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NEW APPROACHES

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*The **Galapagos National Park Service** has its headquarters in Puerto Ayora, Santa Cruz Island, Galapagos and is the Ecuadorian governmental institution responsible for the administration and management of the protected areas of Galapagos.*

*The **Governing Council of Galapagos** has its headquarters in Puerto Baquerizo Moreno, San Cristóbal Island, and is the Ecuadorian governmental institution responsible for planning and the administration of the province.*

*The **Charles Darwin Foundation**, an international non-profit organization registered in Belgium, operates the Charles Darwin Research Station in Puerto Ayora, Santa Cruz Island, Galapagos.*

***Galapagos Conservancy**, based in Fairfax, Virginia USA, is the only US non-profit organization focused exclusively on the long-term protection of the Galapagos Archipelago.*

Photograph: Zorica Kovacevic

Citizen science: A new conservation tool for the Galapagos

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The role of citizen science in Galapagos

The Galapagos Islands could be easily described as a research mecca, attracting scientists from around the world interested in studying the region's unique ecosystems and biodiversity and experiencing its scientific history firsthand. However, timely access to basic scientific information about the archipelago is difficult to obtain. Baseline data and resources for generating new data are lacking even though such information is essential for effective conservation management. These challenges have resulted in efforts to assess new avenues for collecting and disseminating data necessary for maintaining the ecological integrity and sustaining the human population in the archipelago.

Citizen science seeks to involve members of the public as vital partners in the scientific research process, often generating data to inform conservation management and decision-making (Dickinson & Bonney, 2012). Although citizen science is currently used in many areas of the world with impressive results (Dickinson *et al.*, 2012), it has yet to gain widespread use in the Galapagos Islands, where it could be extremely valuable in creating a nexus among scientific research, management, and social-ecological sustainability. Specifically, the Islands provide the opportunity to develop citizen science with both the local community (~25,000 permanent residents) and the community of tourists who visit the archipelago (currently >185,000 per year). While there have been occasional attempts to use citizen science in the Galapagos, a majority of previously initiated efforts have been conducted in isolation and findings from research studies have not been disseminated in an effective way. There has never been an attempt to create a broad, well-integrated program that will deliver answers to the many critical questions faced by multiple stakeholders in the archipelago.

The workshop

Outlining the elements of a successful citizen science program was the overall goal of a workshop convened by the Galapagos National Park (GNP) on June 25-29, 2012. Participants in the workshop included international experts in citizen science, GNP managers, scientists, naturalist guides, fundraisers, local community members, and other stakeholders. Workshop participants sought to examine primary issues about how public participation in environmental monitoring can improve conservation practice through discussion of: 1) priority questions, environmental indicators, and protocols; 2) engaging the public; 3) reaching new audiences, and 4) integrating informal and scientific knowledge. These categories highlighted not only the ecological but also the social aspects the workshop planners hoped to integrate into program development.

Citizen science: benefits and challenges

At the onset, workshop participants explored the benefits and challenges of utilizing citizen science in the Galapagos. By weighing these, stakeholders can better assess the appropriateness of citizen science for the specific research questions and issues that need to be addressed. Evaluation of on-going programs suggests multiple benefits for adopting this monitoring approach in the Galapagos, with benefits spanning across multiple stakeholders. Scientists benefit through the generation of data to assess spatial and temporal trends in societal and environmental indicators. The sampling extent, amount of data collected, and the frequency of data collection are not feasible through traditional scientific investigation (Dickinson *et al.*, 2010). Continued analyses of trends in these data result in scientific findings that can inform management and policy, and generate new research questions.

Managers and policy makers benefit from increased amounts of data made available in real-time that can identify emerging trends or serious issues that need to be responded to in the short term. However, having access to data in real-time is atypical of many professional scientific studies that disseminate results only after all data collection and analyses have been completed, sometimes years after the initiation of the study. Citizen science programs typically use a cyber-infrastructure that enables data to flow in near real-time from community observers to stakeholders via the internet (Newman *et al.*, 2011). These data can then pass through customized filters and analysis mechanisms to decision-makers, allowing them to identify trends in indicators of interest and in places of concern and respond in a timely fashion.

Some of the greatest benefits to development of these programs are to the participants themselves. Participants learn about the environment, gain science literacy, and experience firsthand how information contributes to decision and/or policy-making through participation (Brossard *et al.*, 2005; Jordan *et al.*, 2011; Crall *et al.*, 2012). Participation also gives citizens a sense of ownership in the process of monitoring the environment while building social capital and expanding a collective sense of environmental stewardship (Overdevest *et al.*, 2004). Residents will have access to greater knowledge about the islands, which should translate into increased understanding and greater support for conservation and the development of more sustainable local communities (Overdevest *et al.*, 2004). Engagement and participation by all sectors of the community in the integrated vision that knowledge management creates should produce more informed choices and a shared vision for the future of Galapagos (Danielsen *et al.*, 2005).

Challenges to implementing a citizen science program will also need to be considered in the early stages of the program's development. Because the data collected through the program will be used to guide management and policy, data quality will be paramount. Program developers will need to build on existing quality assurance and quality control procedures from existing programs and adopt protocols that have been tested and validated with citizen scientists in the field (Delaney *et al.*, 2008; Crall *et al.*, 2011; Bonter & Cooper, 2012). Sustainability of the program will also be a significant challenge, directly related to the availability of ongoing financial resources and participant retention.

Project design considerations

Once benefits and challenges were discussed, workshop participants identified priorities, motivations, and participant groups to guide program development. Working groups were established to develop potential pilot projects for tourists and/or residents. These groups focused on developing projects considered most appropriate for a citizen science approach. Specifically, projects addressed research questions requiring monitoring at large spatial and temporal scales and frequent data collection, all of which are not feasible using traditional monitoring methods. When possible, participants also sought to develop projects that complemented existing professional efforts. Issues and research questions deemed less appropriate included those requiring specialized knowledge, those already being addressed, and/or those involving sensitive information such as the location of endangered species.

Projects explored included: an early warning system for reporting both social and ecological indicators, development of a sustainable society (monitoring both water and waste), monitoring the health of terrestrial ecosystems (urban and rural), and monitoring by both visitors and crews during both regular and dive cruises. Working groups developed these projects given the following design considerations: 1) what are the needs of the stakeholders involved?; 2) what management decisions can be informed by the data?; 3) how will the project be implemented?; 4) who is the audience?; 5) what protocols should be used?; 6) will training be needed?; 7) how will data be analyzed and disseminated?, and 8) how will the project be evaluated? Following development, workshop participants sought ways to integrate these projects into the development of a larger, umbrella program.

Program development

To succeed, any program involving the public in environmental monitoring must be flexible, iterative, standardized, user-friendly, and self-reinforcing. It needs to develop positive feedback that will ensure that it becomes embedded in a community's culture. It should produce results that are accessible on a continuous basis for decision-makers and all interested parties. It will also, in the long term, build social capital (a combination of

people and their skill sets) as well as trust in and respect for one another that strengthens everyone's commitment to work together for the betterment of their community and environment. Therefore, the Galapagos citizen science program will be implemented in three phases: 1) program development; 2) initiation of pilot projects, and 3) expansion of the program. Modifications to this general framework may occur based on preliminary evaluation and feedback from stakeholders.

Key start-up tasks for **Phase 1** will include a needs assessment, team development, defining research questions and issues, and developing or refining existing protocols. Most successful citizen science programs begin with a needs assessment to provide baseline data on the needs of the program's stakeholders that will guide program development and implementation (Friedman, 2008). These data can then be used to determine priority research questions and conservation/management issues that need to be addressed. A program management team will be established; with guidance from an external advisory board, the team will be responsible for program development and implementation, balancing the needs of a diverse group of stakeholders.

In **Phase 2**, the program management team will pilot four to five projects within either tourist or resident tracks based on the needs assessment and those projects outlined by the workshop's working groups. Each project will follow five primary steps (participant recruitment, participant training, data collection, data analysis, and dissemination of findings).

Phase 3 will extensively evaluate the pilot projects initiated during Phase 2, making modifications as needed to meet previously defined goals outlined during Phase 1. Depending on the successful implementation of the program, Phase 3 will also include the addition of more projects and greater expansion of the program. If this occurs, a system will be established for coordinated expansion based on the most recently identified needs of the program's stakeholders.

Future development and broader application

Throughout the development and evaluation of the Galapagos citizen science program, stakeholders will need to maintain communication with citizen science practitioners to adopt best practices while also contributing to the broader field of research. Citizen science, community-based monitoring, participatory monitoring, and volunteer monitoring are all types of programs now commonly referred to as "public participation in scientific research" (PPSR). Bonney *et al.* (2009) define three primary models of PPSR (later refined by Shirk *et al.*, 2012) that relate to the level of engagement citizen science participants have in the scientific process: contributory, collaborative, and co-created. These models range from those requiring participation in data collection only (contributory) to those in which participants work alongside scientists and managers to develop projects of common interest (co-created). Because engagement in contributory projects is often short-term, these projects may be more relevant to tourist participants. In co-created projects, participants are actively involved in the entire scientific process, so these projects are more likely to produce results relevant to the local community. Therefore, the larger Galapagos citizen science program will provide an umbrella program for a number of diverse projects, spanning the range across the three different PPSR models (Figure 1). Development of pilot projects for tourists versus residents can account for the degree of participation from each stakeholder group in different aspects of the scientific process.

Building on the models described above, the development and evaluation of the Galapagos program can be further refined by placing it in the framework developed for

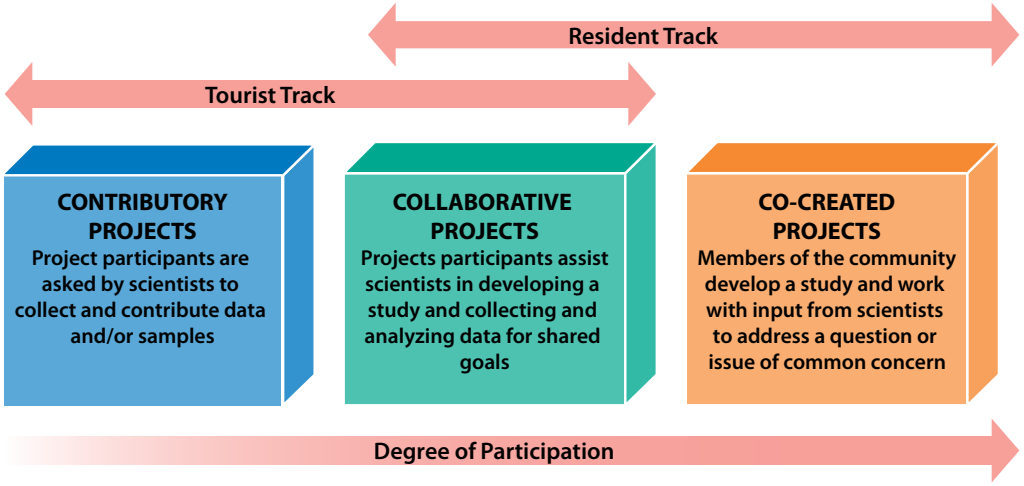

Figure 1. The Galapagos citizen science program will be the umbrella for a number of diverse projects (contributory, collaborative, co-created; Bonney *et al.*, 2009) that involve tourists and residents in the scientific process.

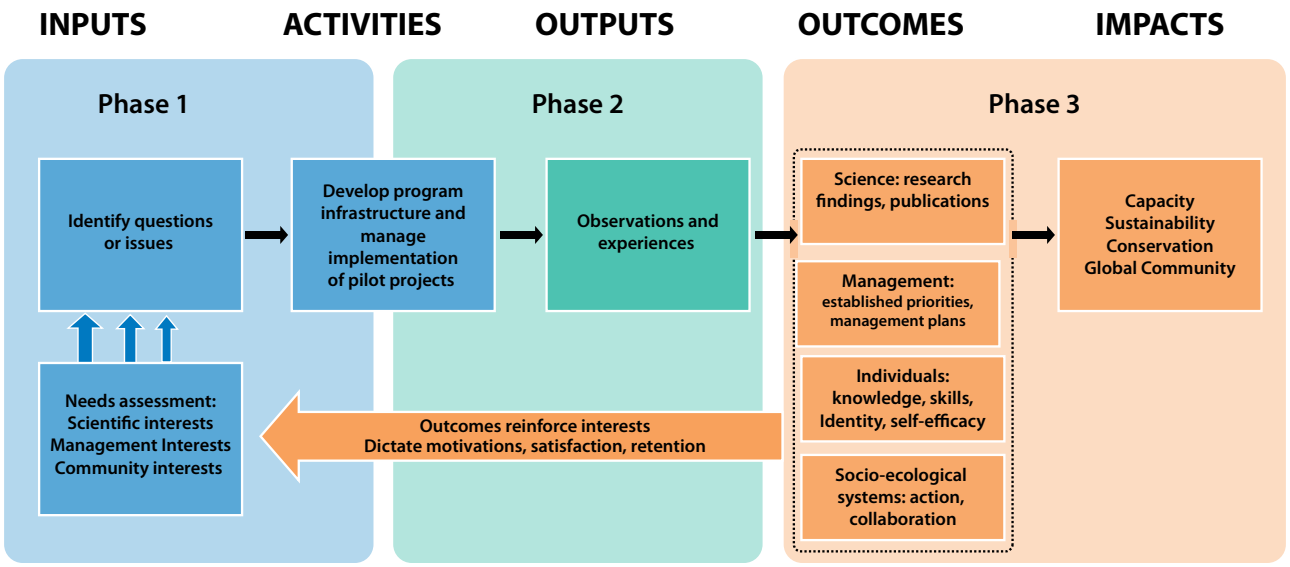

Figure 2. Framework developed for public participation in scientific research projects (Shirk *et al.*, 2012), with modifications for application to the Galapagos.

PPSR projects as they relate to the quality of participation and project outcomes (Shirk *et al.*, 2012). The existing framework closely follows the three phases of program development identified at the workshop and provides opportunities for standardization and evaluation across the larger field of research (Figure 2).

Specifically, inputs into the program will need to balance the interests of each stakeholder in the citizen science program (scientists, managers, local and global communities) as outlined in the needs assessment (Phase 1; Shirk *et al.*, 2012). Inputs will be negotiated through the establishment of diverse pilot projects and will be used to frame project design and influence project outcomes. Activities (Phase 2) will include the work necessary to implement each project and will be carried out by each project team (established in Phase 1). Outputs will include the results of activities such as observations (raw data) and experiences (from data collection and analysis; Phase 2). Outcomes (i.e., measurable elements) will result from these outputs and will include those relevant to each stakeholder group (Phase 3). Achievable outcomes will be defined through the needs assessment, but may result in research findings or publications to advance science; established priorities and management plans to advance management; knowledge, skills, and self-efficacy to build individual capacity; and action and collaborations to sustain socio-ecological systems. Over time, these outcomes may develop into long-term and sustained impacts that build capacity, enhance conservation, and/or build a global community involved with conservation of the Galapagos (Phase 3). Program sustainability can then be realized by quantifying outcomes and impacts to align with the initial goals (inputs) of the program. Goals represent stakeholder interests and motivations, so meeting those goals will result in overall satisfaction and retention (Shirk *et al.*, 2012).

Conclusions and recommendations

Based on the findings from this workshop, many opportunities for developing citizen science projects in the Galapagos exist. These opportunities include, but are not limited to, involving tourists and residents in scientific research and conservation efforts; generating the data necessary for effective management; building capacity among local residents; and developing a global community of Galapagos conservation stewards. However, development of the pilot projects and umbrella program will take significant resources. A detailed plan building on the framework described here will need to be generated. The plan should prioritize the steps necessary to initiate the proposed program within current staff and financial constraints while outlining potential approaches for expansion as new resources become available. The program should also seek to leverage resources available from international partners currently engaged in citizen science. These resources include standardized protocols, cyberinfrastructures, and established volunteer networks. If done well Galapagos will not only benefit from adopting citizen science as a new conservation tool but also become an exemplar around the world for engaging the public in diverse ways to help guide conservation decision-making.

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References

Bonney R, H Ballard, R Jordan, E McCallie, T Phillips, J Shirk & CC Wilderman. 2009. Public participation in scientific research: defining the field and assessing its potential for informal science education. A CAISE Inquiry Group Report. Center for Advancement of Informal Education (CAISE), Washington, D.C.

Bonter DN & CB Cooper. 2012. Data validation in citizen science: a case study from Project FeederWatch. Frontiers in Ecology and the Environment 10:305-307.

Brossard D, B Lewenstein & R Bonney. 2005. Scientific knowledge and attitude change: The impact of a citizen science project. International Journal of Science Education 27:1099-1121.

Crall AW, R Jordan, KA Holfelder, G Newman, J Graham & DM Waller. 2012 - in press. The impacts of an invasive species citizen science training program on participant attitudes, behavior, and science literacy. Public Understanding of Science.

Crall AW, G Newman, DM Waller, TJ Stohlgren, KA Holfelder & J Graham. 2011. Assessing citizen science data quality: An invasive species case study. Conservation Letters 4:433-442.

Danielsen F, ND Burgess & A Balmford. 2005. Monitoring matters: examining the potential of locally-based approaches. Biodiversity and Conservation 14:2507-2542.

Delaney DG, CD Sperling, CS Adams & B Leung. 2008. Marine invasive species: Validation of citizen science and implications for national monitoring networks. Biological Invasions 10:117-128.

Dickinson JL & R Bonney, editors. 2012. Citizen Science: Public Participation in Environmental Research. Comstock Publishing Associates, Ithaca, NY.

Dickinson JL, J Shirk, D Bonter, R Bonney, RL Crain, J Martin, T Phillips & K Purcell. 2012. The current state of citizen science as a tool for ecological research and public engagement. Frontiers in Ecology and the Environment 10:291-297.

Dickinson JL, B Zuckerberg & DN Bonter. 2010. Citizen science as an ecological research tool: Challenges and benefits. Pp 149-172. Annual Review of Ecology, Evolution, and Systematics, Vol 41.

Friedman AJ (ed.). 2008. Framework for Evaluating Impacts of Informal Science Education Projects. National Science Foundation, Washington, D.C.

Jordan RC, SA Gray, DV Howe, WR Brooks & JG Ehrenfeld. 2011. Knowledge gain and behavior change in citizen-science programs. Conservation Biology 25:1148-1154.

Newman G, J Graham, A Crall & M Laituri. 2011. The art and science of multi-scale citizen science support. Ecological Informatics 6:217-227.

Overdevest C, CH Orr & K Stepenuck. 2004. Volunteer stream monitoring and local participation in natural resource Issues. Human Ecology Review 11:177-185.

Shirk JL, HL Ballard, CC Wilderman, T Phillips, A Wiggins, R Jordan, E McCallie, M Minarchek, B Lewenstein, M Krasny & R Bonney. 2012. Public participation in scientific research: A framework for deliberate design. Ecology and Society 17:29.