



## The power and potential of citizen science for park bonding, advocacy, and stewardship

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### Abstract

Citizen science represents an opportunity to invite and encourage broad connections with the scientific community. Fundamentally, the research strategy urges public participation to answer important research questions. Citizen science offers tremendous possibilities to welcome a diverse audience to engage with science on public lands while addressing relevant management questions. The work described in this paper emphasizes the potential for using citizen science in the US national parks to not only advance pertinent scientific inquiry but also foster an appreciation for protected lands. It highlights the Rocky Mountain Sustainability and Science Network (RMSSN) as an organization that has capitalized on citizen science to explore worthwhile social-cultural and environmental studies. Furthermore, RMSSN has stressed the importance of leveraging a diverse cohort of graduate and undergraduate students to accomplish such work. This approach has resulted in participants expressing an enhanced, deeper appreciation for the parks, recognizing them as special places, with stronger motivations to steward and advocate for them. The diverse social components of the citizen science-based experience appeared to have a critical role in cultivating such a response.

*Keywords:* Citizen science, diversity, place attachment, stewardship, advocacy

### Introduction

Citizen science is a potentially inclusive approach uniquely positioned to engage individuals with and without a formal science background to contribute to scientific exploration and knowledge generation (Cooper et al. 2021). This approach integrates the general public into valuable research efforts to address pressing environmental or social questions. Citizen science projects differ in levels of participant involvement: *contributory* projects simply enlist volunteers only to collect data, *collaborative* projects ask volunteers to collaborate on different elements of the research, while *co-created* projects fully involve participants throughout all steps of the research process. Regardless of

the level of involvement, the theme of public contribution to scientific efforts runs through all citizen science projects.

While citizen science may not be appropriate for all research questions, when it is suitable it can offer fantastic benefits for researchers, practitioners, and resource managers. Citizen science can be considered a win-win for all involved. By encouraging the public to partner on scientific studies, exceptional educational opportunities emerge. Additionally, these collaborations can act as springboards to inspire more extensive scientific pursuits for participants. The practice also creates an opportunity for

researchers to address complex and challenging questions with the support of inquisitive volunteers. Research can be, and is, conducted on understudied species, or it may be part of large-scale efforts that span significant spatial and temporal scales. The insights that result from answering these questions can help to inform and guide resource management decisions.

Although the public's engagement in observations of the natural environment is not necessarily new, citizen science as a formal research practice has grown increasingly common over the last decade. One of the first formal efforts was the Christmas Bird Count, first sponsored by the National Audubon Society in 1900, which continues to this day (Cohn 2008). The emergence of the practice within the US national parks is apparent and has continued to grow from some of the early efforts, including Hawk Watch in Acadia National Park (Benz 2019), which began in 1995 and catalogues the birds of prey flying near Cadillac Mountain, or the All-Taxa Biodiversity Inventory (ATBI), launched in 1998 (Nichols 2007) at Great Smoky Mountains National Park. ATBI seeks to involve the public in identifying all species within the park's boundaries. In ways, this project could be viewed as a precursor to National Park BioBlitz efforts conducted across parks as part of the National Park Service (NPS) centennial celebration in 2016 (Baker 2014). Today, numerous citizen science projects dot the US national park landscape, including the Common Loon project, started in 2005, which is unique to Glacier National Park; the Dragonfly Mercury project (Dartmouth College 2020), launched in 2007; or various phenology efforts supported by the National Phenology Network (Rosemartin 2021) instituted in multiple parks. While the breadth, scope, and involvement of NPS citizen science projects differ, the common theme of involving the public in park science continues to grow.

### **Citizen science and participant diversity**

Citizen science presents great opportunities to democratize the scientific community by engaging individuals from a range of backgrounds. According to Cooper et al. (2021), the intent of citizen science has long been to promote inclusive science that allows for broad participation of laypeople in the scientific community. However, the authors noted that, so far, the reality has looked different: citizen science lacks egalitarianism, with many groups still under-represented, and there is still much work to be done in this regard. Bringing diverse groups together to investigate pressing environmental or social questions creates a space for all to contribute to the scientific process. Such collaborative efforts incorporate new and much-needed thoughts and perspectives into the scientific conversation. Additionally, a focus on

diversity within citizen science opens doors and creates a platform where a broader audience can be involved and collaborate. Lastly, the participants are encouraged in their scientific pursuits and can connect with others who share similar interests.

Given the potential to involve a mix of participants of different genders, racial and ethnic backgrounds, sexual orientations, ages, religions, abilities, languages, levels of education, nationality and geographic locations, and socioeconomic status, new richness and depth for citizen science research, as well as the participant experience, can emerge. The strategy can blend a myriad of perspectives and direct them toward a singular scientific purpose. Still, Pateman, Dyke, and West (2021) pointed out that citizen science research has not yet reached its full potential to integrate a diverse population into the scientific community. The authors recognized that citizen science proponents have done a poor job of engaging historically excluded groups, including women and individuals of lower socioeconomic status. Of note, these are groups that have also been disproportionately under-represented as visitors in US national parks (Scott and Lee 2018). Wealthier, white, and retired US residents are more likely to participate in citizen science efforts than people of color and individuals in lower-income brackets (NASEM 2018). In short, citizen science volunteer demographics are highly skewed and represent a very limited segment of the public. Involvement of a broader audience in park citizen science opens doors to introduce under-represented groups to the parks while encouraging diversified involvement in park research.

Providing some insight on the composition of citizen science efforts, the National Academies of Sciences, Engineering, and Medicine (NASEM) (2018) completed an analysis of demographics within various types of citizen science programs. SciStarter, an online platform connecting potential participants with online and hands-on projects, reported that females represented 64% of the SciStarter profiles. The median age of female participants was 41, whereas the median age for males was 47. NASEM (2018) also referenced the work of Theobald et al. (2015) and Burgess et al. (2017), who evaluated the demographic profiles of 125 hands-on, outdoor, biodiversity projects. They found that 88.6% of participants were Caucasian, 6.1% Hispanic, and 4.6% Asian or Asian American. African Americans, Native Americans, and Hawaiian/Pacific islanders were not represented in large percentages in any of the projects. Regarding education, 90.6% of projects noted that at least some of the participants were college graduates. Likewise, 79.5% of projects were composed of at least some retirees. Finally, these authors did not recognize a distinct difference in gender representation.

NASEM (2018) summarized this demographic analysis by characterizing most citizen science participants in this study as “white, well-educated adults” (p. 160).

Lack of participation from certain groups may be due to a variety of issues (Pateman, Dyke, and West 2021). Potential reasons for such a participation gap could include lack of access to nature, unfamiliarity with nature, lack of understanding of the scientific process, and difficulty balancing work and a citizen science project on constrained budgets. While these obstacles likely exist, it is necessary to consider participation in a cultural context, noting that creating welcoming opportunities for anyone to contribute to science is imperative. Embracing projects where all individuals feel invited into the scientific setting is essential in overcoming participation barriers. Ensuring that historically excluded populations find scientific communities that they are able to identify with, value their contribution, and embrace their perspective is necessary. In this regard, sharing the stories of the contributions that women and minority groups have made to science and the parks could serve as a bridge to welcome greater diversity into citizen science. Furthermore, it is important to recognize the place that role models and mentors have in fostering involvement in the sciences. Citizen science projects, designed with such consideration, could be well suited to provide positive models for others to emulate. Such strategies in citizen science may serve to support greater diversity in the scientific community at large. Interestingly, Pateman, Dyke, and West (2021) recommended a targeted invitation and working through community partnerships as opposed to open calls for volunteers as a strategy to further improve diversity. Also, the authors recommended designing projects with a variety of tasks that differ in time demands, thereby helping to overcome participant time constraints as an excluding factor. Ensuring that all individuals find inclusive scientific settings that they can connect with will be critical to encouraging extensive diversity in science. Addressing these participation gaps is an important area of opportunity for citizen science, and is a place that national parks can play a key role.

### The citizen science experience

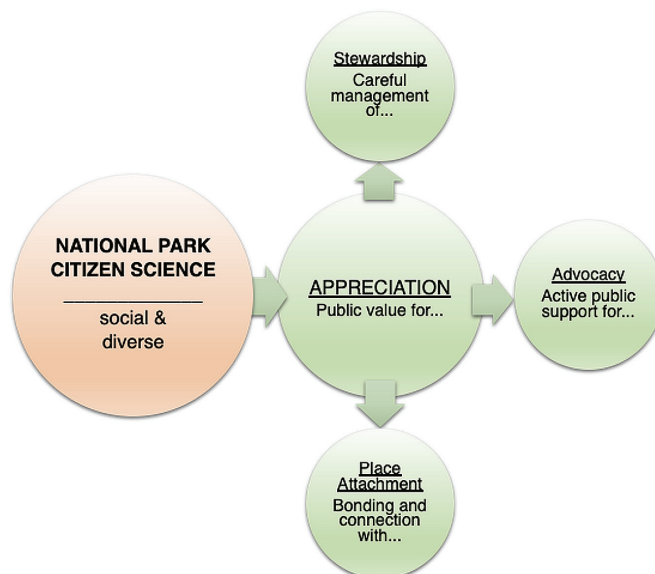
With advancements in citizen science project design, the quality of such studies has greatly improved, yielding actionable findings for park resource managers. However, there are added benefits to citizen science projects that also consider the participant experience. When designed this way, citizen science can potentially instill a deep appreciation for the landscape on which the research is being conducted (Halliwell 2021). The act of attempting to understand a place through a scientific lens can support such a response. A deeper appreciation for these

lands further inspires a sense of connection and a desire to advocate for and steward these places (Figure 1).

### Rocky Mountain Sustainability and Science Network

One organization that has embraced both the potential that citizen science offers and the need for diverse representation in the sciences is the Rocky Mountain Sustainability and Science Network (RMSSN). RMSSN is a collaboratively funded organization that brings a diverse cohort of undergraduate and graduate students together to explore pertinent ecological and social topics. The program, founded in 2009 through a grant from the National Science Foundation, offers valuable leadership and research experience for participants while generating useful science. Approximately 70% of the students in the program are from traditionally under-represented science demographics. Every year RMSSN has to turn away highly qualified candidates due to capacity limitations, highlighting the need for more science opportunities that intentionally and strategically welcome diverse representation. Bowser et al. (2014) explained that the organization is designed to “help train the next diverse generation of interdisciplinary leaders who are prepared to address issues related to global climate change, environmental sustainability, and the management of public lands and resources” (p. 692). RMSSN has displayed a commitment to embracing learning, promoting diversity, and encouraging a collaborative, connected environment in order to build sustainability leaders.

**FIGURE 1.** Theoretical framework for the social elements of national park citizen science. This model recognizes that social and diverse citizen science experiences can nurture a stronger appreciation for the parks, which in turn can help to build a sense of connectedness among participants, along with increased motivations for advocacy and stewardship.



Each year, approximately 25 students participate in a two-week research trip to Grand Teton and Yellowstone National Parks. Partnership and collaborative program grants and donations for all students cover the entire cost of housing, transportation, and meals, thereby mitigating economic participation constraints. While all citizen science research is conducted in the two parks (Figure 2), additional pre- and post-trip workshops are held at the Colorado State University Mountain Campus adjacent to Rocky Mountain National Park. The students (three teams of 5–8 students each) undertake three parallel research efforts: supporting pollinator taxonomic surveys (Figure 3), pika presence or absence studies, and cultural stories connecting to various ecological or geological aspects.

RMSSN is composed of faculty from several institutions, practitioners, and professionals interested in science, sustainability, and education. Examples of diversity among faculty encompass gender, ethnicity, age, and nationality. Faculty represent various areas of academic expertise, and some come from the for-profit sector. This blend of backgrounds creates rich learning opportunities

for cohorts of citizen scientists with various lived experiences and histories. Adding knowledgeable experts in the form of guides, park association personnel, or park rangers throughout the experience only serves to further enhance the learning opportunities. For some participants, engaging with a faculty member or expert who openly shares a familiar cultural background or understanding signifies a life-changing experience.

### The social component

Qualitative and quantitative assessments of the 2018 and 2019 RMSSN cohorts considered how the experience of participating in citizen science research on public lands impacted place attachment, advocacy, and stewardship motivations for participants. Students completed pre-post surveys throughout the effort. The surveys primarily employed two well-established instruments, the Motivations for Environmental Action (MEA) and the Place Attachment Inventory (PAI), which assessed the participant's impressions on a nine-point Likert scale. Quantitative surveys were followed up by focus group sessions in an effort to gain a deeper understanding of each participant's experience. Two separate hour-long sessions were

**FIGURE 2.** An RMSSN student participates in an arachnid survey in Grand Teton National Park. CARRIE LEDERER





**FIGURE 3.** RMSSN field crews pose for a picture after finishing up their pollinator study in Yellowstone National Park. **CARRIE LEDERER**

conducted 75 days post-experience exploring key elements of place attachment and stewardship motivations that were impactful for those involved.

The results revealed that bringing together a diverse group of students to do science on public lands not only resulted in valuable science but appeared to instill a deeper sense of attachment to these lands. The sense of belonging and connectedness was expressed by all students, including minorities. In addition, students indicated greater motivations to steward these public lands in the future (Halliwell 2019). They articulated the value that they understood the lands to have, and often acknowledged a desire to take care of these places and champion their significance to others.

Results of this evaluation revealed that not only did the experience serve to cultivate bonds with the parks and encourage stewardship and advocacy motivations, but that the social facet of the experience is a critical element encouraging these shifts. One student explained, “Just being with everyone got me really excited about it (park stewardship).” Another commented, “It was amazing to be tied in with that community that I was able to make bonds with.” The social element of the citizen science

experience left an impression on those involved and heightened connections that individuals had with the parks. Sharing the experience with others was important. As one student noted, “Obviously the most memorable part of it was the sense of community that you always had. There were all these people who came from so many different backgrounds that were learning about a lot of different things.” This comment illustrates the prominence of community, but it also recognizes the diversity of the community and the learning that was taking place (Halliwell 2019).

### Special places

The experience of engaging with others in scientific pursuit appears to aid in fostering a belief that parks are special places (Leong and Kyle 2014). All students involved with the RMSSN citizen science experience, including students from historically excluded groups, recognized the parks to be special places at the conclusion of the work in Yellowstone and Grand Teton. Only 45% of the same group felt this way prior to the experience (Halliwell 2019). The ability to connect with the parks in a deep manner enhanced this conviction. Time spent on the landscape engaging with the place through a scientific medium had a pronounced impact on those involved.

Students, reflecting on their experience, expressed a range of responses affirming their appreciation, respect, and value for the place (Table 1). Response themes are organized according to theoretical framework outcomes.

The RMSSN experience, like that of many citizen science programs, encouraged participants to explore and understand the parks in an interactive, sensory, and sociocultural manner. In doing so, deep bonds with the place emerge. Participants connect with the parks as they explore them through a scientific medium. These bonds help provide participants a social sense of belonging to a group with a common purpose that involves science within the park while also building on a sense of acknowledging the special essence of the place (Halliwell 2019). Although many citizen science projects are completed by individuals working alone, this project, with this group, was enhanced because of the social element, bringing people together to learn, work, and research collectively.

## Conclusion

Learning, exploring, and studying public lands in a citizen

science forum has the potential to have a powerful impact on participants and offer great scientific results for researchers and managers. Engaging people in parks is central to the mission of NPS. Creating stewards of parks through the discovery of park resources was a core goal of the National Parks BioBlitzes that took place in many national parks as part of the NPS Centennial in 2016. Building on those projects, future citizen science has a valuable place in cultivating appreciation for these iconic lands by a broader and more diverse audience.

Sharing the experience with others and learning from the various voices of a collective cohort is transformative and provides a social sense of belonging that appears to be critical for participants from historically excluded groups. Bonds formed as students learned and worked together with a common purpose. They overcame challenges and celebrated victories together. Being able to share the experience in nature with others added an additional element to the citizen science efforts. The combination of people and place can bring about deeper value to the effort and allow for an advantageous experience for all involved.

**TABLE 1.** Participant quotes reflecting citizen science experience themes.

### THEME: STEWARDSHIP

“... you appreciate how beautiful it is and you’d want to be able to preserve that for future generations.”

“The land is so respected. It’s more sacred to us, a thing to preserve. And that’s what I’m always going to think of these places. It’s very precious. You have to take care of them [parks].”

“We have a responsibility to protect them [parks], visit them, and love them and enjoy them.”

“Walking away from this I have more of a passion for conservation. I feel a responsibility to keep that going, keep expressing that, keep trying to fight for us to treat our lands better, to treat our environment better, and to care for our natural resources.”

### THEME: ADVOCACY

“I definitely want to promote it [parks] to others.”

“Once you get here you want everyone to see it. I want everyone to see it how we have been seeing it ... looking really closely at every square footage. Looking that closely is when you realize what we have to lose.”

“Coming here my connection with nature has risen even more. I want other people to experience that connection. You can’t just spew facts at people because they won’t listen unless they have a connection with the land.”

“This experience gives you this new perspective and connection to nature. I want to go home and tell everybody this little island is not all that is out there. There are bigger things in nature that we should go and visit and appreciate.”

### THEME: PLACE ATTACHMENT

“I connected more in a spiritual way. My mind is blown away by the beautiful landscapes and I don’t know when I will see them again.”

“... the beauty of the place, just the very special environment, all the animals and the ecosystem.”

“... these landscapes are so beautiful and so overwhelming, it’s so amazing.

“This program let us disconnect from ‘real life’ and have a moment for yourself because it is just you, nature, and these people.”

“Being able to do science gave me a whole new perspective of what the park is. There is so much going on on the ground that we should notice. This program gave me that.”

“There is so much to explore ... you just want to dip your hand in everything ... the landscape is so big and there are so many questions that you want to explore.”

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