



Citizen Science

A TOOL FOR CONSERVATION

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CITIZEN SCIENCE

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Citizen science efforts help track endangered species, like most species of sea turtle.

Introduction

Science, particularly the science of conservation, is often a collaborative process. Whether within a single discipline or across numerous fields, people work together to achieve goals. When it comes to environmental science, those goals may be as narrow as identifying what chemical compounds are released into a series of streams due to toxic water runoff, or as broad as establishing protections for endangered species across the globe.

Citizen science is a term that applies to a collaborative scientific process in which non-scientists, or citizen scientists, participate. Garbarino and Mason (2016) define a *scientist* as a trained professional, often with a postgraduate degree, who is employed in a scientific field. *Citizen scientists* may have received science education or have participated in research, but they are not employed as scientists. The words *scientist* and *researcher* will be used interchangeably in this paper, as will *non-scientist* and *citizen*; in this context, *citizen* refers not to one's nation of citizenship, but to one's position as a non-scientist.

Citizen science programs are active in many disciplines, such as astronomy, physics, biochemistry, neuroscience, and more. A simple web search for a citizen science project in any of these fields will yield countless results, as these types of projects have become more popular over the past decade (Pocock, Tweddle, Savage, Robinson, & Roy, 2017). Additionally, citizen science exists in countries across the globe. In the interest of length and clarity, however, the

scope of this paper is limited to conservation and environmentally focused citizen science projects within the United States.

Citizen Science: Participatory Research and Analysis

Citizen science is changing the scientific landscape for both the scientific community and the greater public. It can be classified into one of three types: contributive, where citizens gather data; collaborative, where citizens may also analyze or interpret this data; or co-created, where citizens participate in all levels of a project, from designing the question to analyzing data (Follett & Strezov, 2015). In this paper, we are discussing contributive and collaborative citizen science, where both citizens and scientists have input on a project.



Kids in the Dragonfly Detectives program monitor dragonfly mating and migration patterns.

Contributive and collaborative citizen science allows experiments, explorations, or inquiries to run on a large-scale, ongoing basis, which provides scientists with large and diverse data sets that might have been otherwise unavailable. (While it is true that many research projects take

place over long periods even without citizen science participation, the large-scale volunteer efforts of citizen scientists allow rapid scaling for relatively little capital; Bishop, 2014; Garbarino & Mason, 2016.) Additionally, it gives opportunity for two-way engagement between the public and scientists, can lead to increased topical literacy in participants, and has the capacity to influence policy and decision-making at a range of scales, including, for example, conservation efforts (Mitchell et al., 2017).

Data suggests participation in citizen science helps improve literacy and understanding among members of the public ([Cronje, Rohlinger, Crall, & Newman, 2011](#); [Bonney et al., 2009](#)). In many cases, participants come away with a greater appreciation and understanding of the scientific process and their comprehension of the topic they are researching. However, there is no evidence that citizen science participants improve in all areas of science; their knowledge gains may be limited to the areas of research they participated in. Still, members of the public who participate in a citizen science project report higher confidence in their abilities than those who had not previously participated and a higher willingness to participate again (Lewandowski, Caldwell, Elmquist, & Oberhauser, 2017).

Non-scientists working on conservation-related projects may be likely to take a personal interest in the work. Especially when working on a local project—for example, monitoring insects at a nearby pond—participants can become invested in protecting and learning more about the ecosystem. Over time, they may develop a feeling of ownership and responsibility toward the data being collected (Bonney, Phillips, Ballard, & Enck, 2015). This can also lead to participants gaining a deeper understanding of relationships and interactions in nature, such as how [insects can serve as indicators of climate change](#) (Goforth, 2017; Heino, Virkkala, & Toivonen, 2009) or [how urban congestion affects air quality](#) (Zhang & Batterman, 2013).

Scientists also benefit greatly from the contributions of citizen scientists. A citizen science network enables researchers to view and utilize data from myriad subjects in locations across the world, all at once. This is perhaps one of the greatest benefits of citizen science: not only do citizen scientists provide usable data, but they can analyze it, too. Due to time and resource constraints, it is often unfeasible for scientists to collect and analyze such large data sets on their own (Chatzigeorgiou et al., 2016).

Citizen science can benefit whole societies and communities, as well. The results of research gained through citizen science projects have been used to inform local policies, enhance formal and informal education initiatives, and conserve natural resources and support environmental sustainability.

The process can be incredibly welcoming to individuals without a scientific background, as long as they have the time or the tools. For example, a bioblitz may require no more than an hour of a person's time at a designated site, and an ID app such as iNaturalist requires nothing more than access to a phone. Many conservation projects are observation based and available through phone apps, including NASA's GLOBE Observer and Mosquito Habitat Mapper, the entire Zooniverse suite, and eBird.

Case Studies from Science Connected

Science Connected is a 501(c)(3) nonprofit publisher whose staff and volunteers author science nonfiction for a general audience. The articles, images, and educational materials that Science Connected produces are the result of a two-way communication between journalists and scientists. The examples that follow are the results of research projects reported on by [Science Connected Magazine](#).

Tracking Biodiversity

[PlantNet](#) is a citizen science project and an app that analyzes user-uploaded images to recognize up to 13,000 species around the world. It uses crowdsourced data to provide users with both the common and scientific names of plants, as well as online resources about those species. The backers of the project are “labs working on either botanical or computer sciences,” according to Rémi Knaff, a community manager for the project. “They are public institutions researching biodiversity, ecology, and deep-learning for information technologies.”

“You don’t need to be an expert in botanical sciences to use the app,” says Knaff. “It was made to be easily used by everyone. Knowledge is power. If you know what’s growing around you, you will be able to protect it better” (Stone, 2017, Who is behind the PI@ntNet project?).

Another citizen science project, [iNaturalist](#), also crowdsources data to help users identify numerous species, from plants to fungi to birds to mammals. Users search through data uploaded by others and offer their expertise to help provide identification information. Once another user has confirmed an ID is correct, the data may be considered research grade, as long as a quality photo accompanied the identification.

Apps like PlantNet and iNaturalist allow citizen scientists to learn more about their local environments and become more engaged with the world around them, all while contributing to valuable research. At the same time, several metrics from numerous data sets are being tracked, recorded, and made available, helping scientists from countless organizations and labs find information suitable for their research.



Volunteers from the Friends of Sausal Creek rebuild damaged habitats to help native species thrive.

Other programs such as the Friends of Sausal Creek project based in Oakland, California, have more immediate impacts on biodiversity. They use citizen science to restore eroded watersheds, depleted pollinator populations, and native flora. They also work with the local water board to monitor chemical runoff.

One of their greatest tasks is removing invasive species and replacing them with natives. “A landscape of native plants typically has a good deal of biodiversity, and therefore supports a wider variety of fauna,” according to the program’s executive director, Kimra McAfee.

The [nonnatives, including] ivy and Himalayan blackberry tend to take over large swatches of land, so biodiversity of flora and fauna is greatly diminished. The nonnative landscapes don’t support the pollinators, especially the native bees, like the diverse native flora does. (K. McAfee, personal communication, October 29, 2017)

Volunteers from the town and from local schools help monitor the parks for invasives. They regularly meet to remove the nonnative plants, and they maintain a nursery of native species to repopulate the landscape. A volunteer has catalogued all of the native plants in the area, and has also entered the names of the plants in the citizen science database CalFlora.

“One indicator of the fruits of our work in increasing biodiversity is the increase in bird species found in our bird monitoring. Our 2003 bird checklist had 92 species; our 2016 update had 129 species!” (K. McAfee, personal communication, October 29, 2017).

Protecting Endangered Species

Government, research, and nonprofit organizations often collaborate to oversee and uphold the rules set forth by the United States Endangered Species Act (Jain, 2016). The act has over 1,600 animals listed as endangered, all of which require long-term interventions to ensure their survival. Researchers from dozens of organizations rely on each other and on outside data to manage the daunting task of tracking the 1,600 species officially listed as endangered, while also tracking the thousands of other species living in difficult situations. One strategy they use to monitor the listed species is to use data gathered from citizen science projects, [which helps allay costs and save resources](#). Making this strategy more appealing is that federal scientists often participate in, or even initiate, citizen science projects (Evans et al., 2016).

The National Oceanic and Atmospheric Administration (NOAA), for example, both directly funds citizen science projects (through its Sea Grant program) and facilitates a database for crowdsourcing large-scale projects. It is a member of the Federal Community of Practice for Crowdsourcing and Citizen Science, which helps federal scientists establish and proceed with their citizen science projects (NOAA, 2018). Similarly, the U.S. Forest Service (USFS) offers funding of up to \$25,000 for eligible citizen science projects related to resource management. Their detailed guidelines suggest that in addition to providing a genuine scientific outcome, the collaborative and educational aspects of citizen science are crucial for a project’s success. Additionally, National Science Foundation (NSF) grants are [being awarded to citizen science projects](#) on an increasingly regular basis (2018).

HerpMapper is another citizen science project that shares its information with state and federal agencies, nongovernmental organizations, and universities for research, conservation, and preservation purposes. They have over 50 partnerships, including with various branches of the U.S. Fish and Wildlife Service, the USFS, and the U.S. Geological Survey.

“The data [we collect] are used to develop species distribution maps, determine habitat associations, take in-species status assessments, identify road-mortality hotspots, create niche modeling, and more,” says Christopher Smith, a project administrator with HerpMapper (personal communication, October 21, 2017). Scientists and citizens both participate in the project, and accuracy is maintained with a vigorous screening process that includes user flagging, board administrators and partners, and a taxonomic committee.

HerpMapper is aware that data sharing can have potential consequences, not only for the participants of a citizen science project but also for the species it targets.

One of the unforeseen consequences of online data collection and sharing is poaching. . . . In order to minimize potential impacts to herpetofaunal populations in their habitats, HerpMapper has opted to obscure all observations—not just rare species—to the county level in the US and to an equivalent scale elsewhere. The focus on protecting the resource first, and providing data in as safe a way as possible, has been a major reason for HerpMapper’s success. (C. Smith, personal communication, October 21, 2017)

While many citizen science projects outsource data to organizations that create or enforce conservation policy, others, including Rescue a Reef, based at the University of Miami, Florida, use the power of public participation to conserve local resources. Like corals all over the world, Florida’s reefs have experienced mass bleaching events and other threatening conditions that have led to decline. Across the world, some reefs have lost up to 95% of their populations. The Miami reefs contain over 50 species of coral and more than 100 types of fish, so restoring the degraded reefs is essential to maintaining the rich ecosystem (“What Is Rescue a Reef?” 2018).



Volunteer divers transplant coral colonies with the citizen science project Rescue a Reef.

Rescue a Reef is a program in which researchers cultivate coral and train local volunteers to plant the pups on the degraded reefs. With the help of citizen participants, Rescue a Reef has been able to plant new coral and has reported a [success rate of over 80%](#) (D. Hesley, personal communication, May 2017; Lirman et al., 2010). Volunteer divers, after receiving training from the experts at the university, were just as successful as the scientists (even more so, in some cases), and they came away learning about the importance of the reef for their community and the shoreline ecosystem. Many participants repeatedly volunteer, as they become engaged with the idea of restoring their environment.

“We already knew there was educational value associated with our restoration efforts,” said Dalton Hesley, a research associate with the program. “Our results highlighted that citizen scientists can be trained to our practitioner-level standards.”

Additional Resources

Citizen science is an effective partnership between scientists and nonscientists that, when done well, offers benefits to the participants and beyond. Scientists can gain valuable data, analysis, and assistance in performing high-level procedures; citizens can gain essential understanding of their environments and increased scientific literacy. Perhaps most important, countless species and habitats benefit from the large-scale, collective efforts that citizen science makes possible.

For those interested in learning more about citizen science, the following resources may be of use.

Australian Guide to Running a BioBlitz

http://www.ala.org.au/wp-content/uploads/2011/10/BIOBLITZ_Guidelines_WEB-final-201507.pdf

Choosing and Using Citizen Science: A Guide to When and How to Use Citizen Science to Monitor Biodiversity and the Environment

https://www.ceh.ac.uk/sites/default/files/sepa_choosingandusingcitizenscience_interactive_4web_final_amended-blue1.pdf

Federal Crowdsourcing and Citizen Science Toolkit

<https://www.citizenscience.gov/toolkit/>

Guide to Citizen Science: Developing, Implementing and Evaluating Citizen Science to Study Biodiversity and the Environment in the UK

<http://www.nhm.ac.uk/content/dam/nhmwww/take-part/Citizenscience/citizen-science-guide.pdf>

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About Science Connected

Science Connected is volunteer-powered 501(c)(3) nonprofit organization with offices in San Francisco, California. We are a global group of scientists and science communicators who foster widespread science literacy, education, and communication. We are dedicated to increasing public understanding of science and creating free and equal access to science education. We define education in its broadest sense and believe it is the key to making informed choices, being successful members of society, and acting as responsible stewards of the planet.

Our mission is to increase scientific literacy in underserved communities and the greater public by connecting people with the latest scientific research, translating science into accessible language, and debunking pseudoscience with real research findings.

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About Science Connected Magazine

Science Connected Magazine is an editorially independent, non-profit newsroom producing open-access science journalism and scientific fact-checking for the global public. We work to increase science literacy and public access to reliable information. We are published by Science Connected 501(c)(3) in San Francisco, California.

<https://magazine.scienceconnected.org>

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