Project Description:

The Conservation Trust of Puerto Rico (the CTPR) proposes the *Efficacy of Informal Science Education (ISE) practices to develop Hispanic citizen scientists in the Watershed of the Rio Grande of Manati, Puerto Rico*, which will be a **Full-Scale Development Citizen Science Project**. Throughout the three-year project period we aim to achieve the following **goal**: to study the efficacy of the implementation of ISE practices that promote the development of citizen scientists in a Hispanic audience that is underserved and underrepresented in STEM fields by engaging participants in contributory, collaborative and co-creative projects aimed at assessing the effects of urban expansion on the Rio Grande of Manati Watershed. We intend on achieving this goal through two objectives: **Objective 1:** The project will study if the proposed ISE model based on lessons learned in prior award (0638966) generates a gain in knowledge and skills and a change in attitude and behavior that stimulate project participants within the four municipalities that comprise the Rio Grande of Manati Watershed to become co-creative citizen scientists by project year three. **Objective 2:** To explore STEM pedagogy with Hispanic populations in ISE settings, including how scientists' behavior and communication shifts according to participant profile and environment settings; scientists' gain from the ISE experience; and scientists' commitment to further advance ISE.. **Expected outcome** is for 60% of participants to have experienced a gain in scientific knowledge and skills and a change of attitude and behavior towards generating, understanding, and using scientific knowledge in their everyday lives, specifically as it relates to watershed issues.

Project Rationale: Issue. Increasing participation in ISE activities is critical to addressing low rates of achievement by Puerto Ricans as well as Hispanics in formal science education programs. Hispanics make up 15% of the U.S. population and less than 2% of the nation's STEM workforce (US Census 2000). Therefore, informal learning environments may be particularly important for science learning for this diverse group, but questions remain about how to best empower science learning through informal learning environments (Bell, 2009). This project is aimed to validate previous experience of CTPR regarding ISE by studying the design and methods of informal science learning experiences that meaningfully attend to our cultural practices.

Puerto Rico is an island 111 miles long by 39.5 miles wide experiencing rapid urban development in both metropolitan and rural areas, resulting in loss of biodiversity and major environmental problems (Martinuzzi et al., 2007), such as the impacts to main sources of freshwater from the karst regions of Puerto Rico (Kennaway and Helmer, 2007). The Rio Grande of Manati Watershed (Figure 1) is found within the northern Karst region,

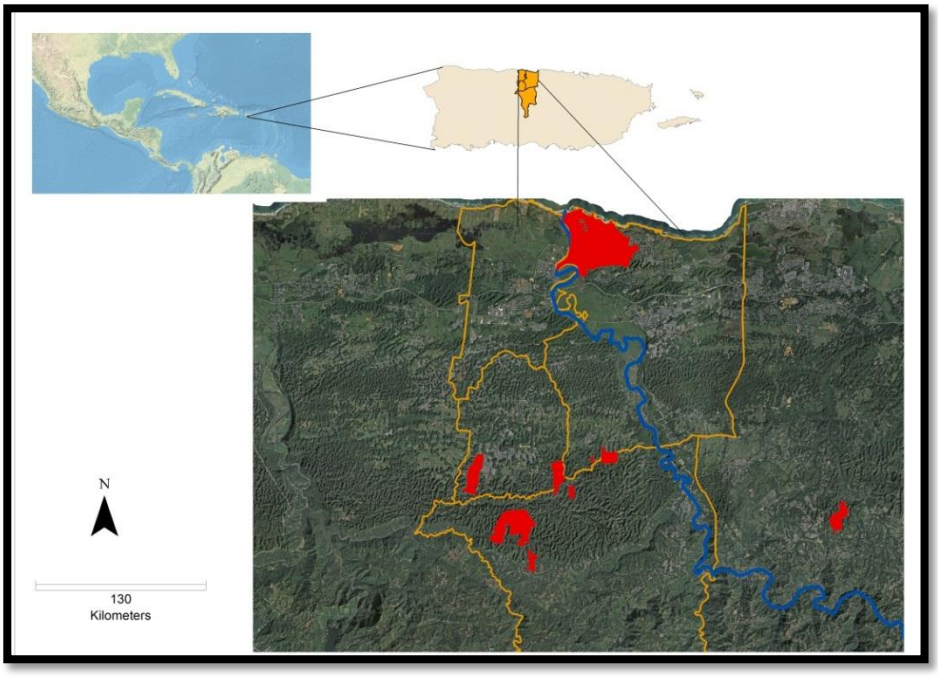

Figure 1: Map Showing the Landscape of the Rio Grande of Manati Watershed. Yellow lines show municipalities and red show CTPR properties

where there are increased proposals for urban developments in its four municipalities: Barceloneta, Ciales, Florida and Manati. During focus group meetings held with volunteer leaders involved in prior NSF award and watershed stakeholders, concerns included loss of biodiversity within the region, impacts to unique ecosystems (caves and underground rivers), reduced water quality, laws that do not take into account the importance of the karst, uncontrolled land use, and deterioration of local roads. Other non-profit organizations of the area have engaged in efforts to increase public awareness on these impacts through dissemination of information, but citizens feel that they do not have the full spectrum of scientific knowledge or the tools to address the issues that are significant to them. Research shows that engaging people directly with phenomena helps them become comfortable with tools and practice of science (Fenichel & Schweingruber, 2010). The Millenium Ecosystems Assessment (2005) shows that citizens who become significant actors in their environments play important roles in decisions linked to the use of those areas. While Mayers & Bass (2004) state that citizens knowledgeable of the areas that they live in develop a sense of ownership and engage in behaviors, initiatives, and processes that address their neighborhood affairs.

Our **target audience** encompasses youth (ages 14-35) and adults (36 and over) from the four rural Municipalities that are within the Rio Grande of Manati Watershed: Barceloneta, Ciales, Florida and Manati. The idea behind integrating the youth with adults is to integrate the enthusiasm of the youth with the skills, wisdom and mentorship of the adults (Catalano, 1999; Camino, 2005). By integrating these different age groups in our various science based projects we will provide a positive environment of sharing and showcasing of community environmental initiatives among different generations. Also, engaging youth in environmental stewardship is necessary because young people play an integral part of society as the future decision makers (Murdock et al 2009).

Project Approach: The proposed project will implement a citizen science project that stems from lessons learned from prior ISE project (0638966) run by the CTPR. Historically informal education in Puerto Rico has focused on disseminating scientific information through outreach activities such as community-based meetings to disseminate scientific information. In prior ISE award we saw a paradigm shift, where citizens participated in scientific projects designed by scientists, with participants involved primarily in contributory activities (collecting samples and recording data), as defined by the Center for Advancement of Informal Science Education (CAISE).

Different to previous award, the proposed project advances ISE in Puerto Rico by purposely including and focusing on two additional levels of activities (collaborative and co-creative), whereas previous award focused mainly on contributory activities. Furthermore, the objectives in new proposed project focus on the process of teaching and learning (education component) for advancement of ISE rather than only on the scientific themes. Similar to previous ward, the proposed model includes a short period of contributory activities to familiarize participants with scientific methodology. In Phase 2 (collaborative) participants will engage in data entry and analysis, and in result dissemination such as giving talks or presentations in public forums and to state and municipal agencies. Ultimately, in Phase 3 (co-creative) with the knowledge gained from the first two phases participants together with scientists will design scientific based short- and long-term monitoring projects that address their community environmental needs at Barceloneta, Ciales, Florida and Manati. During this transformative process we propose to assess and evaluate the impact of curriculum content and ISE methods and practices on how participants learn, reflect, apply or grapple with scientific principles. This study will contribute towards the limited knowledge base in the field of ISE for Hispanics in an informal setting in Puerto Rico.

Project Design: To contribute to research and practice in ISE, and to attain expected outcomes for participants, we will follow the nine-step model of the Cornell Lab of Ornithology *Citizen Science Toolkit Project* (www.citizenscience.org) that fulfills project goals of citizen recruitment, research, and education.

Step 1: Project Goal: To study the efficacy of the implementation of ISE methods and practices that promote the development of citizen scientists in a Hispanic audience that is underserved and underrepresented in STEM fields by engaging participants in contributory, collaborative and co-creative projects aimed at assessing the effects of urban expansion on the Rio Grande of Manatí Watershed. : **Objective 1:** The project will study if the proposed ISE model based on lessons learned in prior award (0638966) generates a gain in knowledge and skills and a change in attitude and behavior that stimulate project participants within the four municipalities that comprise the Rio Grande of Manati Watershed to become co-creative citizen scientists by project year three. **Objective 2:** The project will explore STEM pedagogy with Hispanic populations in ISE settings within each of the proposed 5 themes (crustacean/insect monitoring tools to assess the ecosystem quality in the streams and estuaries of the watershed; protection of life and property and coastal and river system management; comparison of bird communities between recently impacted, early secondary forest and mature secondary forest habitats; bat assemblage and bat dispersal routes in the karst area of the watershed; and cultural resources in the watershed area and cultural use of the region), including how scientists' behavior and communication shift according to participant through the contributory, collaborative and co-creative profile and environment settings; what scientists' gain from the ISE experience; and scientists' commitments to further advance ISE. To do so we will do on-site observations of each scientist's activities; make documentary videos of each of the scientists in action with project participants; apply rubric analysis; administer questionnaires to the scientists; carry out focus groups with scientists; analyze scientists self-reflection journals; and track registration/recording of scientists ISE projects/activities (outside of the proposed project) during and after award period.

By using an instrumental case study design that pursues "to understand a phenomena or affair for the development of a theory or an explicatory model" (Lucca & Berrios, 2009), the project will investigate factors within five scientific research projects that contribute to the development of a movement of community members from peripheral to core participation (Figure 2).

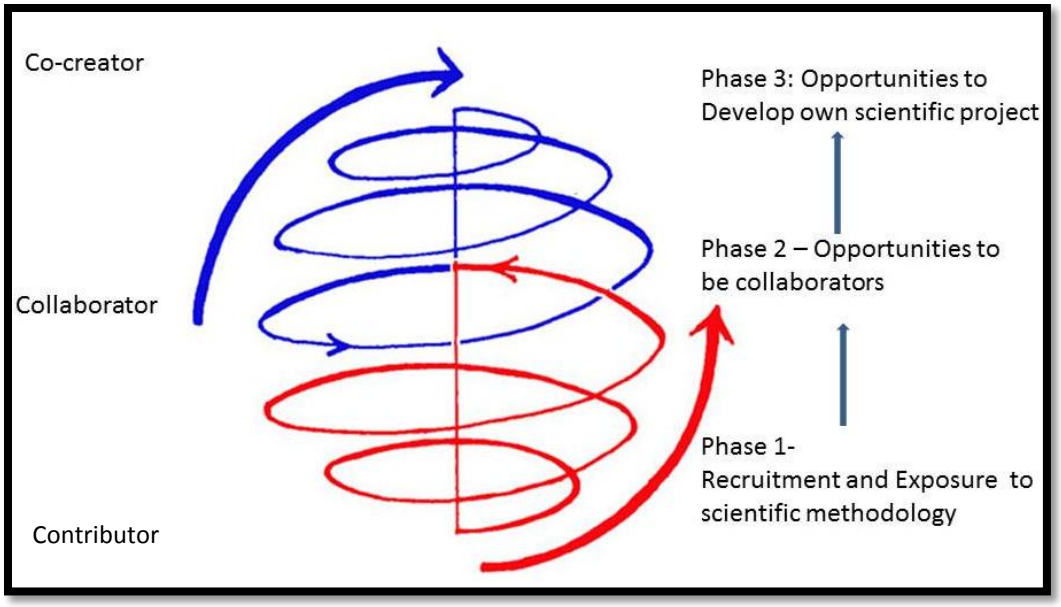

Figure 2: Proposed ISE Explicatory Model

Starting the seventh month of project year one, on a monthly basis the project will have at least 10 citizen science activities in the watershed on any of the five ecological themes (described further ahead), providing up to approximately 140 slots for citizen participation. One-time and repeat participants are welcomed to participate; however, 60% of the spaces will be reserved for core participants. Based on the total minimum amount of core participants (61) for all scientists, a flexible ratio is established at 60:40. Visiting participants can serve as a reserve to the scientists should core participants drop out for whatever reason or not be able to attend a particular activity. The volunteer spaces assure that the activity can be performed according to the needs of the project. Also, allowing for visiting participants will create more awareness and impact to a broader community.,. Core participants will commit to participating throughout the three phases of the project and will participate in all workshops and training sessions together with researchers so they can share ideas to refine existing projects and together develop new projects by year three. Researchers will have a direct and significant role in studying if the proposed ISE model and curriculum content generates a gain in knowledge and skills and a change in attitude and behavior that stimulate project participants to become co-creative citizen scientists by project year three. The three year project will engage an estimated total of 4,200 one time and recurrent participationsof core and visiting participants.

To study the efficacy of the of the implementation of ISE methods and practices from Phase 1 to Phase 3 researcher Dr. Carlos A. Muñiz Osorio and volunteer researcher Dr.Annette López de Méndez will perform a total of 18 passive observations, 2 focal groups, 15 open semi structure interviews, an online open perception survey, and a documentary analysis that includes core participants' reflective journals, project's artifacts and dissemination materials (Table 1). The researcher will explain how the ISE Explicatory Model impacts inexperienced citizens and/or citizens excluded from traditional practices of science to engage in science activities. A Wolcott (1994) analysis will be held after data collection to

validate the model. Throughout the project period the researcher will provide remedial and formative insight to enhance project protocols.

To achieve the ISE Explicatory Model the project proposes an ISE Framework (Figure 3) that integrates grantee's prior experience with a scope of citizen empowerment in science activities, consisting of four dimensions: Scientific Knowledge and Research, Learning Community, Curricular Assessment, and Communication.

Through the *Scientific Knowledge and Research* dimension participants will be exposed to a variety of field research experiences and workshops in the scientific method. The five themes chosen for investigation will be crustacean/insect monitoring tools to assess the ecosystem quality in the streams and estuaries of the watershed; protection of life and property and coastal and river system management; comparison of bird communities between recently impacted, early secondary forest and mature secondary forest habitats; bat assemblage and bat dispersal routes in the karst area of the watershed; and cultural resources in the watershed area and cultural use of the region. The five themes will also be used as instruments to educate citizens about the changes in the watershed due to urban development. Specifically, in each theme will identify STEM teaching practices that promote citizen involvement in scientific research process; learn what scientists gain in experience through ISE settings; and learn the commitment of scientists to further advance ISE experience. To do so we will do on-site observations of each scientist's activities; make documentary videos of each of the scientists in action with project participants; apply analysis rubrics; administer questionnaires to the scientists; carry out focus groups with scientists; analyze scientists self-reflection journals; and track registration/recording of scientists ISE projects/activities (outside of the proposed project) during and after award period. Further, we will assist researchers in each theme will provide citizens with tools to easily reproduce scientific projects to monitor and understand environmental changes within their neighborhoods.

Participants of the proposed project can also engage during and after project period in conservation tasks programmed by the Trust as part of its organizational strategy, to focus conservation efforts through formal and informal education to raise awareness. . rs. These tasks include collecting scientific data, ground truthing, participating in reforestation efforts, partaking in annual bird Christmas counts, assisting in species monitoring and reintroduction projects, serving as volunteers and/or leaders in diverse environmental workshops for youth, and doing beach and wetlands cleanup, among others.

Research conducted within this project could make some fruitful connections with other research institution for example the Luquillo Long-Term Ecological Research Program (LTER) located in Puerto Rico. LTER has offered to collaborate with the proposed project on two levels: first in an advisory capacity to help develop long term monitoring projects with participants from the community and, second, by providing comparative data on watershed characteristics. LTER can provide external review during Phase 3 when participants are developing co-created projects. LTER will also provide baseline information on characteristics of watersheds with different levels of development, for comparison with

the results in the proposed project.

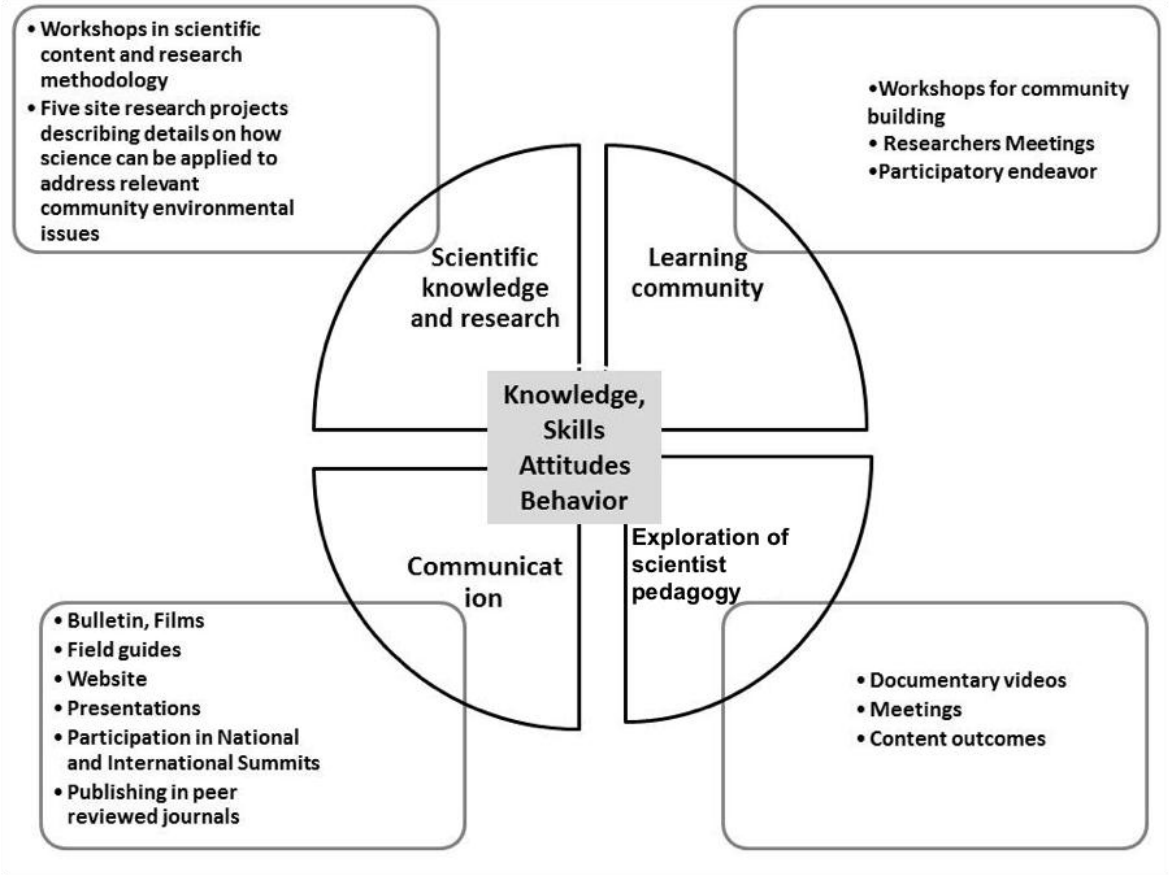

Figure 3: Proposed ISE Model integrating lessons learned from prior NSF award (0638966)

Following is a description of each ecological research study and how they combine for studying the big picture

Concepción Rodriguez-Fourquet, Ph.D. will teach citizens on how to use crustacean/insect monitoring tools to assess the ecosystem quality in the streams and estuaries of the watershed, by establishing monitoring stations along the river that represent different land use types within the watershed. Monthly monitoring activities and train-the-leader workshops will be available for participants. The workshops will be designed to motivate citizens to create their own monitoring groups within their communities and to report results using web-based tools which will augment the dissemination of their findings.

Maritza Barreto-Orta, Ph.D. will provide educational activities about protection of life and property against flood risks, and will provide workshops on techniques for coastal and river system management. Participants will perform sediment collection, field photography, data entry, development of a natural and man-made events databank, data analysis, and dissemination of project progress.

Jose Salguero-Faria, MS will compare bird communities between recently impacted, early secondary forest and mature secondary forest habitats. Target participants that have no or little

scientific experience will be urged to participate in the project from the design phase to the presentation of the results. Through seminars and field practice the researcher will train and mentor participants to design the research study, and select and set the survey transects so they will be able to carry out bird surveys by themselves. Throughout the investigation participants will describe the plant communities in each sampling plot and identify birds visually and by their calls during each survey. Gained knowledge includes interpreting how land use history and plant communities may affect bird community structure, how these communities fluctuate throughout the year, and what these events mean for the watershed communities.

Armando Rodríguez-Duran, Ph. D. will measure bat assemblage and bat dispersal routes in the karst area of the watershed to better understand the consequences of urbanization and fragmentation of natural ecosystems. Participants will measure species richness and diversity subject to various degrees of urban encroachment and fragmentation by applying adequate assessment techniques.

Isabel Rivera-Collazo, Ph.D. will design with participants a catalogue that visually documents the different types of cultural resources in the watershed area and a map of cultural use of the region. The study will follow scientific methodology (building of hypotheses and research questions, identification of methods, data collection, answering the questions and disseminating the results), where the scientist has a specific question that relates to how humans have faced the need to respond to rapid changes in climate and the environment. To do so the researcher will train participants on archaeological research-question building, survey techniques, identification of cultural remains, identification of landforms and anthropogenic modifications, and data collection and recording techniques.

Besides using our five science-based projects to evaluate the transformation process of citizen's scientists from mere participants to co-creators, the projects will also address how different levels of urban development impact the biodiversity within the watershed of Rio Grande of Manati. All the projects will share information generated by CTPR and University of Puerto Rico on landuse/landscover changes within the watershed to select their study sites along a gradient of urban development and all data collected in the individual projects and results will be integrated into a publication that relates which biological component is most sensitive to changes based on the diversity changes along the gradient of urban development. Furthermore, researchers have already discussed combining results from projects to understand the links of sedimentology within the river systems to crustacean demographics; community outreach expert will work with the archeologist to understand community perception of history perception of natural resource use with archaeological findings within the watershed, and researchers studying bats and birds will relate biodiversity to forest fragmentation and loss of habitat. Each project individually will provide indicators of environmental quality; however the combination of the results will strengthen the knowledge on the adverse effects of urban development especially if results indicate a reduction in diversity along an urban development gradient. To ensure combination and collaboration among researchers, project staff will schedule periodic progress meetings with all.

Learning communities are made up of people who share a common purpose. Through this dimension participants and researchers will collaborate to draw on individual strengths, respect a variety of perspectives, and actively promote learning opportunities. The outcomes are the creation of a vibrant, synergistic environment, enhanced potential for all members, and the possibility that new knowledge will be created (Kilpatrick, Sue, et al, 2003). Participants will participate in Learning Community workshops to promote a working atmosphere of aperture to diversity, participation, reflection and conflict resolution. Reflection sessions will assure feedback for ongoing model application.

The *Curricular Assessment* dimension is explained in detail in the evaluation section of this proposal.

The *Communication* dimension is based on transparency and allows for democratic decision making, which is integral for the success of the ISE project. We propose a number of project activities (Table 1), which stem from the proposed ISE Explicatory Model described before, for both researchers and participants to interact and learn. During the first workshops researchers will talk about their research projects to all participants and also how they are relevant to evaluating the impacts of urbanization. Furthermore, the project team will provide participant with examples of how the results from such projects can play an important role in decisions linked to land use in their watershed. A unique aspect of this project is the production of culturally and environmentally relevant materials for studying the impact of urban development on biodiversity of the Rio Grande of Manati watershed in Puerto Rico. These products (Table 1) will be used in the scientific content and in the internal curriculum assessment process.

Table 1: Project Phases, Products, Activities and Timeframe

Phase I: Contributory	Indicators/Products	Activities	Timeframe
Participant exposure to the scientific methodology and opportunities to collect samples and record data in five research projects	Bulletins Data entry -website	Workshops: ▪ Introduction of 3-year Project & commitment ▪ Methodology ▪ 30 hour max workshop in technology for writing, designing, and elaborating bulletins, website ▪ 6 hour max Learning communities ▪ journals	Months 6-18
Phase II: Collaborative	Indicators/Products	Activities	Timeframe
Opportunities for participants to analyze data, refine projects, and disseminate	Videos Poster presentations Website: graphics, Data analysis Field guides	Workshops: ▪ Methodology ▪ 30 hour max workshop in technology for writing, designing, and elaborating field guides spatial data, videos	Months 18-24
Phase III: Co-creative	Indicators/Products	Activities	Timeframe
Opportunities for participants to create their own scientific project and implement in Communities	International summits Posters Peer journals website	Workshops: ▪ Methodology ▪ 30 hour max workshop in Communication skills	Months 24-36

In addition, we will publish all findings through video media and in peer reviewed journals including educational journals such as the *Journal for Museum Education*, *Museums and Social Issues*, *Visitor Studies*, *Science Education*, and *Curator*.

Step 9. Internal Assessment & External Evaluation

To assess the curriculum component the internal curriculum assessor Ruben Estremera-Jimenez, Ph.D. will use an array of techniques and instruments. Ruben holds doctorates in education and social work and has more than 30 years of experience in teaching, research, project evaluation, assessment, and statistics. He will design all internal curriculum assessment instruments on the ISE process and will train project team on the appropriate administering of these instruments.

The process of informal education requires a basic articulation between the objectives, content, activities and evaluative process used to develop scientific citizens in this project. This section presents the basic aspects of the continuous internal assessment that we will perform of the curricular component of the five supporting ecological research projects (bats, birds, crustaceans/insects, coasts and anthropology/archaeology). The internal curriculum assessment will gauge the achievement of forming citizen scientists throughout the project period. The assessment will focus on core participants in each of the phases (contributory, collaborative, co-creative) placing special attention on change of knowledge, skills (including communication skills), attitudes, and behavior. The assessment will include front end, formative and remedial types of evaluation to enhance and support the attainment of project outcomes, which will be measured in the summative evaluation performed by external evaluators Randi Korn & Associates (RK&A).

The project's curriculum assessment model adopts Webb's (1997) conceptual definition, which states that the assessment of learning is a coherent process between objectives, contents, activities, varied data collection instruments, and processes of inferential analysis and decision-making. The internal; assessment will align the learning objective of each ecological research project with the main goal of the project -- *to study the efficacy of the implementation of ISE methods and practices that promote the development of co-creative citizen scientists* – in order to secure internal validity and to facilitate the assessment process.

The internal curriculum assessment will follow the logic model of learning evaluation. The model draws on five specific objectives in each of the five supporting ecological research projects: knowledge, skills, communication, behavior and attitude. The knowledge objective will assess if participants demonstrate knowledge about the concepts, methods and processes of scientific research in the study of Río Grande of Manatí watershed and ecosystems within. The skills objective will assess if participants apply basic research techniques to the collection and data analysis in the following areas of study: crustaceans/insects, birds, bats, coasts and archaeology. The communications objective will assess if participants communicate the ecological research findings in each of the study areas through different media and venues. The behavior objective will assess if participants co-create scientific projects with the researchers to address community environmental issues. The attitude objective will assess if participants show interest in the community dynamics surrounding the watershed and in finding solutions to reduce the effects of urban development on the diversity of species in the watershed. The five objectives are aligned to the goal and the general objectives of the project (See Figure 4).

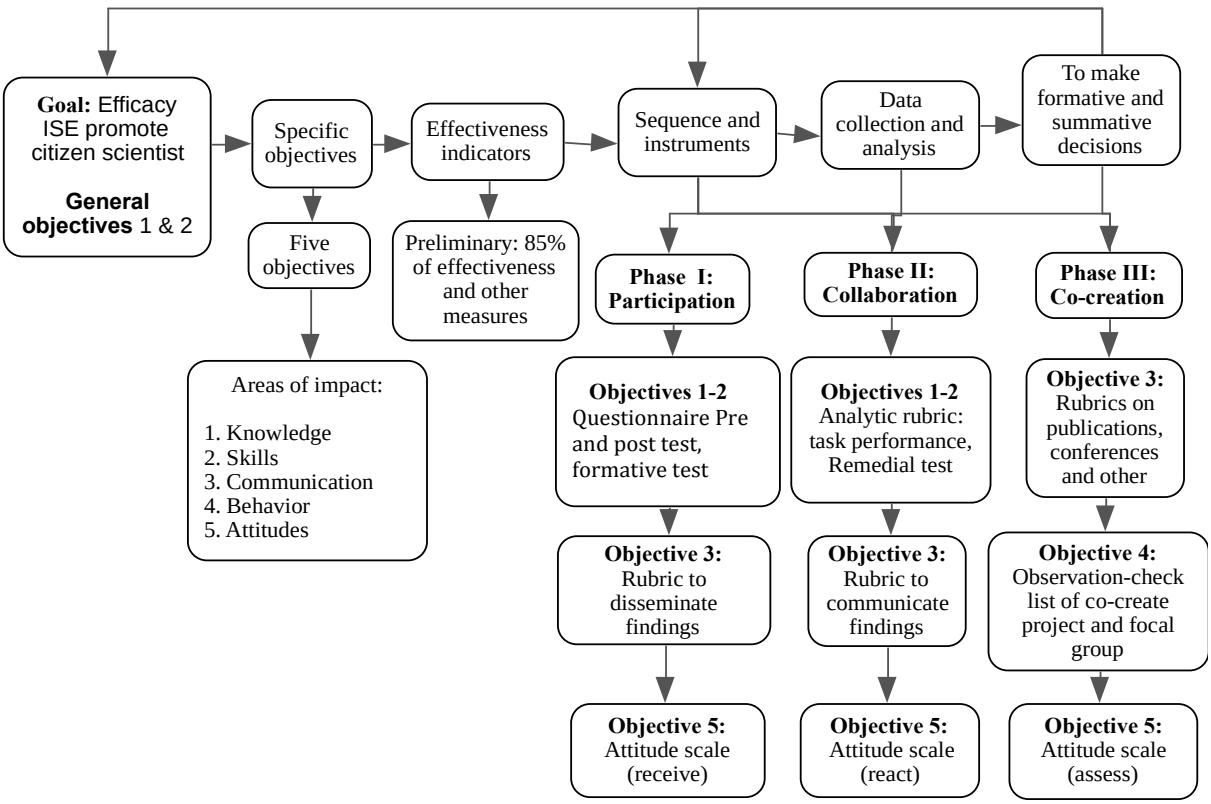

Figure 4: Logic model of learning evaluation

The assessor will use an 85% rate to predict effectiveness of each indicator for each objective. The percentage of effectiveness may increase depending on analysis made with researchers and on participant profiles (e.g., high school students, members of the community, and organizational such as agencies and universities, among others).

A mixed-case quasi-experimental evaluation design will be used in the administering of quantitative instruments (pre-test, post-test, and rubrics) and qualitative instruments (focal groups and direct observations) (Campbell & Stanley, 1963; Denzin, 2000 & Creswell, 1998) through the three phases of the project (contributory, collaborative, co-creative). In addition, the internal formative evaluation will emphasize on collecting data from phase to phase to ensure the progress of the teaching-learning process through phases (Wiggins, 1998; Estremera, 2001). Teaching techniques will be assessed at various periods within each phase to ensure learning goals and objectives of each ecological research maintain alignment with the main goal and objectives of the ISE project; and if necessary, changes will be implemented to ensure alignment (Estremera, 2001). Further, unexpected findings related to the main goal of the project will be analyzed during the education process.

Internal formative evaluation will include periodic reports on the informal teaching-learning process. Content of reports will include answers to questions such as: Do core project participants respond to the criteria proposed? Do project researchers use informal education practices to promote learning? Are participants showing the learning required in each of the phases of the project? Have core participants gained the knowledge, skills, attitude and behaviors expected in each of the phases to become co-creative citizen scientists? (Table 3 & Fig. 4).

Table 3: Internal Curriculum Assessment Plan

Main Project Goal: Study the efficacy of the implementation of ISE practices that promote the development of citizen scientists in a Hispanic audience that is underserved and underrepresented in STEM fields by engaging participants in contributory, collaborative and co-creative projects aimed at assessing the effects of urban expansion on the Rio Grande of Manatí Watershed.					
Main Project Objectives	**Specific objectives of five ecological research projects**	**Impact areas**	**Instruments**		
			Phase I	**Phase II**	**Phase III**
Objective 1: Study if the proposed ISE model generates a gain in knowledge and skills, and change in attitude and behavior to become co-creative citizen scientists.	1. Demonstrate knowledge about the concepts, methods and processes of scientific research in the study of ecosystems.	Scientific knowledge	•Questionnaire Pre and posttest, formative and remedial test	•Analytic rubric, task performance and remedial test.	
	2. Apply basic research techniques to data collection and analysis in the following areas of study: crustaceans, birds, bats, coasts and archaeology.	Skills			
	3. Communicate the research findings in each of the study areas through different media.	Communication	•Rubric to disseminate findings	•Rubric to communicate findings	•Rubrics on publications, conferences and other
	4. Co-create scientific projects in coordination with project researchers in any of the areas of study.	Behavior		•Observation - check list of collaborative project	•Observation - check list of co-create project •Focal groups
	5. Show interest in the community dynamics surrounding the watershed and in finding solutions to the effects of urban planning in the diversity of species in the basin area.	Attitude	•Attitude scale (receive)	•Attitude scale (react)	•Attitude scale (assess)
Objective 2: To explore STEM pedagogy	1. To identify STEM teaching practices that promote citizen involvement in scientific	Scientist Behavior, Communication & Skills	On-site observations of each scientists'	On-site observations of each scientists'	On-site observations of each scientists'

with Hispanic populations in ISE settings, including how scientists' behavior and communication shifts according to participant profile and environment settings; scientists' gain from the ISE experience; and scientists' commitment to further advance ISE.	research process.		activities Documentary videos Analysis rubric	activities Documentary videos Analysis rubric	activities Documentary videos Analysis rubric
	2. To learn what scientists gain in experience through ISE settings.	Scientist Knowledge	Questionnaires Focus groups with scientists Self-reflection journals	Questionnaires Focus groups with scientists Self-reflection journals	Questionnaires Focus groups with scientists Self-reflection journals
	3. To learn the commitment of scientists to further advance ISE experience.	Scientist Attitude	Focus Groups with scientists Surveys Registering of scientists post-grant ISE projects/activities	Focus Groups with scientists Surveys Registering of scientists post-grant ISE projects/activities	Focus Groups with scientists Surveys Registering of scientists post-grant ISE projects/activities

External Evaluation:

Randi Korn & Associates, Inc. (RK&A) is pleased to partner with the Conservation Trust of Puerto Rico on its proposed National Science Foundation (NSF) project *Efficacy of Informal Science Education (ISE) methods and practices to develop Hispanic citizen scientists in the watershed of the Rio Grande of Manati, Puerto Rico*. This project is particularly attractive because it builds on the work that the CTPR has done in their last NSF grant (0638966), which RK&A participated in. If funded, RK&A will serve as the external evaluator to measure the impacts of the project.

Proposal Detail:

Proposal Information

Proposal Number: 1223882

Proposal Title: Efficacy of Informal Science Education (ISE) practices to develop Hispanic citizen scientists in the watershed of the Rio Grande of Manati, Puerto Rico

Received by NSF: 01/11/12

Principal Investigator: Yogani Govender

Co-PI(s): Lee Rodriguez

This Proposal has been Electronically Signed by the Authorized Organizational Representative (AOR).

NSF Program Information

NSF Division: Division of Research on Learning in Formal and Informal Settings (DRL)

NSF Program: Informal Science Education

Program Officer: Ellen McCallie

PO Telephone: (703) 292-5115

PO Email: emccalli@nsf.gov

Proposal Status

Status As of Today Dated: **12/17/12**

Award **1223882** was made on **09/25/12** for **$ 574,052.00** with an effective date of **10/01/12**.

Award Duration: **36** (months)

Comments from the cognizant Program Officer:

INTELLECTUAL MERIT
The project tests a three-phase model of citizen science engagement described by the Center for the Advancement of Informal Science Education (CAISE) working group on public participation in scientific research. Project staff will measure the impacts (that is, changes in knowledge, skills, attitudes, and behavior) of moving citizen scientists along an engagement continuum from being mere collectors of data (contributory activities) to science research project collaborators (collaborative activities) to science research project co-creators (co-creative activities). The project is innovative because it represents the first known test of CAISE's three-phase model of citizen science engagement that moves participants from peripheral to core participation. The project also expands the geographical scope of ISE's projects beyond the U.S. mainland.

The project's goals and objectives are clearly articulated. The project's design builds on and was informed by (1) published literature (for example, Cornell Lab of Ornithology's Citizen Science Toolkit), (2) findings from a previously ISE-funded project, and (3) focus group interviews with residents living in the target watershed. Consistent with CAISE working group recommendations, proposed activities go beyond contributory citizen science activities implemented in the previous project. Because the five science research areas were chosen by residents, and the research activities will help measure the effects of land use changes occurring in the watershed, resident interest in the project should be high. All proposed science research studies collect data that are appropriate for assessing changes in environmental quality (for example, water quality, forest type, sediment type, habitat fragmentation) and making management decisions.

The roles and responsibilities of project personnel are clearly delineated with a thoughtful division of labor.

Personnel are qualified to conduct the project and several have worked on prior NSF-funded projects. Senior project personnel have expertise and experience in science education, project management, nature interpretation, citizen science, ecology/environmental science, web page development, evaluation, statistics, community outreach, and public communication. The Advisory Committee members represent all major stakeholders, including local communities, scientists, and educators. The lead organization recently received accreditation from the Land Trust Alliance, which indicates that the Conservation Trust of Puerto Rico implements nature conservation standards and practices of excellence. To date, the LTA has accredited only 158 trusts within its 1,700 trust network. Letters of commitment from collaborators/consultants/advisors specify contributions of services, personnel, products, and facilities.

BROADER IMPACTS
The SciStarter Blog reported in 2007 that "citizen science is taking off in Puerto Rico!" because of organizations like the Conservation Trust of Puerto Rico. The proposed project will accelerate the development of citizen science activities on an island that needs enhanced science education programming in both informal and formal education settings.

Because citizen scientists will engage in hands-on environmental research, the project has strong potential for advancing scientific discovery and promoting learning of science content and the nature and methods of science. New scientific knowledge generated by citizen scientists will have practical importance within and beyond the Manati watershed because Puerto Rico is undergoing rapid urban development, resulting in the loss of biodiversity and the emergence of environmental problems such as lower water quality. Environmental data collected by the citizen scientists will form an environmental database at the watershed level that permits long-term watershed monitoring and informs land use decision making.

The project has strong potential for broadening participation because nearly all 140 participants will be Hispanic residents of Puerto Rico, including some living in rural areas. The target age range for prospective participants is appropriate for the activities proposed. The in-situ plan to recruit participants via multiple media channels, as well as 80+ groups and institutions in the watershed, is sound. The plan to recruit participants who fall into Falk's five personal identity categories is novel.

The internal evaluator is qualified to conduct formative assessments of newly developed instructional materials and the impacts of project activities on participants. The external evaluator is likewise qualified to conduct the proposed formative and summative evaluation studies, and has prior experience working with project personnel. Proposed methodologies for collecting and analyzing evaluation data are sufficient for detecting anticipated impacts on participants, but not local residents (see negotiations). Metrics for success are reasonable. Impacts, indicators, and evidence are clearly articulated. I agree with the panel that the quasi-experimental, mixed-method evaluation plan is strong, except for a few uncertainties that need clarification (see negotiations).

The dissemination plan communicates project findings via multiple channels, but I agree with the panel that more effort should be devoted to reaching informal science educators on the mainland more directly through their professional organizations. If implemented more widely in Puerto Rico and elsewhere, the work models an ISE-based strategy for addressing lower-than-expected science achievement among Hispanics.

SUMMARY STATEMENT
I agree with the panel that the proposal is highly competitive because of the thoroughness of the project's design, the depth to which core participants are engaged in scientific inquiry, the research and evaluation studies, and the strong potential for replication in other underrepresented Hispanic communities in Latin America and elsewhere. The scientific findings generated by citizen scientists have the potential to inform economic development decisions on the island.

David A. Hanych, Ph.D.
ISE Program Officer
20 July 20120

Reviews

All of the reviews of your proposal that have been released to you by your NSF program officer can be viewed below. Please note that the Sponsored Project Office (or equivalent) at your organization is NOT given the capability to view your reviews.

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Context Statement

Informal Science Education (ISE) Program
Division of Research on Learning in Formal and Informal Settings (DRL)

General Information for Applicants

For the project grant full proposal deadline of January 11, 2012, the Informal Science Education (ISE) program received 343 full proposals in four project types: Research, Pathways, Full-scale Development and Broad Implementation. It is anticipated that approximately 10% will receive support. These proposals are reviewed by at least three external individuals with expertise in relevant professional areas and audiences; as necessary, additional ad hoc reviews are sought. Pursuant to NSF policies, proposals for Grants for Rapid Response Research (RAPID) or Early-Concept Grants for Exploratory Research (EAGER) may be reviewed by cognizant program staff.

Verbatim (but anonymous) copies of all completed reviews related to your proposal submission are available on FastLane. Please keep in mind that reviewers address their comments primarily to the National Science Foundation and not to you as the Principal Investigator (PI). Although reviews provide information helpful to you, they sometimes contain remarks without detailed references or specific suggestions for improving the proposed project. Occasionally, reviews may include irrelevant or erroneous statements. The latter statements do not enter into the decision-making process of the cognizant program officer. Comments from the cognizant program officer may also be found in the PO Comments module in FastLane.

Decisions about particular proposals are often difficult to make and factors other than reviewers' comments and ratings enter into the decision of the program. Ensuring a range of projects (e.g., new vs. established activities, new vs. experienced PIs, geographic balance, type of informal activity, disciplinary content) and general Foundation policies are also important factors. Also, for renewal applications, the PO often has additional information, such as annual progress, not available to reviewers.

The ISE program solicitation (11-546) is posted at http://www.nsf.gov/pubs/2011/nsf11546/nsf11546.htm. The process of requesting reconsideration of a declined proposal can be found in the NSF Proposal and Award Policies and Procedures Guide: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=papp

Panel Summary #1

Proposal Number: 1223882

Panel Summary:
Panel Summary

1. Summary of proposal:
This is a Full Scale Development proposal from the Conservation Trust of Puerto Rico that will study the effectiveness of using informal science education techniques to develop citizen scientists among a Hispanic audience. The proposal, which builds on previously funded work, seeks to create citizen science projects in which participants move along a continuum from contributor to collaborator to co-creator and evaluate the degree to which participants demonstrate changes in knowledge, attitude, skills, and behavior.

2. Intellectual Merits:
Strengths:
- The proposed work has the potential to advance both the ISE field and watershed management.

- The results of this work will likely be applicable to Hispanic communities beyond Puerto Rico. Furthermore, it may serve to dispel misperceptions about Hispanic audiences' level of interest in STEM disciplines in general and watersheds in particular.
- The project seeks to expand on past work and takes advantage of infrastructure developed during the previous work.

Weaknesses:
- Of the five core areas of ecological research described, the area addressing cultural resources was less clearly defined; however the panel felt that the choice of this topic may be indicative of the involvement of local participants, which ultimately is a strength of this proposal.

3. Broader Impacts:
Strengths:
- By design, this proposal targets an underrepresented audience.
- The work takes advantage of existing literature in citizen science.
- The evaluation plan is very strong and it is clear the external evaluator was involved from the beginning.
- The community-based participatory research piece is very good and highly valuable.
- The proposed work has strong buy-in from the community, which the panel appreciated. The panel also noted that the work is very scalable and has the potential to be applicable elsewhere.

Weaknesses:
- Given the potential for this project's work to be applicable in other communities, the panel suggests broadening the planned dissemination of findings to ensure it reaches a wider audience within the States.
- The impact on the local population beyond the core participants is not clearly described within the narrative.

4. Review of prior NSF
The proposed work builds on a prior NSF-funded project and integrates it into the proposed activities - a real strength of this proposal; however it was difficult to determine the impact of the past reward on participants.

5. Summary
The panel was impressed by the thoroughness of this proposal's project design as well as its research and evaluation elements. The panel appreciated the degree to which the local community was involved in the project work and the depth of engagement that would result among the core participants. The panel felt that the proposed work had strong potential for application in other underrepresented communities.

The summary was read by the panel and the panel concurred that the summary accurately reflects the panel discussion.

Panel Recommendation: Highly Competitive

Review #1

Proposal Number:	1223882
NSF Program:	Informal Science Education
Principal Investigator:	Govender, Yogani
Proposal Title:	Efficacy of Informal Science Education (ISE) practices to develop Hispanic citizen scientists in the watershed of the Rio Grande of Manati, Puerto Rico
Rating:	Very Good

REVIEW:

What is the intellectual merit of the proposed activity?

Positioned in the larger context of watershed ecology and urbanization impacts, this proposal seeks to create citizen science projects that more fully engage people in the scientific endeavor (from contributor to collaborator to co-creative in the language of the proposal); and to study and document the methodology and the longer term impacts on the participants (e.g. attitudes and behavior towards the use of scientific knowledge in their everyday lives esp in relation to watershed issues). It also seeks to generate scientific results from the five ecological research projects. The core audience will be 50 volunteers who will make a 3 year commitment to the project, other individuals will be involved as volunteers in the research projects. The project builds on a related previous NSF grant and which provides existing infrastructure and partnerships (e.g. with a local radio station.). Plans for recruitment with an emphasis on community engagement are strong (e.g. initial project design involved a community focus group). Aspects of the budget would benefit from greater clarification especially in the participant support category.

What are the broader impacts of the proposed activity?

The project is well positioned and by design reaches undeserved and underrepresented populations. Integral to the project is a mixed media communications plan that has potential for broad reach as well as traditional publishing and conferences for scientific and educational research dissemination. It would be informative to articulate potential larger impacts of the project beyond the core 50 volunteers in the proposal text (a number of 4,110 participants is embedded in the budget justification), and metrics for assessing impacts on this larger population. Larger societal benefits would include the watershed monitoring database and associated findings.

Summary Statement

The ecological context of the project is timely and of interest. The efficacy of a program to engage citizen scientists at a deeper level also is of interest. The team has demonstrated past success at eco citizen science efforts and engaging the broader community; and by design this project would reach an underserved and underrepresented community. This proposal could be strengthen by better capturing and examining the broader impacts of the project and re-examining the budget. It would also be enhanced by demonstrating sustainability beyond the initial funding cycle.

Review #2

Proposal Number:	1223882
NSF Program:	Informal Science Education
Principal Investigator:	Govender, Yogani
Proposal Title:	Efficacy of Informal Science Education (ISE) practices to develop Hispanic citizen scientists in the watershed of the Rio Grande of Manati, Puerto Rico
Rating:	Very Good

REVIEW:

What is the intellectual merit of the proposed activity?

Significance of Issue
The goal of this project is a real strength, to study the efficacy of the implementation of ISE practices that

promote the development of citizen scientists in a Hispanic audience that is underserved and underrepresented in STEM fields.
The focus is changes in a watershed ecosystem due to urban encroachment, and the target population is highly from an underrepresented population.

Audience and Approach (strategic, appropriate)
The audience is well known and understood by the PIs and the preliminary studies have provided them with experience that will help to move this project forward. The employment of citizens as full partners in the process is an added plus of this project. The project is not just supplying them with information but is allowing for feedback into the science itself. The five core areas of ecological research: birds, bats, water quality through aquatic inverts, cultural heritage and flood risk, make good use of the faculty that are available. A very strong plus in that the topics were chosen by the local stakeholders themselves.

Project Design, Methods and Deliverables
The program is well concieved, the five areas of study make sense for the environment and are germane to the citizens that reside there. The nine-step model that the program will follow is solid and the PIs have done a very credible job of outlining the process through the steps. As such, there is every indication that this project is ready for implementation. The project may indeed raise the overall bar with respect to ISE, as it will ask the question, will citizens participate in a program when they are fully incorporated into its design, despite their lack of STEM experience. The team is sound as they have had prior NSF funding to conduct a pilot project, and there are multiple deliverables.

Innovation (sources and degree)
The project has the potential to be innovative and potentially transformative as per the comments above.

Qualifications (of team and partners, and their collaborative processes)
The collaborative capability of the team as well as their qualtifications are top notch, another strength of this program.

Prior NSF work (nature and quality, if applicable)
Preliminary work directly focuses on this proposal. A plus.

What are the broader impacts of the proposed activity?

Field Advancement (research and/or practice)
As above, this project has the potential to answer a basic ISE question while at the same time generating a community based ISE program that is likely to be sustainable.

Evaluation (includes learning impacts, thorough, realistic, and appropriate to goals)
Learning impacts are mentioned and fairly well elucidated (take another look at this)

Dissemination (breadth, plausibility, specificity)
Dissemination (across Puerto Rico) will be broad and multifaceted.

Participation (of underrepresented groups)
Participation of underrepresented groups is a virtual given (a strength of this proposal).

Capacity / Infrastructure (builds)
This is not explicitly mentioned. Building infrastructure is not a strength of this proposal, per se.

Other Benefits to Society (if applicable)
This project could provide a model that could be incorporated into other programs dealing with underrepresented communities and could be a valuable model for international programs.

Post-doctoral Mentoring Plan (if applicable)
None

Summary Statement

The project ranks as being very good to excellent based upon the population involved, and the strong capability of the PIs to interact with the local population and to actually get them involved in the determination of the research problems themselves. The project may in fact raise the bar, as it can address the question of local involvment as a mechanism of instilling involvement.

Review #3

Proposal Number:	1223882
NSF Program:	Informal Science Education
Principal Investigator:	Govender, Yogani
Proposal Title:	Efficacy of Informal Science Education (ISE) practices to develop Hispanic citizen scientists in the watershed of the Rio Grande of Manati, Puerto Rico
Rating:	Excellent

REVIEW:

What is the intellectual merit of the proposed activity?

Significance of Issue: The proposed activity will study the effectiveness of using informal science education techniques to develop citizen scientists among a Hispanic audience in Puerto Rico.

Field Advancement: Because the target audience for the proposed activity has minimal prior exposure to STEM, this work has the potential not only to advance understanding of STEM disciplines within the Hispanic community, but also to provide insight to the field on the effectiveness of ISE approaches to STEM education with audiences with little prior STEM knowledge.

Audience and Approach: The audience and approach for the proposed activities are well-conceived and described. The target audience encompasses both youth and adults living in the regions most directly impacted by the proposed scientific research. Building on previously funded work, the project proposes to deepen the involvement of the audience in the scientific research activities, moving from contributory to collaborative and co-creative participation.

Project Design, Methods and Deliverables: The overall project design is thorough and clearly informed by the team's previously funded work. The proposed activities provide multiple avenues for scientific research and citizen involvement therein. The design describes detailed efforts to document and share the work of participants.

Innovation: Given that the target audience for this work is a predominately Hispanic audience that is underrepresented in STEM disciplines, the proposed activities have the potential to shed new light on using citizen science strategies to increase science literacy in this and similar audiences.

Qualifications: The project team is very strong and most of them collaborated on the previously funded work that informed this proposal. Collectively the team has expertise in science education, the relevant science disciplines, working with volunteers, recruitment of volunteers, documentation via web and video, and evaluation. A number of advisors are also continuing from the previously funded work.

Prior NSF work: The proposed work is directly informed by and builds on prior NSF funded activities.

What are the broader impacts of the proposed activity?

Evaluation: The proposed evaluation consists of an internal curriculum assessment and an external evaluation. Both aspects of the evaluation are very thorough and clearly articulated. The personnel are

highly qualified and have proposed studies that utilize appropriate multi-method approaches to assess clearly defined impacts.

Dissemination: The proposed activities include a comprehensive communication plan to share scientific and educational results broadly, including web-based media, television, and radio, as well as publication in peer-reviewed journals and presentations at ISE-related conferences.

Participation: The majority of the target audiences for the proposed work are individuals who are underrepresented in STEM disciplines, including Hispanics and those with limited higher education.

Capacity/Infrastructure: The proposed work builds on past work and has the potential to cultivate a growing network of citizen scientists within the target communities.

Summary Statement

The proposed work is thoroughly and thoughtfully described, building on successes and lessons learned from previous work. Applying research on effective approaches to citizen science activities, the proposers put forth a well-conceived design to testing those approaches on the specific audience of Hispanic individuals with limited previous exposure to science û the results of which may be applicable to other, similar audiences.

Review #4

Proposal Number:	1223882
NSF Program:	Informal Science Education
Principal Investigator:	Govender, Yogani
Proposal Title:	Efficacy of Informal Science Education (ISE) practices to develop Hispanic citizen scientists in the watershed of the Rio Grande of Manati, Puerto Rico
Rating:	Excellent

REVIEW:

What is the intellectual merit of the proposed activity?

The Conservation Trust of Puerto Rico has developed and articulated a coherent and well structured proposal rooted in a prior project that will apply and test a proposed ISE model, targeting underrepresented and underserved groups, with broader ISE implications. The research team is uniquely qualified to implement the proposed project based on their prior experience, outputs and outcomes, interdisciplinary expertise, and advisory committee. Prior ISE project deliverables to be used include a scalable database, web page, protocols, and educational support materials.

Based on results from the prior ISE project that was successful in achieving its goals of educating predominantly HIspanics on the scientific method, and of creating awareness on how citizens can insert themselves in land management efforts, The Conservation Trust of Puerto Rico proposes a full-scale citizen science to assess the efficacy of the implementation of the ISE Explicatory Model that promotes the

development of contributive, collaborative, and co-creative citizen scientists in a Hispanic audience that, based on their percentage of the U.S. population, is significantly underserved and underrepresented in STEM fields by engaging participants in a study on the effects of urban expansion on the Rio Grande of Manati Watershed.

This will be accomplished through two objectives using the Citizen Science Toolkit. The first objective is to study if the proposed ISE model based on lessons learned in the prior award generates a gain in knowledge and skills and a change in attitude and behavior that stimulates project participants within the four municipalities that comprise the Rio Grande of Manati Watershed to become co-creative citizen scientists by project year three. The second objective is to measure the scientific curricular component and to what extent it generates gain of knowledge and skills in project participants through the contributory, collaborative and co-creative projects that will be performed throughout the Rio Grande of Manati Watershed during the three-year project period. These objectives will be assessed using formative and summative bilingual instruments.

This project proposes to advance the fields of ISE and watershed management by evaluating the pedagogic methods used and how citizen scientists, from an underrepresented and underserved group, acquire and apply STEM knowledge,specifically to assist in watershed management.

What are the broader impacts of the proposed activity?

Using prior ISE results and results from focus group of the underserved and underrepresented citizens living within the watershed, the proposed project seeks to expand their prior ISE project to the entire watershed and include research themes that were chosen by representatives of community focus groups. Further they propose to engage citizens in interactive hands-on research projects to evaluate and monitor their environment including the evaluation of the teaching and learning processes that transform citizens from being mere participants in scientific research to becoming co-creators of projects that are relevant to measure the effects of land use change in their watershed.

The proposed project activities will consist of six research studies: five will focus on different STEM watershed related topics with target audience engagement, while the sixth research study will assess the ISE methods and practices employed in each of the five STEM studies and specifically how citizens assimilate and apply scientific knowledge learned through ISE methods (Explicatory Model) to their everyday lives.

The proposal targets a unique Hispanic audience of youths and adults that is underserved and underrepresented in STEM. The results of this work have broader impacts for engaging the Hispanic community at large and others in STEM.

Summary Statement

This proposed project has the potential to be very successful in advancing the proposed ISE Explicatory Model of contributor, collaborator, and co-creator citizen scientist its applications and effectiveness in underserved and underrepresented groups. A unique strength of the project is its foundation and prior experience in previously funded NSF projects that successfully engaged the same groups in public participatory ISE activities that will be integrated into this proposal its broader implications for ISE.

Review #5

Proposal Number:	1223882
NSF Program:	Informal Science Education
Principal Investigator:	Govender, Yogani
Proposal Title:	Efficacy of Informal Science Education (ISE) practices to develop Hispanic citizen scientists in the watershed of the Rio Grande of Manati, Puerto Rico
Rating:	Excellent

REVIEW:

What is the intellectual merit of the proposed activity?

Significance -- This proposed activity is significant in a number of ways. The audience is totally underrepresented and the extensive evaluation and dissemination will advance the field in learning ways to develop and implement programs with this audience. The extensive evaluation shows what effort it takes to adequately assess an ISE's program impact.

Audience -- Congratulations,this proposal has involved the audience,since inception,in planning and design. Every step taken is backed by research. Literature reviews, diagrams of learning models adapted and used with charts of outcomes for the intended audience added. This is one of the most thorough presentations of audience research and program design with which I am acquainted.

Project Design -- The goals and strategies are clearly articulated and coordinated with the evaluation methods and measurements. Stem content is articulated, the logic model is employed to synthesize the learning evalution. The 5 themes for content focus are adequately descibed.
Consideration of the deliverables provokes some questions. The deliverable in terms of the 140 or more participants is clear. What,in addition to knowledge and publications, will be the deliverable to the citizens of the watershed? In other words will these trained participants now be asked to conduct workshops of their own? How will the effort be continued and sustained?

Innovation -- One of the most creative and original parts of the project is the evaluation from day one including the manner by which the results and findings from the field will be disseminated throughout the project. This is a very unique way of public involvement. In other words, the public and field are involved in continuous learning and not a plan in which dissemination of results, including evaluation, occurs at the end. And, fundamentally, that is the way learning occurs and evolves.

Qualifications -- A large team - of PI's, evaluators, scientists, advisors, all extremely well qualified and experienced. Even the core participants are named! A lot of planning has gone into the development of this proposal; it builds well on NSF's previous grant.
No prior NSF support is listed for the PI's although they were involved in prior award 0638966.

What are the broader impacts of the proposed activity?

Field Advancement -- This proposal outlines a unique approach. Not only does it provide teaching, training and learning to the core participants but also thru its extensive media plan, results and info are communicated continuously to the public for their educational benefit. So the project advances the understanding in 3 areas simultaneously -- the participants, the public and the field.

Evaluation -- What a complete and deep evaluation plan. Tables 2 and 3 excellently communicate the assessent plan and projected impact. How refreshing it is to see actual % listed as project goals! It is obvious from the narrative that Randi Korn has contributed to the external evaluation. With the extensive evaluation projected, the proposal is part full-scale development and part research!

Dissemination -- A large number of dissemination materials and media efforts, including ongoing radio slots, are being developed for dissemination. Not only the public in Puerto Rico but the extensive list of NSF's partners listed on page 10 are targeted. The DVD' s developed both for the toolkits as well as for program documentation and promotion will provide excellent and extensive coverage.

Participation -- This proposal is all about the involvement of underrepresented groups. Results from the prior NSF grant support the success the Trust has had in working with the underserved Hispanic audiences. Having the participants be the co-planners and co-developers of the materials as well as serve on the Advisory Board is perfect!

Capacity -- Definitely in Puerto Rico, the infrastructure for use and continuation of the research will be enhanced. It would be very beneficial for the results of the resesrch and for the program design to also be disseminated in the States, particularly to areas with Hispanic audiences. The ISE field could learn a lot

regarding program design, audience involvement and evaluation that measures behavoral and additudinal change.

Summary Statement

This is an excellent proposal in every way -- a well- qualified team building on previous NSF support, an extensive and well-conceived evaluation plan, a co-developed project design, and extensive audience involvement. The project is innovative both in its design and dissemination plan. The strong focus on educational methods employed with underrepresented audiences and the evaluation of this process has strong implications for the field.