THREE

Current Approaches to Citizen Science

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The citizen science approach one chooses will depend on the context of the project. There are many different ways to do citizen science, and the choices made when designing a project will influence its outcomes (Shirk et al. 2012). Common to all citizen science projects is the involvement of participants. However, the amount and type of participation differ substantially from one project to the next. As a result, citizen science projects can be divided into five models based on the degree of participation (Shirk et al. 2012):

1. *Contractual projects,* where communities ask professional researchers to conduct a specific scientific investigation and report on the results;
2. *Contributory projects,* which are generally designed by scientists and for which members of the public primarily contribute data;
3. *Collaborative projects,* which are generally designed by scientists and for which members of the public contribute data but also help to refine project design, analyze data, or disseminate findings;
4. *Co-created projects,* which are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all aspects of the research process; and
5. *Collegial contributions,* where non-credentialed individuals conduct research independently with varying degrees of expected recognition by institutionalized science or professionals.

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Among these five models of participation, it is important to understand how the contributory, collaborative, and co-created approaches differ. In contributory projects, participants are involved primarily as data collectors, whereas in the collaborative and co-created approaches participants are involved in additional stages of the scientific process, including identifying the question of interest, designing methodologies, and analyzing data.

Citizen science projects can also be categorized by the types of activities in which the participants are involved (Bonney et al. 2016). We will discuss three such categories here:

Citizen scientists as data collectors

Citizen scientists as data interpreters

Citizen scientists as full partners

CITIZEN SCIENTISTS AS DATA COLLECTORS

How Does It Work?

Projects in this category involve participants only in data collection. Design, analysis, and interpretation of the results are undertaken by professional scientists.

Examples In developed countries, participants are often volunteers who donate their time (e.g., to survey water and air quality, vegetation, weather, or populations of birds, amphibians, fishes, invertebrates, and invasive species; see, e.g., Støttrup et al. 2018). Commercially exploited wildlife populations are also surveyed by volunteers through such approaches as fisheries statistics, hunter records, and angler-diary programs (Venturelli et al. 2017). These citizen science projects often involve hundreds or thousands of participants whose efforts are embedded within a strong organizational infrastructure that provides sophisticated professional support and feedback to the participating volunteers. In developing countries, there are fewer examples of volunteer-based surveys (see chapter 17) and participants are more commonly paid to collect data as rangers working in protected areas, as staff on scientific expeditions, as staff assisting tourist volunteers doing survey work, or within hunter or fisher survey programs (Brofeldt et al. 2014, Chandler et al. 2017).

Pros and Cons In this approach, participants collect large amounts of data that otherwise would be extremely costly to gather. The skills required of participants are limited, the investment in training is small, and the interactions between professional scientists and participants are minimal. Sometimes the reliability of data collected by citizen scientists is questioned. However, the results of multiple studies demonstrate that such data are just as accurate and precise as data collected by professional scientists (Danielsen et al. 2014a; see chapter 9). Citizen science projects in this category are mainly of the contributory approach.

CITIZEN SCIENTISTS AS DATA INTERPRETERS

How Does It Work?

Projects in this category involve volunteers in data interpretation only. Professional scientists design the survey, collect the data, and analyze the results.

Examples In this category, we find citizen science projects with very large datasets that do not require a high degree of technical skill to interpret, such as images taken by trail cameras. Participants observe photos or videos and detect and classify specific, easily recorded features. Each classification is conducted by multiple participants, and the results are cross-validated. Examples of such projects include Camera CATalogue, Snapshot Serengeti, Snapshot Wisconsin, Western Shield Camera Watch, and WildCam Gorongosa. There are also examples of projects in which participants identify individual age classes of wildlife, such as adults, chicks, and eggs of penguins (PenguinWatch), or classify submerged kelp forests in satellite images (Floating Forest) or plankton in underwater images (Plankton Portal). Sometimes volunteers classify the behavior of wildlife in video recordings (Arizona BatWatch, Chimp&See) or hand-drawn pencil lines representing African rainforest trees' life-cycle events (Jungle Rhythms). There is even a project in which volunteers classify the similarity of spatial patterns within a river catchment, helping scientists model the hydrology of a river basin (Pattern Perception).

Pros and Cons The advantage of this approach is that it significantly reduces the time needed to interpret huge datasets from passive recording devices, which would otherwise need to be done by professional scientists. A potential challenge is inaccuracy of interpretation by the participants, though this is easily overcome by ensuring that the same images are interpreted by multiple people. Moreover, the basic knowledge required for interpretation can be provided by introductory training. This category is useful in surveys with large datasets in which the data's interpretation does not require technical skills but cannot be conducted by machines. It is particularly effective when patterns or features need to be recognized in many images. Projects in this category are mainly examples of the contributory approach.

CITIZEN SCIENTISTS AS FULL PARTNERS

How Does It Work?

Projects in this category involve citizen scientists in the entire research process—from formulation of questions and project design to data collection, analysis, and finally use of data in natural resource management, although professional scientists may provide advice and training.

Examples Projects in this category are often undertaken in areas where community members have some degree of control over the management of land and resources (Danielsen

et al. 2014b). They are more participatory in character (Pocock et al. 2018) and are typically developed as part of an adaptive management plan. Most citizen science programs in the tropics and the Arctic belong to this category (Johnson et al. 2016). Sometimes they involve local and traditional knowledge held by communities who have long-term affiliations with specific landscapes (Zhao et al. 2016, Mustonen and Tossavainen 2018, Tengö et al. 2017). Examples in developed countries include volunteer wardens at nature reserves collecting data on which to base local management decisions and providing those data to national programs for larger-scale analyses. In the United States, projects of this type are often seen in relationship to environmental justice, where communities take up science as a tool to help address critical problems related to water, air, food, or personal health. An example is ALLARM (Alliance for Aquatic Resource Monitoring), a project in Pennsylvania that assists communities in addressing water quality concerns through data. Assistance is provided at all stages, from establishing protocols to interpreting data (Wilderman et al. 2004, Shirk et al. 2012). Examples from developing countries include community-based observation schemes—particularly those operating in community-managed protected areas, for instance in Namibia and other African countries (Danielsen et al. 2005, Chandler et al. 2017).

Pros and Cons While this category of project requires a large effort by the participants, it is also potentially very rewarding and beneficial to those involved. Benefits include participants having their voices heard, influencing how an area is managed, and contributing to capacity building and self-empowerment (Funder et al. 2013). However, if this category of project is to be successful, scientists must be able to facilitate a constructive dialogue with the participants. The category is particularly useful in areas where community members are closely connected to wildlife and the environment and where the government has a policy of involving and listening to community members in decisions on resource management (Danielsen et al. 2020). When digital platforms are used for storing and sharing data (Johnson et al. 2018), it may often be possible to connect and cross-weave with scientist-executed projects (Fidel et al. 2017). Projects of this category are mainly collaborative or co-created approaches.

SUMMARY

Citizen science projects are often categorized by the degree of participation of volunteers, but they can also be categorized by the types of activities in which volunteers are involved. The first such category involves citizen scientists in data collection only and is useful in ecology and natural resource projects where large amounts of data need to be collected, an effort that would not be possible without a large number of participants. Even though citizen scientists only collect data, they are critical for the entire process, since there will be no data without their involvement. The second category involves citizen scientists only in interpretation of data and is useful when there is a very large number of items to be classified or interpreted (e.g., photos or other forms of data from passive recording devices) and when volun-

teer participation can significantly reduce the time spent by professional researchers in interpreting huge datasets. The last category involves citizen scientists in the entire scientific process, from formulation of questions to use of the data for conservation and management. This last approach is more demanding in terms of time and effort on the part of the participants, but the potential benefits are huge. Specifically, the full-participation approach can provide valuable data and, at the same time, help generate transparency, accountability, and local ownership in conservation and management initiatives, thereby empowering participants and prompting locally meaningful conservation actions. Since volunteers may be involved in a wide array of activities, their knowledge can play a greater role. While we recommend that you begin by thinking of particular types of citizen science projects, the reality is that each project is tailor-made to the particular needs being addressed and to the available resources and participants. Furthermore, regardless of the approach used, the amount of investment you put into the project is likely to influence the social cohesion and interactions among participants, and hence the quality of the work performed.

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HANDBOOK OF CITIZEN SCIENCE IN ECOLOGY AND CONSERVATION

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WITH A FOREWORD BY REED F. NOSS

NATURAL SCIENCE | ECOLOGY

Handbook of Citizen Science in Ecology and Conservation is the first practical and comprehensive manual for creating, implementing, or improving natural science research and monitoring projects that involve collaboration between scientists and the general public. As citizen science projects become increasingly common, project leaders are seeking information on concrete best practices for planning and implementing projects—practices that allow them to guide and gauge success while also ensuring the collection of high-quality data and rewarding experiences for volunteers. In this handbook, citizen science practitioners from around the world and with decades of experience provide step-by-step instructions, insights, and advice, and they explore real-world applications through case studies from a variety of citizen science projects. This is the definitive reference guide for anyone interested in starting or improving a citizen science project with ecological or conservation applications, from professors and graduate students to agency staff and nongovernmental organizations.

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