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Developing a Citizen Science Program that Supports Your Park's Resource Management and Monitoring Needs

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Abstract

Budget cuts, decreasing staff, and increasing resource management issues are common themes for parks and other protected areas. How do parks address the growing resource management issues given the decreasing available resources? Engaging visitors in citizen science programs that support the park's resource management needs and issues may be part of the answer. This paper discusses citizen science and its benefits, points to consider when developing a citizen science program, and concrete examples of citizen science projects that support natural and cultural resource needs of Mammoth Cave National Park (MCNP).

Introduction

Citizen science has been around for centuries and has been called many different things. Public Participation in Scientific Research (PPSR), volunteer monitoring, crowd-sourced science, and amateur naturalists are just a few of the names it has had throughout history. At one point, it was even just called "science" because full-time, professional, scientific careers didn't exist.

Of all its aliases, the term "citizen science" is the one that has gained the most popularity in recent years. It is the term that the public is most familiar with, the one the National Park Service and many other agencies are using, and the one most funding sources recognize. However, the political connotation of the word "citizen" can create inherent issues with the phrase in some locations and among some populations. These are real concerns, and practitioners should be sensitive to them, especially when reaching out to many underserved or under-represented audiences.

At the same time, there is a strong need for the field to come together around a single name and common terminology. If everyone is calling the same technique by a different name, then it is difficult to find that technique in the professional literature. By building consensus around a

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single name, the value and validity of citizen science as a tool or technique can be studied like any other scientific or educational technique (Miller-Rushing 2015).

Whatever we call it, citizen science is simply a collaboration between the public and scientists to conduct research. It is an extremely valuable scientific tool that also has built-in educational opportunities because of the public engagement.

Benefits and challenges

Citizen science integrates research and education in a very hands-on way that deeply engages participants with the resource, and has scientific, educational, and policy-related benefits (Figure 1). One of the advantages of a citizen science project is the number of volunteers that can be involved. By utilizing well-trained volunteers, a scientist or resource manager can collect more data than he or she could do alone. Data processing of videos and pictures also goes faster when there are more eyes sorting through the videos and photographs.

Another advantage of citizen science is that the participants often have a very different knowledge-base and skillset than the scientist or resource manager. Having a diverse set of skills and knowledge working on a project can be valuable in identifying new ways of looking at situations,

Figure 1. Citizen science projects engage visitors in research and have inherent scientific and educational benefits. Many MCNP citizen science projects were developed specifically for the park to address its unique resource management needs. However, the park also participates in national projects like this multi-park citizen science project studying mercury bio-accumulation in dragonfly larvae.

and in developing solutions to some of the inevitable challenges of fieldwork and data management.

Citizen science projects also have important educational benefits. The volunteers have the opportunity to learn first-hand about the resource and the work that goes into caring for and managing that resource. This can lead to deeper visitor connections to the resource and to the park or protected area. Participation in citizen science projects may also lead to increased scientific literacy at a larger scale because the volunteers are actively involved in conducting scientific research.

Citizen science projects may also lead to greater buy-in and support for science-informed policy decisions that are based on the results of a citizen science project. The increased support and buy-in comes from the volunteers' active engagement in the research. Their engagement in the research gives them first-hand experience and a better understanding of the issues, how the research was conducted, and the research results. Even when disagreements occur, the citizen science project can provide a shared platform for conversations based on the science and research.

Like anything else, citizen science also has its challenges. Some of the challenges, like data management, quality control, and fieldwork, are inherent in any scientific research project. One of the biggest challenges unique to citizen science is the idea that it is free. Often the impetus for creating a new citizen science project goes something like this: "We need this research done, but we don't have any time or money to do it. I know! Let's turn it into a citizen science project and get some volunteers to do it for free."

Well-done citizen science projects are not free. Citizen science projects may not even be cheap when the cost of staff time and other resources to support the project are taken into consideration (Fauver et al. 2015). However, just because citizen science isn't free, doesn't mean that it isn't valuable or that it can't be more valuable than the resources that are put into it. It is and can be.

When developing a new citizen science project it is important to recognize and account for the staff time and other resources that need to be invested. If the necessary time and resources are not available, then creating a citizen science project is probably not the best answer. Adequate staff time must be dedicated to working with and training the citizen scientists, building and maintaining relationships, and managing the data. Volunteer training is one of the keys to a successful citizen science project. Professional scientists spend years in college and on the job learning how to conduct the research. It is unrealistic to expect anyone to be able to collect valid data without any training. How much training is required depends on how complicated the task is.

Another challenge is the misperception that citizen science is primarily an educational activity. Luckily this misperception is beginning to fade, but it still exists in some circles. Helping to change this misperception are numerous studies showing that citizen science is a valuable scientific tool that can result in scientifically accurate and valid data (e.g., Meentemeyer et al. 2015, Hoyer et al. 2012, Droege 2007, and Fore, Paulson and O'Laughlin 2001).

Developing a citizen science program

Not every research project is a good candidate for turning into a citizen science project. Before creating a new citizen science project, it is important to consider whether it is the best technique to use in the given situation. All good citizen science projects have four characteristics in common.

First, the volunteers' contributions must matter. Studies show that the primary reason people participate in citizen science projects is to contribute something and make a difference (Raddick et al. 2013). One important way to ensure that their contributions matter is to use the data they collect. If the data aren't being used, then the project is a science experience, not a citizen science project. Whenever possible, share with the participants how their data are being used and the results of the project. Reinforcing how their work is being used helps show that their work is important and is making a difference.

Second, the project needs to have clear, scientifically valid protocols. Clear, scientifically valid protocols are important for any research project. Citizen science projects are a scientific tool and have the same requirements as other research projects when it comes to protocols that produce valid data. Making sure those protocols are in place also helps ensure that the participants' contributions matter.

Third, the protocols should be easy to follow and include relatively easy techniques. Many of the citizen scientists will have little or no previous scientific training to draw upon. Being able to train them how to do the work is critical to the project's success. Therefore, relatively easy techniques are important because it is easier to learn something simple than to learn something complex. That's not to say citizen scientists can't conduct complex research or use more complicated techniques. They can, but will either need more training or more knowledge and experience coming into the project.

Fourth, the project should be something people care about or can have fun doing. Don't forget that the citizen scientists are volunteers. They are choosing to help with the research instead of doing the multitude of other things they could be doing.

Developing a new citizen science project for a park or protected area can be done in a number of ways. Given the importance of making sure the data are used and that the participants' contributions matter, we typically consider two important questions when developing new citizen science projects for MCNP. What projects would we do if we had unlimited resources? Do our researchers need help with a piece of their projects?

The unlimited resources question can be divided into a number of sub-categories including inventory and monitoring projects, follow-ups to previous studies, and pure research or curiosity questions. There are a number of national inventory and monitoring citizen science projects that already have established protocols, educational tools, and data management systems. Tying into these projects whenever possible saves time and allows the data collected at your site to also be used for larger, landscape-scale questions. Project Budburst is an example of a national citizen science project that Mammoth Cave has partnered with and is using to look at phenology and climate change.

Many citizen science projects focus on natural resources; however, cultural resource projects can also be sources for new citizen science projects. At MCNP, there are ongoing questions about when cultural resources in the cave appeared or were modified. In 2013, a series of these questions came up that were eventually answered by looking back through the historic photographs. We realized that people in 50–100 years will likely ask similar questions about the cave in the early 2000s. To address this issue, we developed a citizen science project that uses photo-documentation to monitor changes in cultural resources within the cave. This project finds historic photographs and retakes the picture from as close to the same location as possible. The pictures create a photographic record showing any changes that may have occurred between the times when the two pictures were taken.

Follow-up studies are another source for new citizen science projects. In the mid-1990s, wood frog and salamander egg mass surveys were conducted at Mammoth Cave. Since that study concluded, climate change has continued, amphibian diseases have spread, and policy changes have occurred that allow for brining of park roads during winter weather events. Each of these changes could impact early breeding amphibian species. A group of middle school students from the park's neighboring school district is now conducting wood frog and salamander egg mass surveys as an ongoing citizen science project (Figure 2). They are using the same protocols and a subset of the same ponds as the original researcher so their results can be directly compared to the earlier research. These students are actively engaged in every step of the scientific process and their teacher is the PI on the research permit.

Figure 2. A class of middle school students are conducting wood frog and salamander egg mass surveys at MCNP. This is a follow-up to a project that was originally conducted in the mid-1990s.

Pure research and curiosity questions provide yet another rich source of citizen science projects. This can be a dangerous category to pursue because there are so many interesting questions and topics, but it can also be very rewarding. One of the questions that we pursued was to learn more about one of Mammoth Cave's underground rivers that routinely flows backwards. Seventh graders from a local middle school did a 4-year study gathering temperature data on the river. They used that data as a proxy for determining the frequency and duration of the reverse flow events. We are currently working on a paper publishing the students' findings.

When developing new citizen science projects, MCNP also talks to its researchers to find out if they need additional help with their projects. One scientist conducting research at the park is studying how quickly runoff from parking lots and roads can transport contaminants from the surface into the cave at different times of the year and with different precipitation patterns. However, the scientist needed more data than he and his students could gather on their own. We worked with him to develop a citizen science project where middle school through college students who visited Mammoth Cave could collect data for his project (Figure 3). The citizen scientists use the same techniques the PI and his students use to collect water-discharge data. The data are then sent to the researcher who incorporates it into his mathematical model. We are also beginning to develop additional citizen science projects with him.

Conclusion

Citizen science can be a valuable asset to parks and protected areas that have the time, resources,

Figure 3. Researchers who need help gathering additional data may be receptive to developing a citizen science project to gather that data. The Mammoth Cave International Center for Science and Learning worked with a researcher to develop two citizen science projects based on his work at MCNP.

and interest to invest. It is an important scientific tool that includes inherent educational and visitor outreach opportunities. Like any other tool, citizen science projects have benefits and challenges which should be considered before the project is started. MCNP is one of many parks and protected areas that are using citizen science projects to support the park's resource management and monitoring needs.

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