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Citizen science and conservation: Recommendations for a rapidly moving field

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ABSTRACT

Research taking place at the intersection of conservation and citizen science holds great potential for advancing both fields as well as for addressing grand challenges in the field of conservation. This Special Issue highlights the work of twenty research groups actively working at this intersection and examining participant motivation, learning and action; evaluating and improving research design and data quality; and investigating conservation science applications. The results of these studies directly contribute to advancing our understanding of the role that citizen science can play in conservation. As research continues in these fields, directing our efforts toward communicating insights, creating interdisciplinary teams that use citizen science to tackle wicked problems, and improving coordination among investments in citizen science are actions likely to have the greatest impact. We invite conservation and citizen science practitioners to contribute to the dialogues initiated by articles in this Special Issue.

1. Introduction

Conservation tools currently available are not sufficient to address existing conservation needs, and this situation will likely only be exacerbated in the future. Financial backing for conservation activities provides crucial support, but rarely is assistance from governments, foundations, and businesses enough to fully fund effective, sustainable, long-term conservation strategies (Nerbonne and Nelson, 2004). To build and sustain conservation efforts at adequate scales, we must increase the capacity and efficiency with which we conduct conservation activities (Sullivan et al., 2017–this issue). Accordingly, citizen science is frequently offered up as one solution to these problems. The potential is great: citizen science can expand research capacity while providing stimulating opportunities for participants, engaging volunteers directly in conservation science and management, and improving science and environmental literacy. Citizen science has already made tremendous contributions to conservation science, and this approach of leveraging the power of volunteered data, information, and skills has the potential to do much more (McKinley et al., 2017–this issue).

In recent years, the field of citizen science has grown exponentially (McKinley et al., 2017–this issue). Professional citizen science societies have been established around the world; the largest of which are based in the United States (Citizen Science Association; citizenscience.org), Europe (European Citizen Science Association; ecsa.citizen-science.net), and Australia (Australian Citizen Science Association; citizenscience.org.au). Also, a new peer-reviewed journal for citizen science researchers and practitioners, *Citizen Science: Theory and Practice* (theoryandpractice.citizenscienceassociation.org) was launched in mid-2016. Government agencies (see citizenscience.gov), universities, and national and international organizations have recognized the potential of citizen science and are formally integrating citizen science into their work. Likewise, new organizations that are devoted to citizen science-based research have formed, many with strong conservation goals.

Several strong models demonstrate the potential for addressing grand conservation challenges on a large scale using citizen scientists. For example, the USA National Phenology Network (usanpn.org) blends citizen science and conventional professional research to understand phenological responses to environmental change. The results of this organization's work will have broad implications given the sensitivity of phenology to climate and the range and magnitude of impacts that changes in phenology have on ecosystems, conservation, and key Earth systems, including global and regional climate and carbon and water cycles. Further, projects such as iDigBio (Integrated Digitized Biocollections; idigbio.org) and the Worldwide Engagement for Digitizing Biocollections (WeDigBio; wedigbio.org) Event greatly enhance the research potential for documenting long-term changes in biodiversity and many other topics important to conservation by engaging professional museum personnel and citizen scientists in digitizing biological collections (Ellwood et al., 2015; Page et al., 2015). The scale of these types of projects would be impossible without the efforts of citizen scientists. However, it is not yet clear how citizen science can be leveraged

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most effectively in aspects of conservation science. Specifically, how are citizen scientists motivated to participate in conservation-oriented programs and how might participation lead to learning or changes in behavior? Also, how can the design of citizen science projects lead to higher quality data that supports conservation and how can these projects most effectively be evaluated? Broadly, how well do conservation-oriented citizen science projects truly support conservation action? There is much to be gained from continued research focused on all facets of citizen science, and in sharing these findings widely and efficiently. The contributions assembled in this Special Issue begin to address some of these challenging conservation questions.

2. Motivation, learning, and action

Several articles in this Special Issue investigate the motivations of citizen scientists or explore how citizen science can translate to learning, agency, and action. Some of the conclusions essentially confirm findings previously documented; others address new aspects of citizen science projects. All are valuable contributions, providing important insight on how the design of citizen science projects can lead to meaningful outcomes.

The studies included in this Special Issue reveal, for example, that individuals participate in different kinds of projects for different reasons—e.g., to learn, to enact change, or to support their favorite organizations. This finding underscores the importance that citizen science project organizers must understand both their own goals and those of their target audiences. For example, Domroese and Johnson (2017–this issue) found that the primary motivator for their New York City-based volunteers was an interest in learning about their target taxa, bees, as opposed to the more commonly cited desire to help the environment. Peters et al. (2017, this issue) explored volunteer-based monitoring by land trusts, and discovered that civic engagement is one of the most important motivations, though also the most difficult to achieve. Newman et al. (2016–this issue) explored reasons why many citizen science projects struggle to accomplish their goals and concluded that leveraging the power of place can lead to more resilient and sustainable projects and communities.

Papers in this Special Issue indicate that achieving learning outcomes from citizen science is difficult. Instigating changes in volunteers' behavior is even tougher. For projects that aim to enhance the environmental stewardship of volunteers, as many citizen science projects purport to do, it is critically important to understand how to instigate that change in behavior. In a study concentrated on youth-focused citizen science programs, Ballard et al. (2017–this issue) name three processes that enable participants to develop an appreciation for environmental science and therefore encourage participation in conservation action: ("ensuring rigorous data collection, disseminating scientific findings to authentic external audiences, and investigating complex social-ecological systems)." Several other papers in this Issue investigate factors that have led to conservation outcomes and actions. Demonstrating the use of participatory modeling by citizen scientists, Gray et al. (2017–this issue) show that combining online coordinated learning and participatory modeling techniques can lead to self-organized and co-created conservation action. Ballard et al. (2017–this issue) show that citizen science programs that are run through natural history museums support conservation both directly, through site and species management, and indirectly, through research, education, and policy impacts. Transitioning from action to promotion, both Forrester et al. (2017–this issue) and Lewandowski and Oberhauser (2017–this issue) report an increase in conservation advocacy among participants in citizen science projects.

3. Evaluating and improving design and data quality

Published evaluations in the field of citizen science are rare, though the practice of project evaluation has been common practice for decades in the field of informal education. One of the most common forms of evaluation implemented in citizen science projects is the comparison of data collected or conservation projects completed by volunteers to those done by professional researchers (Boudreau and Yan, 2004; Fuccillo et al., 2015; Lovell et al., 2009). Far fewer studies have evaluated how volunteers engage with projects, how scientists perceive data from citizen science projects, or how citizen science projects have translated into conservation outcomes. The insights from these studies, and more like them, could greatly improve the design of existing and future citizen science projects and how they are perceived and used by the broader scientific, conservation, and policy communities.

The quality of data yielded by citizen science projects is a regular concern among scientists, and a common reason these data are less likely to be used by scientists, as demonstrated by Burgess et al. (2017–this issue). MacKenzie et al. (2017–this issue) evaluate the quality of data collected in an alpine monitoring citizen science project, and report concerns related to plant species identification and how they affect the validity of the data collected for research purposes. In contrast, van der Velde et al. (2017–this issue) show that adult citizen scientists and primary and secondary-level students can document marine debris with equivalent skill as conventional, professional scientists, depending on the method and metric under consideration. The take-away message is that given the proper training and matched with appropriate tasks, citizen science volunteers of all ages can make valuable contributions and broaden the coverage and increase the sampling power of ecological survey assessments without compromising data quality.

The strength of these studies is that we can learn from them how to design projects that maximize data quality and efficient data collection across often large geographic areas. Zapponi et al. (2017–this issue) show that mapping the geographic distribution of invertebrates is an ideal task for citizen science; in a European effort focused on three species of beetle, volunteers collected the equivalent number of records in two years that required ten years of effort following traditional methods. Likewise, Pocock et al. (2017–this issue) show how citizen science can be especially powerful in tackling geographically extensive problems such as detecting rare species or documenting the establishment of invasive species. Liebenberg et al. (2017–this issue) demonstrate the richness and complexity of scientific data that can be contributed through community-based citizen science, through a suite of case studies involving non-literate trackers.

Project evaluations such as some undertaken in the studies collected in this Special Issue can yield important insights into broader impacts of citizen science efforts. Chandler et al. (2017–this issue) evaluated dozens of Earthwatch citizen science projects from the perspectives of science and management outcomes and participant experience, and found that "personal growth is greatest for individuals who are least predisposed, knowledgeable, or active in environmental stewardship activities prior to participating."

4. Conservation science applications

A primary goal of many conservation-related citizen science projects is to improve conservation. We know that citizen science has contributed greatly to conservation science, though it is often difficult to quantify the contributions from volunteer participants (McKinley et al., 2017–this issue). In this issue, we include some papers that use citizen science approaches to provide fresh insights to conservation and direct recommendations for best management practices. Citizen science surveys of animals in the Brazilian Pantanal informed Eaton et al. (2017–this issue) of the extent of cattle impact and the necessity for cattle management. Volunteer divers in Australia collected data on inconspicuous fish species, highlighting the urgent need for listing several handfish species on the IUCN Red List (Edgar et al., 2017–this issue). Sullivan et al. (2017–this issue) and Barnard et al. (2017–this issue) present the successes and limitations