS

Interviewees were asked to discuss the purpose of the research project in which they participated (for repeat participants, they discussed the research activity in which they most frequently participated). About one-half of interviewees described a clear understanding of the research goals; for example, they discussed how the Trust's research on bats helps scientists understand the species' role in reforestation. Several of these interviewees also connected the individual research goals to the Trust's larger goal of developing a management plan for the Hacienda's plant and animal species (see the quotations below).

(What was the purpose of that activity?) I understand the purpose was to examine the bats' excrement. We trap them throughout the night to see if they have anything in their excrement to analyze it later in the laboratory to see and identify the seeds the bats eat to nourish themselves. (Why is that important?) Because the Hacienda has a reforestation project; it's to reforest the plant-life, but they really want to do it to get it ready for the public, so they want to see how the bats work to disperse seeds and how they contribute to the reforestation of the Hacienda. [male, 23, first-time participant]

You choose a specific time in order to know, more or less, in statistics, how many populations are going through there, or how many birds of a given kind. If you do that for a given amount of time, you can multiply the time or calculate certain specific data. . . . So, in so many minutes, so many birds were seen, so during the day it might be that so many birds will come by. . . . And, since it's a census, it's about finding out how many birds [are present]. (What do you think is the purpose of performing the bird census?) To learn about the native populations that are still in the Island, to learn how many migratory birds there are, to learn whether those birds'

populations are decreasing, to learn whether the populations grow or diminish, so you can take measures one way or the other. If they are decreasing, you may decide to categorize a bird in danger of becoming extinct. [female, 46, first-time participant]

Another almost one-half provided a more vague or general description of the individual research goals; some of these interviewees described a partial understanding of research goals (see the first quotation below), while others primarily discussed the purpose and/or benefits of having citizens participate in the research (e.g., knowledge gains, offsetting costs, etc.) (see the second quotation). Most of these interviewees did not make a link to the Hacienda's broader land management goals. A few interviewees could not articulate the research goals.

(What do you see as the purpose of that program)? It was very good for the group's integration. (I mean, what do you think the purpose of that program or activity was?) To know the flora that, I don't know, the island has. [female, 20, first-time participant]

Through this program, the aim is to integrate the community adjacent to the Hacienda or from other communities interested to participate in this project, with the scientists, their assistants, and the Trust's staff; it's to create an integration of different sectors with a common goal, which is to acquire knowledge that will benefit all parts; for me, that is the purpose of that program. (Is there anything else in addition?) I would also say that it is to create an interest in everyone that participates in this project: in science, in research, in the relationship with the environment. [male, 23, repeat participant]

UNDERSTANDING OF THEIR ROLE IN THE RESEARCH PROCESS

Interviewees also were asked to discuss the specific tasks they completed in the research project and why. About one-half of interviewees recalled in detail many of the things they did and had a clear understanding of why they performed certain tasks, often relating it back to the larger research goals (see the first quotation below). Slightly more than one-third recalled specific tasks they performed, but articulated only a partial or vague understanding of why they did it (e.g., to contribute to the research project, to obtain information about crabs, etc.) (see the second quotation). A few interviewees could not articulate why they performed certain tasks during the activity.

We took measurements of the beaches at the Hacienda; we basically took the measurements and the salinity of the water as well. (And how did you take the measurements and the salinity?) To take measurements, we went to three fixed points from the vegetation line, and we put markers down from there to the water line, and then used a big pole, which basically acted as a ruler, only larger obviously, to measure the distance from the fixed points to the waterline, as well as the height of the sand level of the beach. (And the salinity, how did you do that?) For that, we used a certain mechanism that uses x-rays I believe to measure the content. (And, why do you think you do those things?) To know the status of the beach is very important. If we know at what rate, for example, the beach is eroding, we know what we can do, what we can't do, whether we can build a lot, or whether we should start trying to protect it, or trying to improve it. The salinity content sometimes can become dangerous as well in a place that has [a] content that isn't right, that can affect the sea life there too greatly; it [the salinity] can kill off many species, so to know that is very useful. [male, 14, first-time participant]

(And, what specific tasks did you perform?) We set up the traps, we labeled the area, we placed the bait, and we waited. Then, we went through all the traps to see where crabs had been caught, and then we measured and weighted them, and placed computer chips in them if the crab's measure and weight allowed us. (And why did you do those things)? Well, first of all, to make sure the animal had the capacity to carry the chip. And, I think the larger the animal, the more it will walk and the more you'll get to know about his area. [male, 34, repeat participant]

SELF-REPORTED PROGRAM IMPACTS

EFFECTS ON KNOWLEDGE AND SKILLS

When asked about any discoveries or learning that resulted from program participation, most interviewees discussed gains in awareness or knowledge. Many discussed content knowledge or facts they had gained about animals, plants and/or habitats that are native to the Hacienda (see the first quotation below). About one-quarter said they realized the importance of following a specific process and being precise when collecting data (see the second quotation). Also, several said they gained an awareness of the Trust's role in research and preserving Puerto Rico's natural resources (see the third quotation).

I learned about the sediments in the sand, the different types of sand, their thicknesses, that they are examined. . . . You're accustomed to see the finer sand, because you usually walk around the edge of the water, but there [during the program] we collected different types of sand. Some were finer, some thicker, some even darker that looked like dirt, as we were getting closer to the river, the sand was blacker, and the salt, I did not know that as you approach the mouth of the river, it loses its salinity. That was also new for me, I did not know that. I thought that the water was salty everywhere [at] the same level. [female, 60, first-time participant]

In general, [I learned] that things have a procedure, that's something that one doesn't see, because you don't do that for a living, [and] you don't see the procedures behind the science, the mechanics behind that, the care you have to have. And, those people [the staff and scientists] allowed us several things; they allowed us to see that things are to be done with care, with a strict order. For example, they explained that we should not mix pieces from one bag with pieces from another bag because they were from different periods, or they could be from different areas, and then history's path [would be] altered. [male, 35, first-time participant]

The thing that impressed me the most was that when I arrived at the Hacienda, I thought there were going to be very few people. I was surprised that there were so many people that were really [interested]. . . . On television, there is a lot of talk about the environment and how no one is supporting the environment, but when I arrived, I saw that, yes, there are really people who are looking for the same thing, to conserve nature, that everyone shared the same ideal. I liked that. [female, 18, first-time participant]

About one-third discussed skills they had gained from participating in programs. About one-quarter said they learned specific techniques for collecting data and/or how to interpret data (see the first quotation below); and, several said they gained team-building skills (see the second quotation).

In that Citizen Science activity, we learned how to clean those objects; how it's done; what's the procedure; the care you have to have so the artifacts don't break; how much force to apply; how much water pressure; it's impressive. Those are things that you don't think have a protocol, but yes, they do have it. [male, 35, first-time participant]

I think I've learned a little more about working in a team; it's an aspect that many of us don't like to do, to work in a team, because we don't want to let others down, or to be let down by others, and I think this project has been fundamental in that aspect, in developing that confidence among each one of the [participants]; each [participant] has a job to do, and at the end of the day, everyone has [contributed]. I think that's something that I had [doubts about] before the project, because I hadn't [had] a chance to work so much in a group, and I think I've learned to manage the situation very well thanks to this project. [male, 23, repeat participant]

EFFECTS ON EVERYDAY LIFE

When asked whether the program has affected the way they see or do things in everyday life, about three-quarters of interviewees said it had, in some way, affected their awareness, attitude, interest, and/or behavior as it relates to the environment and/or science. About one-half of interviewees discussed an increased awareness of the value or role of nature, certain animals (e.g., bats), etc. (see the first quotation below). Slightly less than one-quarter expressed a more heightened awareness that has led to specific attitude or behavior changes (e.g., adopting conservation behaviors, etc.) (see the second quotation). Several explained that their program participation has heightened or confirmed an interest in science as a career path (see the third quotation).

My daughter, who was able to capture [a bat] that was female and pregnant, [had] a very good experience, it was very positive, because she lost her dread of bats, and she learned that rather than being little animals that you have to fear, you have to respect them. And, [she learned] that they can [play an important role] in the [development] of new plants that emerge in the area, that is new flowering patterns in the Hacienda. [female, 48, repeat participant]

It [the Program] has allowed us, me and my family, to appreciate nature, to understand many things, even thanks to the Trust we recycle at home; we are Friends of the Trust; we have become very involved with nature. The Trust and these types of activities have affected [us] in a very positive way, the way we see the environment, definitely. [male, 14, first-time participant]

Well, now [that] I know that I can do investigations with [The Trust], it encourages me to continue in the field of science in the university. [female, 19, first-time participant]

The remaining one-quarter of interviewees said the program did not affect their everyday life and/or reinforced existing beliefs about the importance of nature (not originally developed in the program) (see the quotation below).

I enjoy these kinds of activities and that was one of the main reasons I was so happy to go. No, it's not affected the way I do anything, not in my day-to-day life. It hasn't changed my attitude towards the environment either. I think it's very important to protect the environment so, if anything, my attendance at that event just confirmed my views further or confirmed my conviction that the environment is important and studying it is important, especially for reasons of future preservation. [male, 25, first-time participant]

PRINCIPAL FINDINGS: CASE STUDIES

INTRODUCTION

Trust staff purposefully selected three case study participants, all of whom have a high level of commitment to the Citizen Science program. In essence, these case studies represent a best-case-scenario for program engagement, suggesting what is possible to achieve through repeated exposure to program activities. Each case study includes interviews with the case study participant at different points during his or her program participation, interviews with those who have worked with and know the participant well (i.e., family/friend, staff, scientists), and observations of the case study participant during the program. Data were collected during Fall 2009, Winter 2010, and Spring/Summer 2010. Findings are presented by individual case study participant.

CASE STUDY A: SHORELINE PROGRAM

Case Study A is a senior at the university, studying geography. He is an experienced volunteer with the Citizen Science Shoreline program.

RK&A interviewed Case Study A on three occasions and observed him in shoreline twice, once in Fall 2009 and once in Spring 2010. In addition, RK&A interviewed the scientist and assistant scientist he worked with, as well as a friend also involved in Citizen Science.

BACKGROUND AND MOTIVATION TO PARTICIPATE

Case Study A discussed that he has long been interested in geography. He has taken courses in the subject and is familiar with the scientific method. He learned about the Citizen Science program through his professor, who is the lead scientist for the Shoreline program. Because Case Study A transferred from another university, the program was his first time doing fieldwork. Despite his long-term interest in geography, Case Study A also showed an avid curiosity for other subjects and seemed to be unclear as to his ultimate career goals. In the first interview, he expressed both a desire to continue in geography and also an interest in studying linguistics (see the quotation below).

I knew that I wanted to continue studies in marine geography. By having this experience, I've [become] even more convinced that is was what I want to do. . . . It's not that I grew tired of geography; it's just that I want to try something different for now. That's why I'll probably continue Linguistics. [Interview 1]

Case Study A is very engaged in the Citizen Science program. At the time of the first interview, he had been attending the program about once a week for four months, despite a busy schedule. His attendance fluctuated over the course of the interviews. At the time of the second interview, he had not been able to attend since the first interview due to academic commitments, although he still had a strong desire to be involved. During the third interview, Case Study A said he had returned to regular attendance at the Shoreline program and also started attending the Botany program.

PROGRAM SUCCESSES

Case Study A has had many successes throughout his involvement in Citizen Science.

INDEPENDENT RESEARCH

Case Study A initiated and explored independent study throughout his program experience. One investigation arose from his curiosity about the retreating sea level (see the first quotation below). He showed a genuine interest in the subject matter throughout interviews. This interest was further reflected in interviews with the scientists and his friend (see the second quotation).

We started seeing that the sea level was retreating, when it was supposed to be rising; so after we saw that, we wanted to see if that was happening on other beaches in Puerto Rico. So after we saw that the sea level was retreating, I think that was when I realized that I wanted to do something to compare other beaches with the one that we were studying. [Interview 1]

He just enjoys everything; the best thing about [Case Study A] is his personality . . . whoever knows him, knows that he enjoys every detail, every moment; from the beginning of the activity, you see him smile, and enjoy not only the scenery, but also the changes he encounters; he's a young person who takes pleasure in and enjoys everything he does.
[Assistant Scientist Interview]

PRACTICAL APPLICATION OF THEORY

As early as the first interview, Case Study A expressed appreciation for the hands-on, practical learning experience, which he said enhanced classroom theory and helped him identify an area of academic focus. This is supported by statements made in an interview with his friend (see the first quotation below). In the second interview, he expressed enjoyment in teaching and training (see the second quotation). The scientist agreed that he has a gift for working with people, especially young people, and is good at motivating and leading others.

[Case Study A] has acquired, just like me, a knowledge that cannot be gained anywhere else. To start with, it's not the same to go to class and get theoretical knowledge, than to put it into practice yourself. That is, you acquire real-time knowledge that is priceless, that is an experience for life. In other words, it has allowed him to define his specialization in physical geography.
[Friend Interview]

I still enjoy the activity itself, but also, each time we [have] volunteers, [we are] integrated more in the project in the sense that each time we serve more like scientists; it's no longer going to the activity [to] see what's being done, but to train other people. Last Friday, a group of school children came and I had to explain processes to them; that process of being able to transmit what I've learned, I found impressive, I really liked it. [Interview 2]

KNOWLEDGE AND COMPETENCY

Interviews and observations indicate that Case Study A is knowledgeable about the research process, and he is detail-oriented and comfortable with lab equipment. This adeptness is especially powerful when combined with his enthusiasm for the process and his strong communication skills (see the first quotation below). Further, interviews and observations highlight how successfully Case Study A's team worked together in the spirit of collaborative teaching and learning (see second quotation).

[Case Study A] has demonstrated an initiative and passion for the shorelines, and that passion shows in his day to day work with us, and his frequency at the activities, and not only that, but he contributes ideas, and he has demonstrated his performance in the handling of the equipment, in his fluidity when speaking and using the terms, etc. [Assistant Scientist Interview]

It's nice, we've created a work atmosphere that's so beneficial for new volunteers, because the knowledge is not only in one or two people; it is in five or six persons. You can dedicate more time to people. . . . For example, [Case Study A] takes three volunteers, I take three more; it's easier for them and for us. . . . I think that many times that's what attracts the volunteers, because our own work atmosphere is [so] friendly. [Friend Interview]

SERIOUSNESS OF STUDY

Interviews with Case Study A indicate how seriously he takes his Citizen Science work; he believes it is real science with important implications for the field. Although, according to interviews, the process did not teach him anything new about the scientific method; it did provide the resources and encouragement for him to engage in independent research (see the first quotation below). The sense of urgency and importance Case Study A feels about his research was reflected in interview comments about his upcoming presentation for a conference in Washington. He also mentioned multiple times that his projects helped him discover data that will be useful to the ongoing work of the Trust and will improve community awareness of important issues (see the second quotation).

I love the project, that's why I keep going. Thanks to all the opportunities that the Trust has given me, not only for Machuca's study, but they also allowed me to use their facilities for another study I did on four other beaches, so I'm eternally grateful and super happy that they've done programs like this one. [Interview 3]

My investigation here, I'm going to donate this information to the Conservation Trust. I hope that they can donate this information to the community because I think that it's very important for them to know what is happening since they live close to the Coast. It is very important to create awareness in the people that live nearby. [Interview 3]

PROGRAM CHALLENGES

According to interviews, Case Study A experienced a few challenges. The key initial challenge he faced was his lack of availability to regularly attend activities, interrupting his learning at times. The observation suggests that he may have to make special arrangements to attend (e.g., he did not have the appropriate attire because he did not have time to return home). The other key challenge he faced was in his independent research; he could not find enough additional people to support his Machuca project and had to suspend work (see the quotation below).

The most difficult thing has been, particularly in that Machuca project, [Case Study A] realized that in research projects, if he can't depend on other people to help him for the collection process, it's not going to happen. For example, the collection work [that] he began doing, he had to stop it for several months, because people who were going to help did not come back. That frustrated him, because he wanted to keep doing it, but alone he couldn't do it. [Scientist Interview]

CHANGE OVER TIME

Interviews indicate that Case Study A became more comfortable and confident in both teaching and research roles throughout his experience with Citizen Science. Further, he explained that participating changed the way he views beaches and coastal ecosystems (see the first quotation below). In the second and third interviews, he expressed a belief that Citizen Science is creating awareness of important shoreline issues. Another indication of change over time is Case Study A's deepening commitment to the field and narrowing of focus within it (see the second quotation). By the third interview, he said that he had chosen to pursue advanced studies in glaciology, and his friend explained that this decision came about from his involvement in Citizen Science. Interviews also showed a marked transition in the way Case Study A perceived his program role. He confidently applied the "assistant" title to his role by the

third interview, which he hesitated to do in the second interview. He also began referring to the group as “we” (see the third quotation). This sense of program ownership was echoed in the interview with the scientist.

I can no longer see coastal ecosystems in the same manner; I can no longer grab a book that talks about tourism in the beaches and see it in the same manner, because now one thinks further than the simple fact of seeing the beach and seeing the sand. [Interview 3]

The result of what I do [in Citizen Science] is a very important experience for me personally, because it’s what I’ve always wanted to work in as a professional, and really, doing it, I’ve realized that yes, this is what I want to do in the future, it is what gives me pleasure to do. [Interview 2]

That is the advantage we have in Citizen Science; *we* are integrating [volunteers] directly with field work, which is a lot more educational than the simple fact of only teaching theory. [Interview 3]

LASTING PROGRAM EFFECTS

Involvement in Citizen Science significantly supports Case Study A’s academic and professional career. It helps define what he wants to do and will most likely support future next steps (see the quotation below). It also helped him motivate others to get involved in this work and participate in research that he believes will have lasting value. Overall, Citizen Science has had a positive impact on Case Study A.

It has influenced me a lot and it has helped me in defining what I really want. Because now that I’ve done this, I know that I want to apply this in other things. . . . I’m seeing that the sea level is rising in Antarctica and the glaciers are eroding. So, I think that by learning these techniques, I can apply them. . . . This experience could help me a lot in what I plan to do in the future. [Interview 3]

CASE STUDY B: BIRDS PROGRAM

Case Study B is a PhD student in Curriculum and Education in Physics. She is an experienced volunteer with the Citizen Science Birds program.

RK&A interviewed Case Study B on three occasions and observed her in the Birds program once. In addition, RK&A interviewed the scientist she worked with, a staff member from Citizen Science, and her sister, who participates with her in the Birds program.

BACKGROUND AND MOTIVATION TO PARTICIPATE

Case Study B explained in the first interview that she had no prior involvement in Citizen Science and only very general knowledge of birds before she and her sister began participating. They learned of the program while attending a meeting at the Reserve, which they appreciated because of its welcoming learning environment. Case Study B had a background in science, but her program motivation stemmed from her involvement in the Reserve and a growing interest in birds (see the quotation below).

[My sister and I] started to look at the birds around us, around our house, at our work, and we started to relate, to investigate, and to read. Then, the Citizen Science Program came about, specifically the Bird program; we felt like the heavens had opened because it is a good place to learn since we do not know anything. . . . Apart from the reserve, [our initial participation in Citizen Science] coincided with the time when we became Friends of the Trust; we also became interested in birds. [Interview 1]

Case Study B's involvement in Citizen Science remained consistent over the course of the interviews. At the time of the first interview, she had attended the Birds program nearly 40 times. During the second interview, she said she had attended another six to eight times. She explained during the third interview that she had attended an additional 10 times, including one intensive weekend project that involved work with the crab census and other activities. Even after trying other activities, Case Study B continued to work almost solely with the Bird project.

From early in program involvement, a motivating factor for Case Study B was the opportunity to work side-by-side with well-known field scientists who are knowledgeable about birds (see the first quotation below). In later interviews, she described additional motivations. She developed a strong interest in being able to identify birds on her own (see the second quotation), and this drove further involvement. She also was compelled to participate by the opportunity to utilize the scientific method, enjoy the natural environment of the Reserve, and share the experience with her sister and others.

[The scientists] are like rock stars, but of the bird world; we had read about them. . . . And, then you come here and you meet them, and we interact with them just like you and I are now. Well, we thought, "This is the opportunity to learn from the experts." [Interview 1]

One day I'd like to be able to identify more than a handful of birds. I'd like to not be such an amateur. Of course, I'll never be an expert, but at least to be able to identify a few more types of birds; also, the location where it is held. I like the *hacienda*. I like the environment of the people that work there, the people that go there. I like going with my sister. [Interview 2]

PROGRAM SUCCESSES

There were many successful aspects of Case Study B's involvement in the Citizen Science program. Consistently throughout interviews, she expressed a holistic appreciation for the experience, using words such as "everything" to describe what she most enjoyed. She articulated a variety of beneficial opportunities that her involvement in the program provided: the opportunity to connect with her sister, be in a relaxing environment, have special access to the reserve and its staff, learn about birds, apply the scientific method, challenge herself physically, be part of a community, and support the larger goals of the Trust.

ENVIRONMENT AND ACCESS

Case Study B seemed to benefit greatly from the simple opportunity to be in the Reserve on a regular basis, providing a sense of calm to her otherwise busy lifestyle (see the first quotation below). This was also mentioned by her sister, who felt that being at the Reserve is one of the most important benefits of Case Study B's involvement in Citizen Science (see the second quotation).

It gives me a certain amount of tranquility. Being here on the weekends, you let everything go and you return relaxed, refreshed, renewed. . . . Being in such a spectacular place brings freshness to your work. [Interview 2]

They give [Case Study B] a route, and she happily goes on her way because she's in the Reserve, and for her that is . . . the hustle and bustle of the week. . . . She uses it as a respite from that hectic life she lives during the week. [Sister Interview]

KNOWLEDGE GAIN AND NATURAL CURIOSITY

Learning about birds is an area in which Case Study B was very motivated to excel and also was successful. She and her sister both noted the sense of accomplishment, celebration, and even community that comes with bird identification (see the first quotation below). She learned throughout the experience that there are more advanced methods for identifying birds, and although she does not consider herself to be an expert, the scientist she worked with indicated that bird identification was an area of mastery for her (see the second quotation). Recognized by all interviewees, Case Study B took advantage of special opportunities to improve her knowledge of birds such as connecting with other bird-watchers, purchasing a CD with bird sounds, and taking workshops outside the Trust. Her sister explained that the scientist they work with made these additional learning opportunities more accessible to them.

On a recent trip, I said to the interpreter, 'Look, there's a climber!' It's not always the expert who raises the flag and identifies the bird. For me, it was interesting to look for them and identify them and be able to show them to other people. I think it's a small step forward in that sense. [Interview 2]

They've developed, especially [Case Study B], the ability to identify birds. For example, she identifies *reinitas rayadas* (Blackpoll Warblers) very well. She identifies the Prairie Warbler very well. She can distinguish between the Adelaide's Warbler and the Northern Parula, which is very difficult for a lot of beginners. [Scientist Interview]

PROGRAM ROLE AND CONTRIBUTIONS

Despite her avid and passionate interest in birds, Case Study B consistently identified her role as a volunteer data collector. However, she also expressed recognition that her role and ability to be rigorous are important to the project and conducting research in general (see the first quotation below). When asked to describe her contributions to the project, she explained them in terms of the scientific method and broader work being done by the Trust (see the second quotation). The seriousness, detail-orientation, and patience with which she goes about collecting data for the Birds program were also evident in the observation.

Rigor minimizes any bias we may have. Without it, we may become biased or our observations are biased or incorrect and that would take validity away from the findings. If we released incorrect findings that would create a cycle that would continue to affect the research if it wasn't corrected. [Interview 2]

My contribution [is] if we develop from these investigations information that can boost this type of work, to integrate the community, people like me, that have or do not have scientific knowledge, that we can get involved in something as serious as an investigation of this type, I think that that is a contribution. [Interview 1]

THE TRUST AND COMMUNITY

In the first interview, Case Study B was articulate in discussing what she believes the purpose of Citizen Science to be and, in particular, she noted the role of community in science and research (see the quotation below). Throughout all three interviews, Case Study B was vocal about the need for the Trust to reach out to the community. The importance she placed on community came from her personal enjoyment of meeting new people and her belief that reaching out is an important way to expand the

impact of the Trust's work.

I understand that the purpose [of Citizen Science] is twofold: the scientific research part itself, of what is being studied, the birds, and the relationship between the birds and the moist soil. . . . But I also understand that the purpose is to integrate the people, the citizens . . . to make people part of the investigative process. I understand that those two purposes go hand in hand because if, from the results of these investigations, we can establish patterns, we can establish things that are in the scientific literature and others can use it, it is very important. But, also [important is] that the people integrate themselves, the people of this community can feel part of this property, [so] that they will protect it and take care of it. [Interview 1]

PROGRAM CHALLENGES

According to interviews, Case Study B faced very few challenges throughout her involvement in the program. Initially, she said that the physical activity was somewhat challenging. However, this challenge diminished considerably over the course of her involvement.

In the second interview, she expressed insecurity about her knowledge of birds. She explained that as she gained responsibilities, she felt that she should be able to identify birds without help from the scientist (see the first quotation below). In the third interview, Case Study B said she initially (but no longer) struggled with unfamiliar vocabulary words. Interviews indicate that she was recognized as a highly motivated and skilled volunteer and did not have many challenges other than her own insecurities.

Although they've always trusted us and even permitted us to be group leaders for people who have less experience than we do, [there is now the] challenge of [having] more responsibility. For example, we hear a bird and we go to the expert or principal investigator. We lean on him and perhaps depend too much on him. Now, [when people ask] 'what bird is that?' I have to be able to recognize it and know [things] more deeply. [Interview 2]

CHANGE OVER TIME

INCREASED CONFIDENCE AND PHYSICAL ABILITY

Throughout her involvement in the Citizen Science program, Case Study B became more comfortable navigating the physical environment (see the first quotation below). By the third interview, she even expressed enjoyment about a more physically challenging activity in the Crabs project. The staff person said Case Study B has overcome her shyness and self-doubt in a significant way (see the second quotation). She not only became more comfortable and confident, she became a leader for the Trust and an adventurous researcher.

Today when I was walking there, I was conscious of the roots; I did not want to damage them. Maybe in the question that you pose to me, of what was most challenging, I would say that, because I did not do that before on a daily basis, now I can say that I walk around in relative comfort and security [with] something that was challenging before and now it is not. [Interview 1]

At the beginning, [Case Study B] felt a little inhibited. She would say, 'I can't do this and I can't do that.' I have seen her development over the last two years. She changed from a person one would think of as very introverted to someone who, for example, for the beach cleaning and reforestation activities, I used as a group leader. I know at other moments she might have felt like, 'Oh no, I don't dare.' Now, I see that she expresses the Trust's message; she expresses them even better than I do, with such gusto. It's incredible. [Staff Interview]

PERCEPTION OF ROLE

Another key indication of change over time is the way in which Case Study B perceived and described her role in the Citizen Science program. Throughout all three interviews, she made a point to identify her role as that of a volunteer and/or data collector. She seemed careful not to inflate her role with the project. However, as early as the first interview and throughout subsequent interviews, Case Study B recognized her growing responsibility and changing role over time. She said that the Trust has allowed her to act as a group leader, that her role has deepened, and she has naturally assumed the role of interpreter on occasion. She expressed a sense of responsibility and ownership about her role by the final interview (see the quotation below).

I keep being a volunteer, that's my job, and I know my place; that is, when there's an activity, the chores that are asked or assigned for me to do . . . but I have to recognize that on occasion, certain leadership is expected from those of us who have participated a longer length of time. . . . In fact, sometimes, even without planning it, we assume an interpret role for persons who come there for the first time. . . . We also feel responsible for keeping or maintaining the role of safety. [Interview 3]

WORLD VIEW AND SCIENTIFIC METHOD

Involvement in Citizen Science also changed the way Case Study B perceives the world and the scientific method. She did not elaborate, but said the program has increased her awareness of nature and its value, and her sister's comments supported this. According to interviews, an even more significant shift for Case Study B occurred in her use of the scientific method. Although she was already very familiar with the scientific method, the Citizen Science program allowed her to see its universality, which has had an impact on her daily life and professional work (see the quotation below).

[Involvement in Citizen Science helped] confirm the universality of the scientific method You never take anything for granted. . . . We say, joking sometimes, 'Hey, what is this bird doing here now? It hasn't read the book!' So that skepticism part, that you never take anything for granted, that also is common to all science fields, of doing science. [Interview 3]

LASTING PROGRAM EFFECTS

The most significant outcome of Citizen Science for Case Study B seemed to be rooted in her present experience: the pure enjoyment, even therapeutic effects, she feels when participating. Case Study B also experienced an undeniable expansion of knowledge about birds, which was one of her primary initial motivations for participating in the program. Case Study B's knowledge of birds has also had a secondary effect; it has enabled her to participate in additional bird censuses in the area because she has garnered a reputation for being knowledgeable.

In addition, Case Study B's participation in Citizen Science has supported her pursuit of a PhD in physics, even though the work is in two different scientific fields. She spoke about her research experience in Citizen Science during her doctoral interviews (see the first quotation below), which helped her gain acceptance into the PhD program. In fact, the Citizen Science staff member said she believes Case Study B's decision to pursue a PhD was in part motivated by her experience in the program. Citizen Science has affected her work in the classroom as well. By helping her students understand issues related to the ecosystems protected by the Trust, Case Study B promotes their efforts to reach a broader community. She also encourages students to get involved in the program as volunteers (see the second quotation).

When, [in my doctoral interview], they mentioned requirements of classes on research, I spoke about my research experience. I have my Master's, but I also said, 'Oh, but wait, I have this other experience [in Citizen Science], and from a completely different scientific point of view compared to what I've done.' It's different and it gives you confidence because it's another area. [Interview 2]

At the university, there are students that approach [Case Study B] with an interest in science. She gives the bird study as a reference, as well as the coast study and crab census. She encourages the students to participate. She invites them to learn more about the Citizen Science program so that they'll participate and get involved, since they're science students, and have a background with relation to how to conduct a study, the different methods for collecting data. [Sister Interview]

CASE STUDY C: CRABS PROGRAM

Case Study C is a cabinetmaker and professional cyclist who also has an educational and professional background in science. He is an experienced volunteer with the Citizen Science Crabs program.

RK&A interviewed Case Study C on two occasions and observed him in the Crabs program once. In addition, RK&A interviewed the scientist he worked with and a staff member from Citizen Science about his involvement in the program.

BACKGROUND AND MOTIVATION TO PARTICIPATE

Case Study C explained in the first interview that he had a significant background in science before participating in Citizen Science. He studied science, participated in other science programs, and also worked in a lab environment for ten years before becoming a carpenter (see the first quotation below). He learned about the program from television, but was also familiar with the area from cycling in or near the Reserve and having grown up near the beaches (see the second quotation).

I have studied biology since I was young in different programs like this one. [There were] field trips, teachers, classes, quizzes, tests. . . . Most of the places we went were science fairs, so we also did our own projects; we learned the scientific method, everything you needed to perform an investigation. [Interview 1]

I heard about this program on television and I live in the next town. I walk a lot and I'm a professional cyclist, so I actually use this area as part of my training. . . . I also grew up here. Even though I live in the next town, much of my childhood was here on these paths and on the beach. We used to fish here too. [Interview 1]

According to interviews, Case Study C attends the Crabs program frequently. At the time of the first interview, he had attended at least 20 times. During the second interview, he explained that it is rare that he ever misses the program. Case Study C also said he received recognition from the Trust for having volunteered for 350 hours and estimated he had completed many additional hours since then.

When asked to explain his program motivations, he said he comes simply because he likes it. He also said that he has a long-term interest in crabs and is very knowledgeable on the subject, so this program was particularly exciting for him (see the quotation below).

[I attend because] I like it. I like everything that has to do with marine life. A large part of my studies was actually crabs and crustaceans, so when I heard about this program, I felt like I was in Disneyland. . . . Ever since I was young, my studies in biology have been about crabs. I even won a prize at a science fair here and in the United States for some of my research. I researched the symbiosis between crabs and anemones for about two years. I can identify tons of species of crabs. [Interview 1]

PROGRAM SUCCESSES

According to interviews, Case Study C's involvement in the Citizen Science program is successful in many ways. In the first interview, he expressed a generally high level of comfort and confidence with the research process. This comfort and confidence was also noted in the observation, in which he skillfully helped set up the grid for the trap plot and helped other participants.

RELATIONSHIPS AND THE LEARNING EXPERIENCE

When asked what he likes most about the Citizen Science program, Case Study C said that he most enjoys working with others through the research process, both because the group seems to work well together and also because he can expect a high level of competency from them. In the first interview, he also expressed appreciation for the many opportunities to learn, including learning about crabs, the scientific method, and related details about the research process.

During the second interview, Case Study C's comments indicate that he had progressed significantly in terms of teaching and learning. He shared stories about learning directly from the scientist on more high-level research techniques. He also described an increased teaching role with other volunteers (see the first quotation below). He showed a degree of mastery, competence, and leadership in the observation that matches his interview comments. The scientist he worked with shared her perspective on his strong teaching abilities (see the second quotation).

We train the other volunteers that come from beginning to end. I already train people and give informational talks to them. We teach them the process of how to set the traps, how to collect them, how to set the bait. We teach them how to differentiate one crab from another; also, if it's from another species and all the tricks you learn in the field. [Interview 2]

I think it's something that [Case Study C] really likes. He likes being a teacher, because when he's with a group or with someone, he's constantly explaining and showing them, 'look at this crab, this does this, and this is what happens.' Within the group he's always sharing everything he knows with others. [Scientist Interview]

AUTONOMY AND RELATIONSHIP WITH SCIENTIST

Case Study C developed greater competence and autonomy throughout his experience in Citizen Science; this was largely due to a positive working relationship with the scientist in the program who allowed flexibility and provided encouragement. The scientist was confident in Case Study C's ability and remarked that he led groups well without her supervision. He, in turn, showed appreciation for her guidance by expressing his willingness to do anything to help with her research.

A key indication of success for Case Study C is his interest in putting together a guidebook about crabs for the Trust. In the second interview, he described having had the idea to update and improve an older guidebook that the scientist shared with him. He proposed the idea of pursuing this project, and the scientist supported it by providing guidance (see the quotation below). Case Study C explained that this guidebook project was a direct result of his involvement in Citizen Science and his work with the scientist.

I'm re-making [the guide book] in color, with new photographs, new crabs. I'm dedicating myself to the task that they're correctly identified down to the detail. For example, if one has a leg different from the other, well, I'll photograph that piece. . . . In addition to having different colors, crabs have different details . . . the mouth is a different size; it might have extra spines, or the antenna. You know, so that it's a little more specific [than the previous version]. But I want to do it with all crabs. It's not an easy thing. I'm doing land crabs and water crabs. [The scientist] told me, 'That's really difficult' and I said, 'I want to do them all' and she told me, 'Well then, I'll [help with] the land [crabs].' [Interview 2]

ENTHUSIASM FOR SUBJECT

Case Study C is extremely enthusiastic about crabs and takes advantage of every possible learning opportunity through the Trust. For example, he avidly explores books on the subject (see the first quotation below) and brought his family to a weekend program where he led a group and provided transportation for volunteers (see the second quotation).

[The scientist] lent me those three books, and I'm devouring them. I'm reading them; for example, they tell you that the crab is from such-and-such order, such-and-such family, [and] how many specimens there are. For example, with the *cocolías*, multi-colored crabs, there are 10 to 12 different types in addition to the ones that we regularly see. [Interview 3]

In the summer, we had crab weekends where volunteers stayed at the Hacienda. We would begin on Fridays and have activities until Sunday and [Case Study C] and his wife, who also comes a lot, were an essential part of the program. We would divide the people when there were a lot of people, and [Case Study C] took a group. He even brought a cart from his home, and we used it that day as part of the equipment to be able to move people to the study places. And, the Trust, they even put him in their insurance so he could also drive the Trust's vehicles. [Scientist Interview]

SCIENTIFIC METHOD & "REAL RESEARCH"

There were several indications that Case Study C views the Citizen Science program as an opportunity to do "real" research. He said that he felt the role of the program is to educate people about the scientific method and provide an opportunity for practical application (see the first quotation below). In the second interview, he commented on the importance of the research they do in Citizen Science by saying that information about crabs available elsewhere, such as on the Internet, is much less reliable (see the second quotation).

I think [the goal of Citizen Science is] that people understand what the scientific method is. A lot of people learned it in school but have no idea what it is. Here they may not be told, but they're putting it into practice. That way they learn and can recall it in the future. [Interview 1]

You search the Internet and you enter *Gecarcinus ruricola*; when you look at the picture you see a *Cardisoma*. So that's why we're doing it very carefully so that it will be really accurate and can be trusted. So that if another person uses it, they can say that it's perfect without fail. [Interview 2]

PROGRAM CHALLENGES

According to interviews, Case Study C has faced various challenges throughout his experience in Citizen Science. The primary challenge was finding time for Citizen Science, which he loves to do, in the midst of a busy work schedule and family life. On a number of occasions, he remarked on his struggle

between wanting to do more work with the Crabs program and recognizing that he also has to work to support his family (see the quotation below). Neither the staff person nor the scientist interviewed said that they saw this as a challenge for Case Study C.

The difficulty I have in continuing with this is that I have to survive and I'm doing this for free, volunteering. So, let's say that I'm volunteering four days. Well, those are four days of work I've lost. So that creates some serious problems with the family. [Interview 2]

Case Study C has also faced challenges related to the work itself. While doing the guidebook project, he struggled with some of the computer technology and solicited help from his wife and daughter (see the quotation below). He also commented on the challenging nature of fieldwork, both physically, in terms of having to dig large holes, and mentally, in terms of having to wait long hours.

The only thing I have trouble with is that I'm not an expert in the computer aspect. I don't know how to handle word processing programs like my daughter or [my wife]. I tell [my daughter], 'You have to help me with this.' And, I know that it's not easy; for example, I've already done the first ten [crabs for the guide book] and I was working with my daughter for more than ten hours do that. [Interview 2]

In addition, Case Study C described a general challenge that he and others face during their work with the Crabs program. In both interviews, he discussed community relations difficulties related to restrictions on crabbing (see the first quotation below). Although, during the first interview, Case Study C expressed a sense that progress was being made (see the second quotation). Case Study C expressed ownership over the community relations issue, describing some of the strategies they have used to combat the problem (see the third quotation below), but explained that he also understands the perspective of the community members from having grown up in the area.

The people who live around here . . . this used to be their yard; they would come here and eat, drink, fish or catch crabs, etc., and now they can't. They feel they can't live because the police won't let them. . . . I know they've been giving orientations to the people who live here, to the police, all the government entities; I've seen them do it. Honestly, some people don't even know what a crab is. [Interview 1]

The Hacienda has been here for some years now, and I've noticed that people have realized that they were mistaken. Times have changed and now the kids don't learn to capture crabs, but now this will be preserved for everyone to enjoy. [Interview 1]

What we did, for example, to attack this is that we called the Department of Natural Resources, [which] can fine [someone] for fishing on the Reserve. In addition to that, they can fine you \$100 for each crab [someone] has in the sack. [Interview 2]

CHANGE OVER TIME

Case Study C grew in his role with Citizen Science throughout his experience in the program. In the first interview, he described his role as a volunteer participant in the fieldwork. However, in the second interview, he recognized that he and other experienced volunteers had been functioning as leaders and teachers (see the first quotation below). The scientist and staff person interviewed also described Case Study C's role in the program as increasing in importance over time, saying that he functions as an assistant for the investigations (see the second quotation). He also was recognized for being especially committed and trustworthy.

They really need us. Actually, right now, we can help the Hacienda staff [teach] the interpreters because sometimes they have new interpreters that don't know anything about crabs. So we teach them too. [Interview 2]

He has become like one more assistant in the investigation. . . . At first he was the type of person like a spectator [that] participated little [and] now he has been able to run nights alone. [Staff Interview]

Case Study C expressed a change in his perspective of the need to protect crab species (see the first quotation below). Although he did not elaborate on this change, it is clear from interviews that he has become very invested in the protection of their habitat and ecosystem. His increased knowledge about crabs has led to increased sensitivity about the species' needs, and the staff person interviewed reiterated this idea (see the second quotation).

I guess we see it a bit differently now; we try to be conscientious about it, and we try to let others know not to capture too many [crabs]. I know of people who don't even worry about if a crab is male or female; maybe a female is coming to lay her eggs and they capture her pregnant, they don't let her finish her cycle. For me it's important for her to make it to the water to lay her eggs, because those are crabs you can eat later; you shouldn't catch her before she lays them. [Interview 2]

Being a person who comes from the coastal area, [Case Study C] has learned about the importance of the care you have to have with the species we have. . . . We enjoy it but we don't always have the perception of how important they are for us. And, that is something he has gained from this process. [Staff Interview]

LASTING PROGRAM EFFECTS

There are several examples of how the Citizen Science program has had lasting value for Case Study C. First, he learned and received mentoring from the scientist he works with on the Crabs program. She taught him scientific methods, provided constructive feedback for him while working on the guidebook, and, served as an important mentor. He expressed the importance of this by explaining that the mentoring relationship with the scientist in Citizen Science was similar to a seminal one he had had with a teacher in high school. Through the process of doing such dedicated research and having a strong role model, Case Study C significantly increased his knowledge of crabs.

Case Study C also benefited from having his research expanded through his own efforts as well as encouragement from the Trust to share his research with the field. For example, a lasting effect of his involvement in Citizen Science is the guidebook that he is working on as an independent project. He expressed a hope and expectation that it would be published, which a staff member had encouraged (see the first quotation below). Similarly, the Citizen Science program led Case Study C to present about his research at a conference in Pittsburgh (see the second quotation).

I told [the staff member], 'I'm doing this [guide book project] and it's coming out well and I'd like you to publish and display it as an exhibit.' And, she said, 'Yes, don't worry about that. There's a lot of money for that.' And, when she told me that, I knew I was on the right track. So, I'm hitting it hard so that it will come out [on time]. [Interview 2]

[The scientist is] going to take me to the United States for a week. She's taking me to a conference where we're going to talk about crabs. . . . We also have to prepare information to go with and be on top of the information. [The scientist] already told me, 'You know we have to prepare a binder and a paper, like a paper where they put all the information.' [Interview 2]

APPENDICES

APPENDIX A THROUGH E: REMOVED FOR PROPRIETARY PURPOSES

APPENDIX I: QUESTIONNAIRE STATISTICS

DESCRIPTIVE STATISTICS

CATEGORICAL VARIABLES: FREQUENCIES

Program
Day (Friday, Saturday, Sunday)
Time of day (morning, afternoon/evening)
Number of participants (TBD)

Gender (respondent)
Age category (respondent)
Education (respondent)
Puerto Rican resident
Primary language spoken
Municipality
Visit group composition
Currently enrolled student
Employed in a science-related profession
Member or active in conservation organization
Volunteered for other activities like Citizen Science
Amigo member
Red Amigo member

Q1 First-repeat participation
Q1a Number of times participated (1, 2, 3, 4 or more time(s))
Q1b Other programs participated in (repeat participant)
Q2 How first heard about Citizen Science
Q3 Top two reasons for participating
Q7 Top two phrases to describe the experience
Q8 Perception of role in Citizen Science
Q9a Behaviors affected by participation

DESCRIPTIVE STATISTICS

INTERVAL VARIABLES: MEAN, MEDIAN, STANDARD DEVIATION

Age (respondent)
Number of participants
Q5 Ratings of preparedness, logistics, and materials
Q6 Ratings of program experiences that day
Q10 Ratings of perceptions of scientific process abilities
Q11 Ratings of interest in being a scientist

INFERENCEAL STATISTICS

CHI-SQUARE TEST

Program	
Day (weekday, weekend day)	
Time of day (morning, afternoon/evening)	
Membership (Amigo, Red Amigo)	
Q1 First-repeat participation	Gender (respondent)
Q1a Number of times participated (repeat)	Age category (respondent)
Q1b Other programs participated in (repeat)	by Visiting with children (yes/no)
Q2 How first heard about Citizen Science	
Q3 Top two reasons for participating	
Q7 Top two phrases to describe the experience	
Q8 Perception of role in Citizen Science	
Q9a Behaviors affected by participation (repeat)	

INFERENCEAL STATISTICS

ANOVAS

		Gender (respondent)
		Age category (respondent)
		Visiting with children (yes/no)
		Program
		Day (weekday, weekend day)
	by	Time of day (morning, afternoon/evening)
		Number of participants (≥ 10 , 11-20, ≤ 20)
		Membership (Amigo, Red Amigo)
Q5 Ratings of preparedness, logistics, and materials		Q1 First-repeat participation
Q6 Ratings of program experiences that day		Q1a Number of times participated (repeat)
Q10 Ratings of perceptions of scientific process abilities		Q8 Perception of role in Citizen Science
Q11 Ratings of interest in being a scientist		

APPENDIX J: MUNICIPALITIES

TABLE A
RESIDENCE (COMPLETE LIST)

MUNICIPALITY (<i>n</i> = 295)	<i>n</i>
San Juan	38
Manati	37
Vega Baja	37
Bayamon	22
Arecibo	20
Carolina	19
Dorado	17
Toa Alta	15
Toa Baja	11
Vega Alta	10
Hatillo	6
Morovis	5
Barceloneta	5
Aguas Buenas	5
Caguas	4
Guaynabo	4
Trujillo Alto	4
Yauco	3
Florida	3
Ciales	3
Catano	3
Aguadilla	2
Aibonito	2
Corozal	2
Isabela	2
Mayaguez	2
Anasco	1
Cabo Rojo	1
Camuy	1
Canovanas	1
Cayey	1
Fajardo	1
Guayanilla	1
Gurabo	1
Humacao	1
Quebradillas	1
Sabana Grande	1
San Germain	1
Utua	1
Villalba	1