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Climbers for Bat Conservation: creating a citizen science program in Red River Gorge Kentucky

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In recent years, North American bat populations have been presented with new conservation threats including white-nose syndrome. As these threats continue to impact bats it is important to locate and study these populations. Though most bats tend to roost and hibernate in caves, still many roost in cracks, crevices, and other hard to reach places. Rock climbers recreate on a large array of rock features that are inaccessible or unknown to bat biologists and could serve as a valuable resource in identifying the location of bat species for conservation efforts. Yet, developing and maintaining a productive relationship between recreationists and the conservation community can be challenging, making environmental communication vital to successful collaborative efforts. We explored rock climbers' willingness to participate in a citizen science program for reporting bat sightings through Climbers for Bat Conservation (CBC) while at Red River Gorge (RRG), Kentucky. We utilized a mixed methods case study consisting of a world café facilitated dialog with members of a local climbing organization, bat biologists, land managers, and landowners ($n = 18$) as well as semi-structured interview data ($n = 12$) collected at a local climbing festival. Results indicate mutual importance given to bats, climbing, and conservation from world café attendees. Additionally, attendees identified three key parts of a bat observation that would be critical data for rock climbers to report which included presence of a bat, the location, and the climbing route name. Finally, attendees identified having a local climbing ranger or climbing liaison as important to organizing other climbers to submit data. Interview data revealed that the most mentioned barriers to submitting a bat report were awareness of CBC, time, convenience, forgetfulness, fear of route closures, and access to a phone. A discussion follows detailing how this information may be used to further the design and implementation of a citizen science program as well as increase climber engagement at RRG.

KEYWORDS

citizen science, adventure recreation, bat conservation, world café, collaborative research, rock climbers

Introduction

Citizen science is a broad term often used to refer to involvement of the public in scientific research (Eitzel et al., 2017). Although citizen science continues to grow in its use for biodiversity research (Theobald et al., 2014), there are still many scientists who are wary of the reliability of the data obtained by the public (Riesch and Potter, 2014).

Despite these apprehensions, many scientists rely on the breadth of data obtained by citizen scientists as it would be infeasible, either financially or practically, to collect in alternative ways. In these cases, environmental communication, specifically through user-friendly interfaces, face-to-face interactions, social platforms, and accessible dissemination of results, is vital to the success of the scientific endeavor as well as the social benefits and feelings of contribution obtained by citizen scientists (Golumbic et al., 2019). Environmental communication can be broadly defined as "the pragmatic and constitutive modes of expression of our ecological relationships in the world" (Pezzullo and Cox, 2018, p. 13). This type of communication becomes increasingly important when working within the complex intersection of recreation, resource management, and conservation which involves multiple, diverse stakeholders who hold different values toward natural resources (Lindenfeld et al., 2012). Collaboration with land and resource managers is seen as a key underpinning to the future success of conservation and access of outdoor adventure recreationists (Schild, 2019). As we move forward into an era of greater and more diversified use of citizen science, environmental communication will continue to play an important role to both connect and inform the multiple stakeholders who utilize natural areas for recreation, conservation, management, and beyond.

Outdoor adventure recreation is an increasingly popular activity in the United States, and rock climbing is no exception. Recreational rock climbing is a growing sport, with over nine million individuals participating annually (Farris, 1998; McMillan and Larson, 2002; Cordell, 2004). There are more than 2,000 identified crags (climbing areas) in the United States (Attarian and Keith, 2008), and land managers collaborate with natural resource professionals and outdoor enthusiasts to prevent, limit, and mitigate ecological damage to recreational areas. Rock climbing can impact flora and fauna diversity along cliff systems, so it is important to collaborate on resource conservation issues to maintain recreational and ecological value (Covy et al., 2019). Climbers have begun to aid bat conservation by providing data on where they see bats roosting on cliff systems, and this has been especially valuable for filling knowledge gaps about height, aspects, and repeated use of roosting sites (Schorr et al., 2022).

With over 1,400 bat species worldwide, and 15% considered threatened by the International Union for Conservation of Nature (IUCN) (Frick et al., 2019), bat conservation is essential. Bats, the most widely distributed mammal group, provide multiple ecological, and human-health benefits. As insectivores they consume massive quantities of insects that can be either crop pests or disease vectors (Boyles et al., 2011; Ghanem and Voigt, 2012). As frugivores, bats disperse seed and pollinate flowers of many fruits consumed by humans (Fleming et al., 2009). Even extracts from bat saliva have proven to be beneficial heart medication for humans (Fernandez et al., 1999).

In North America, wind energy development and white-nose syndrome (WNS) have contributed to precipitous declines in the past two decades (Frick et al., 2016). WNS is normally identified by characteristic lesions caused by the psychrophilic (cold-loving) fungus *Pseudogymnoascus destructans* (*Pd*). The fungus erodes and replaces the living skin of bats as they are in their hibernacula resulting in arousal from torpor, energy depletion, and fatality (Cryan et al., 2013). Total losses exceed millions of bats and as much as a 90% population decline for certain species from 2006 to 2018 in the eastern United States (Thalken et al., 2018; Cheng et al., 2021). Most declines have been documented at caves and mines, with little information about how bats might be using other roost structures, like cliff cracks.

Bats roost in obscure places, often in difficult-to-reach areas. Areas that are difficult for humans to access, like cracks, may house thousands of bats and be critical bat habitat (Bogan et al., 2003). The inability to reach precipitous areas, such as cliffs, has resulted in a void of information concerning potential winter and summer roosting sites for bats (Schorr et al., 2022). Though cliffs and cracks serve as prime bat habitats, historically there has been little attempt to complete cliff surveys (Knecht and Lyons-Gould, 2016; Bat Rock Habitat Key, 2021) that would provide bat biologists with data to understand population dynamics, and life history characteristics to best conserve these organisms.

Rock-climbing biologists along with recreational climber information can provide route-specific information on hard-to-reach locations where bats may reside (Knecht and Lyons-Gould, 2016; Davis et al., 2017). As rock climbing gains popularity, there are new opportunities to learn about bat ecology. Communication through collaborations between rock climbers and biologists may be key to understanding bat population changes and how bats use cliff systems.

Six major zones used by climbing recreationalists have been identified as having potential to be negatively impacted by human use; the approach (access trail), staging area (cliff-bottom), climb (cliff face), summit (cliff-top), descent (descent trail or rappel route), and campsite (Access Fund, 2001). Each zone provides niche habitats and resources for flora and fauna. Climbers are the only recreational user group to utilize cliff walls and it remains unclear what impacts climbers have on bat roosting along cliffs (Loeb and Jodice, 2018), largely because it is challenging to study roosting ecology in inaccessible cracks and recesses (Wood et al., 2006; Bat Rock Habitat Key, 2021; Schorr et al., 2022).

While peer-reviewed literature regarding climbers contributing to the conservation of bats is scarce, there is evidence that climbers and bat scientists are collaborating. Schorr et al. (2022) completed cliff surveys and were able to determine prevalence of bats along existing recreational climbing routes in Colorado. Several protected areas in the U.S. National Parks system have been working with climbers in various ways to conserve cliff dwelling bat populations. In 2014, cliff roosting bats were found in Devils Tower National Monument. Shortly after, seasonal biological science technicians with rock climbing experience were hired to conduct surveys for bat roosts on a seasonal basis and monitor for the *Pseudogymnoascus destructans* (*Pd*), the fungus that causes white-nose syndrome in bats. Climber technicians chose survey locations based on observations of bat emergence areas, in addition to following up on citizen science bat reports. In 2021, wildlife researchers in Devils Tower National Monument confirmed the first case of WNS in the state of Wyoming (US National Park Service, 2021a). Since then, monument staff are working with climbers to develop guidelines on how climbers can best help prevent the spread of *Pd* in Wyoming (US National Park Service, 2021b).

Yosemite National Park's Big Wall Bat Program was established in 2018 by a climber biologist, with the goal of finding and monitoring bat roosts before the arrival of *Pd*. The program is working to identify as many roosts as possible to monitor temperature and humidity. This information provides valuable insight into whether *Pd* is viable in Yosemite's cliff conditions. During the 2022 season, the project received approximately 40 reports of bats and documented at least 16 new roosts (Miller, 2022).

In 2018 Zion National Park started their own Big Wall Bat program and employed a vertical habitat specialist. The habitat specialist works closely with climber volunteers on a daily basis to carry and rig climbing gear, collect data, and occasionally assist on rescues (Pope, 2021). Zion National Park also recruits climber volunteers to assist in Peregrine Falcon (Falco *peregrinus*) conservation, with an estimated 172 h of volunteer participation (from both climbers and non-climbers) in the 2022 season (US National Park Service, 2022).

Citizen science is also being used to study bats (Davis et al., 2017). A non-governmental organization, Climbers for Bat Conservation (CBC), was co-founded in 2013 by the third (RS) and last authors (SD), to address the dearth of data on cliff dwelling bats and the need for conservation of bats. The organization aims to encourage climbers from around the world to communicate the location of bats seen or evidence of bats (e.g., guano) and features of the route while rock climbing. Primarily using social media and tabling at climbing festivals to become better known in the climbing community, CBC's community sourced reports are made available for scientists to use in their work (Davis et al., 2017). In 2019, RS worked with local climber researchers to survey 48 climbing routes which resulted in the identification of two roosts and an additional citizen science report (Schorr et al., 2022). While early research found that the biggest challenge for bringing biologists, land managers, and climbers to the same collaborative mindset was overcoming an external belief that scientific data would be used to restrict access to climbing areas (Davis et al., 2017), it was also confirmed that collaborative opportunities exist. Recently CBC has focused on collaborative research (Pasmore et al., 2008) efforts to learn how to increase reports of bats in one of the most popular climbing areas in the U.S., Red River Gorge (RRG), Kentucky. This community case study reports the collaborative research that has thus far occurred with this effort.

Context

One region of Kentucky where cliff cracks are abundant is also a popular climbing area known as the Red River Gorge (RRG). The cliffs in this geologically-important region may be home to a variety of the 16 bat species known to occur in Kentucky. Red River Gorge, Kentucky (also known by many climbers as "the Red") is a world-class climbing destination, and also boasts a uniquely tight-knit climbing community. This community is cultivated at a location known by rock climbers as Miguel's Pizza, which has amenities beyond just the restaurant that goes by this name, including a climber-only campground, climbing gear shop, and a meeting spot (Rickly, 2014). This area is located to the southwest of the town of Slade and just outside the boundary of Red River Gorge Geological Area, located within the Daniel Boone National Forest. The climbing areas are vast and spread between seven main geographic locations: Bald Rock Recreational Preserve (BRRP), Cathedral Domain, Miller Fork Recreational Preserve, Muir Valley, Natural Bridge Region, Northern Gorge, and Pendergrass-Murray Recreational Preserve (PMRP). From mid-September through November, climbers from around the world flock to climb the roughly 3,000 routes many of which are located on Corbin sandstone conglomerate (Reding et al., 2022). These steep cliffs, with pocketed features attract many rock climbers to the area, and likely provide habitat for many Kentucky bats.

While the Red hosts many events for climbers throughout the year, the largest is Red River Gorge Climber's Coalition's annual festival called Rocktoberfest with approximately 1,200 attendees per year (Maples, 2020). Every October, sponsor booths encourage participants to try out climbing gear, play games, and buy merchandise and food. Climbers take part in climbing competitions, workshops, and connect with their local climbing community. This festival financially benefits the Red River Gorge Climbers Coalition (RRGCC) via entrance fees paid. RRGCC is a staple of this community as it works to secure access to climbing areas while conserving the cliff face and its surrounding environment (Figure 1).

Details

Development of this citizen science program follows a process outlined by Fraisl et al. (2022). The researchers identify six distinct stages for designing and implementing citizen science projects focused on ecology; (1) identify the need or the problem; (2) determine if citizen science is the correct approach; (3) design the project; (4) build the community; (5) manage the data; and (6) evaluate the project (Fraisl et al., 2022). The first stage of this process was completed by (RS), who conducted a thorough literature review and identified a lack of information pertaining to crack and crevice roosting bats. We determined that citizen science was an appropriate approach for this process through an earlier world café held in Fort Collins, CO in 2014 (Davis et al., 2017). The world café process is a participatory method designed to create a collaborative and productive dialogue and deliberately seeks everyone's voice and wisdom in a welcoming, conversation-based atmosphere (Brown and Isaacs, 2005). Fraisl et al. (2022) recommend that citizen science projects meet the dual goals of obtaining the desired scientific results as well as delivering tangible benefits to the participants. During this world café we uncovered that climbers could obtain the data required by bat biologists while also obtaining recreational benefits and helping to ensure access to climbing areas remained intact (Davis et al., 2017). Stages three through five remain the focus of the current collaborative research process outlined below (Figure 2).

Collaborative research efforts involved multiple stakeholders, namely a social scientist from Slippery Rock University, a bat biologist from Colorado State University, CBC employees, two graduate students, scientists from a federal agency and numerous rock climbing volunteers. This project used a single-case study design (Yin, 2003) which combines qualitative data from the world

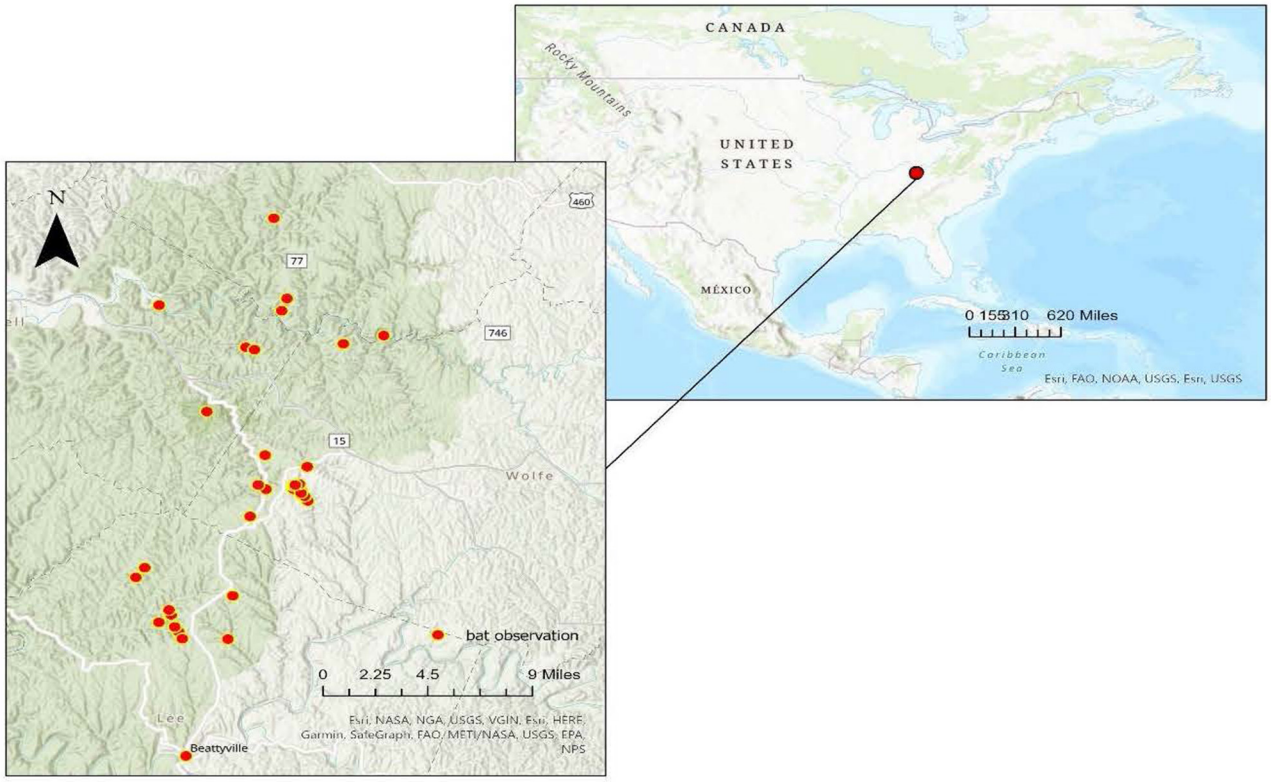

FIGURE 1
Map showing study area and number (32) of reported bat observations.

cafés (Brown et al., 2008) and semi-structured interviews (Willis, 2007) to build a greater understanding of the context. In the following sections, we will begin by describing the world cafe process followed by the semi-structured interview processes.

World café process

On Saturday, October 5th of 2019 the CBC, Slippery Rock University's Department of Parks and Conservation (SRU), the U.S. Fish and Wildlife Service (USFWS), the U.S. National Forest Service, and the Red River Gorge Climbers' Coalition convened a meeting of bat biologists ($n = 4$), rock climbers ($n = 11$), and land managers ($n = 3$) to develop a collaboration and potential new chapter of CBC. This meeting was hosted at Hemlock Lodge, Natural Bridges State Park, in the heart of some of North America's most scenic climbing terrain. This partnership of climbers, biologists, and land managers aimed at helping biologists locate new bat roosts while maintaining access to recreational climbing areas. This meeting presented an opportunity to discuss what a collaboration could look like, how we could develop mutually beneficial scenarios for biologists and climbers, and how we could increase bat knowledge in Kentucky.

Following presentations about bat conservation and the CBC organization, an introduction to the world café process was presented to the group. During the facilitated world café process, participants were asked to seat themselves in equal groups, then posed three questions pertaining to collaboration among rock climbers and bat biologist. These questions served as a catalyst for conversation during the meeting and were created by the facilitation team using a process outlined by Vogt et al. (2003). The questions asked included: (1) What is important to you about bats, climbing, and/or conservation, and why; (2) What information is important to gather about bats and how can we leverage our unique skills and talents to achieve it; and (3) What doors could we open today that would allow for greater collaboration moving forward.

After the first question was posed, participants within each group discussed their ideas and shared their responses in café-like conversations, and then each group shared their main ideas through a full group harvesting process (Brown and Isaacs, 2005). Prior to the second question, participants were asked to disband their group and assemble with participants from other groups, as a way of reshuffling the participants, increasing exposure to different viewpoints, and ensuring open communication and exchange of ideas. This was repeated prior to the third question, as well. Throughout the discussions, groups were asked for their main points, then to post those points on the surrounding walls using adhesive notes. Notes were grouped by the facilitator as well as participants according to main ideas through a process of inductive coding. Participants discussed those points, ideas, challenges, and opportunities.

Data obtained from the questions posed during the world café process were analyzed differently as the process builds upon previously established levels of understanding. Answers to

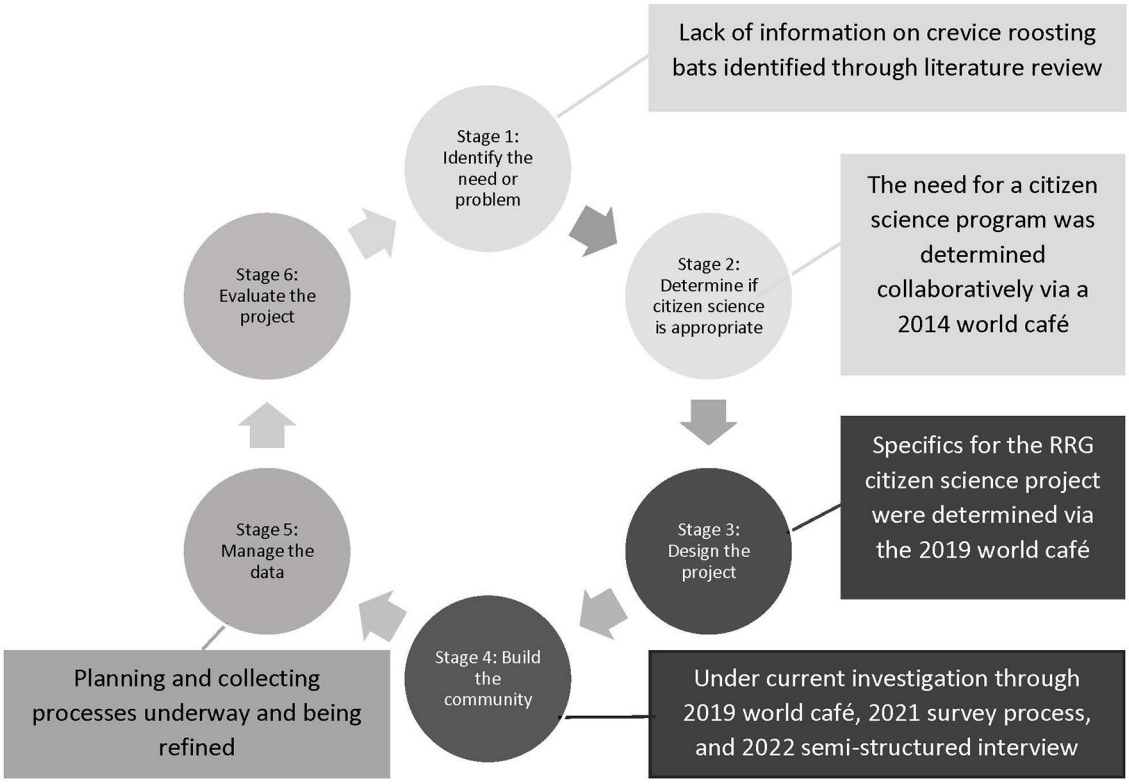

FIGURE 2
Stages of design and implementation of the Climbers for Bat Conservation citizen science project in Red River Gorge (RRG), Kentucky. Activities pertaining to the current research are in dark gray. Adapted from Fraisl et al. (2022).

question 1 were coded inductively by the lead researcher and later deductively coded by another member of the research team to achieve an original inter-coder reliability of 77%. After discussion, both researchers agreed on the thematic placement of the answers.

The answers to question 2 were split into two categories of what constitutes important information to gather and how to achieve that information. Participants posted their important information responses alongside the corresponding best way to achieve it. Participants met together at the board where responses were posted and together decided how these best fit together. Participants were then given two dot stickers to vote on what they determined to be the two most important pairings (the information to gather along with its method to achieve it) to work toward.

In the final question, each smaller café discussion group was asked to decide on their best solution for creating greater collaboration in the future. Groups announced and posted their decisions on the board. If a group deemed that their idea was similar enough to a previous idea, they could group the ideas together. Participants were then given two dot stickers to vote on what they determined to be the two most important solutions moving forward.

Answers to the question, "What is important to you about bats, climbing, and/or conservation, and why?" demonstrated a broad range of importance for bats, climbing, and conservation (Table 1). A theme of connection and coexistence resonated as can be seen in the first set of comments. These results point to the greater importance of these collective subjects (bats, climbing, and conservation) and how they work together rather than their disparate parts. Education of others was another theme found through the second set of comments. Finally, a theme of resource conservation emerged in the third set of comments.

Of the different pieces of information that were deemed important to attain, presence of bats, location, and date of observation were found to be most important (Table 2). It was also determined that these data would be best reported using a phone app with a location and time tag. Alternatively, climbers could report the route on which they saw bats via the same app if location tags were unavailable or if reporting the route would lead to more exact locations. An emphasis was put on keeping it simple; reporting only the top three pieces of information. Additionally, it was also deemed important to provide the climbing community basic bat information. Participants decided that the best way to achieve this was through a field day guided by a bat biologist, however, this could also be achieved via kiosks at climbing sites.

In order to keep this collaboration moving forward, the group overwhelmingly decided that a local liaison, specifically a climbing ranger, would be the best method to continue engagement efforts and work with CBC to communicate new information (Table 2). Having a point person who can span the realms of conservation and recreational climbing was found to be desirable as it was mentioned in two of the six solutions. Also, of importance, was the idea of

TABLE 1 Participant answers to world café question one organized by theme.

Theme	Answer
Connection/Coexistence	"Bats connect and bring together realms of management, conservation, and climbing"
	"Multi-use areas that allow for bats and climbing to co-exist"
	"Conservation groups act as a structure for the environment and recreational culture"
	"Rock climbing rangers who can fill both roles of conservation and climbing"
	"Builds and connects the community"
Education	"Education of others through facts about bats"
	"Education and awareness to a specialized user group"
	"Increasing the impact awareness of climbers"
	"Mentorship of others"
Resource Conservation	"Helping landowners to better care for their land/natural resources"
	"How the development of trails influences climbing and the impacts from such development"
	"Bats act to improve the ecosystem"
	"Long term data on bats, climbing, and impact"

communicating successful examples of collaboration as a means of reporting progress and enticing participation.

Semi-structured interview process

In the fall of 2022, semi-structured interviews ($n = 12$) were conducted by EG with area climbers over two days at Red River Gorge's annual climbing festival, Rocktoberfest, to gain insight on awareness of CBC, barriers to reporting bats, and bat reporting behaviors. Every third individual, who walked by was selected and asked if they were a rock climber and 18 years or older. If they responded in the affirmative they were then asked to participate in an unrecorded interview. Interviews ranged from 15 min to 1 h. Nine interviews were conducted with masculine presenting participants and three with feminine presenting participants. Detailed notes were taken directly following each interview to best capture the details of the conversation and saturation was reached after 12 interviews (Bernard, 2002). The study was conducted under Colorado State University IRB Protocol 3864.

Half of the interviewees were aware of CBC and recognized why reporting bats was important. Ten categories of barriers emerged from the interviews. Besides awareness of CBC, the most frequently mentioned barriers to reporting bats were lack of time, inconvenience, forgetfulness, fear of route closures and no access to a phone (see Table 3 for full list of barriers). Knowledge concerning CBC may also impact reporting behavior. For example, some climbers who had heard of CBC and not reported a bat had inaccurate knowledge of what that information was used for, which may have prevented them from reporting. Alternatively, one interviewee had inaccurate knowledge of the purpose of CBC, but still reported a bat due to their friend wearing a CBC shirt. Most interviewees mentioned how they identify as a climber, although this question was not prompted. Identity is an important factor but becomes more nuanced when considering locality, climber discipline, and organizational affiliation. Five participants of the semi-structured interviews self-identified as locals to the Red River Gorge region, while two alluded to their local status in their answers. Climbers who identified as non-local reported fear of climbing route closures as a barrier more than climbers who identified as local. Additionally, members of River Gorge Climbers Coalition shared that their perspectives were directly influenced by their involvement with the local climbing organization (LCO).

Discussion

Results from the world café process demonstrate that participants conceptualize the holistic importance of bats as well as rock climbers' roles in both education and conservation related initiatives. This result may be expected as participants self-selected to attend the world café. Nonetheless, these themes of connection, education, and resource conservation will be important to consider as they serve as intrinsic motivators for the group and help to outline important benefits for the participants; an important consideration when considering citizen science (Fraisl et al., 2022). The feeling of community and connection toward a common cause of facilitating bat conservation and continued climbing is pivotal in moving forward. Increased attention to education is vital to ensure everyone knows how such a collaboration helps conservation, as well as to clarify the role of CBC and counter misinformation regarding the organization's purpose. These results point to a population that may be interested in participating in a citizen science program such as submitting bats sightings to CBC.

Answers to the second question in the world café revealed valuable considerations for the data needs and the design of collection tools; hallmarks of the third stage in designing a citizen science project (Fraisl et al., 2022). Participants emphasized the need for simplicity in both the data they were to submit as well as in the mode of submission, favoring a cell phone app with a fillable form that automatically used geolocation and timestamps. Since the completion of the world café in 2019, CBC has created a fillable form that is accessible from their website. The form has fields to collect the observer's name and contact information, date and time of observation, type of evidence (whether seeing a bat or signs of a bat such as guano), number of bats, pictures of bats, climbing route, type of feature the bat was found in, height of the observation, width, length, and depth of the crack or feature, and aspect of the route. Though the form includes nearly all the important information discussed during the world café, it goes beyond the simplicity desired by the participants and shown to be effective in engaging other citizen scientists (Arienzo et al., 2021). However, these short comings are alleviated by only requiring the name of the observer, name of the climbing route, and location on the form to submit a report. Additionally, CBC has begun producing stickers which feature a QR code that links directly to the reporting form, in the absence of an associated app.

TABLE 2 Participant answers and subsequent voting for world café questions two and three.

Questions	Answers		Votes (*n*)
	Important information	How to achieve	
Question 2. What information is important to gather about bats and how can we leverage our unique talents and skills to achieve it?	"Best observation times"	"Time stamp observations"	1
	"Bat species"	"Photos sent to biologists"	1
	"Crack dimensions"	"Climber observations"	1
	"Climber buy-in"	"Bat outings/kiosks"	2
	"Roost parameters"	"Cell phone app fillable form"	3
	"Location, sight/sound, staining, stay or flee"	"Key characteristics observation"	3
	"Top three pieces of information"	"See a bat? What Route? Give a shout!"	9
	"Location, height, aspect"	"Phone photo GPS"	9
	"Bat 101 information"	"Field day guided by biologist"	10
	Answers		
Question 3. What doors could we open today that would allow for greater collaboration moving forward?	"Have a representative guide the process"		1
	"Build a consortium of trust"		2
	"Put the focus on what everyone can do for the community		2
	"Climber education through RRGCC social media"		3
	"Communicate successful examples of collaboration"		10
	"Employ a local liaison, i.e., a climbing ranger"		16

Basic information about bats was also desired by participants. This is currently being achieved through extensive information on the CBC website, however, participants overwhelmingly favored field days with a bat biologist for this information. Though this does exemplify in-person collaboration between bat biologists and climbers, the feasibility of performing this type of activity frequently and at scale is questionable. Still, CBC has managed a number of these types of excursions in the past.

In moving forward in this collaboration, participants indicated that having a liaison, or someone who actively rock climbs and manages the citizen science aspect of the collaboration would be favorable. Though having a paid rock climbing ranger may not be feasible, a dedicated, trained member of the RRGCC may be able to fill this role well, for example serving in the role of a volunteer ambassador. This approach is widely employed in citizen science efforts dedicated to environmental research (for examples see Chu et al., 2015; Schläppy et al., 2017). Having a well-known, respected member of the RRG rock climbing community may also help to speed the social diffusion of this citizen science effort by having pre-existing social connections to many climbers in the area. Such opinion leaders have been found to be influential in promoting new behaviors and behavior change (Burn, 1991; Rogers, 2003; Abrahamse and Steg, 2013). Additionally, learning about CBC through a trusted source, such as a fellow climber, could help to clarify key facts and misinformation about the organization's purpose (Goldberg et al., 2019). Though this would certainly aid in encouraging more community participation in the project, it should be noted that the researchers have actively employed other means of building the community as suggested by Fraisl et al. (2022) such as hosting facilitated workshops (e.g., world café) as well as acknowledging contributions through gifts of CBC tee-shirts and visualization tools such as displaying participant generated bat sightings on an ArcGIS dashboard accessible from the CBC website.

Results from the semi-structured interviews demonstrate that at least ten types of barriers exist for reporting bats to CBC. The research was carried out to inform a community-based social marketing (CBSM) campaign which has been identified by CBC as a priority for increasing reporting of bats. In part, identifying barriers to a specific behavior, such as reporting bats to CBC, is paramount to a successful CBSM campaign (McKenzie-Mohr, 2011). CBSM applies principles of psychology and traditional marketing to encourage behavior change by working closely within a specific community to establish behavior change campaigns. CBSM campaigns have been used with success for changing recreationalists' behavior resulting in increased protection for wildlife. For example, to increase safe wildlife viewing in four U.S. national parks, Abrams et al. (2019) shifted the messaging strategy from highlighting the risk to the animal, to highlighting the barriers and benefits to the individuals visiting the park. Highlighting personal safety, as well as removing barriers to photo opportunities and wildlife viewing resulted in an increase of safe wildlife viewing in three of the four parks. With such a wide range of barriers identified in our study, future research should identify the most common barriers specific to climbers at the Red in order to know which ones should be focal points in a CBSM campaign.

Climber identity was also highlighted by a few interviewees, and we hypothesize that this may also impact reporting behavior. Climbers typically identify by the discipline of climbing they participate in such as top-rope climbers, who climb a route that is protected by a rope that is fixed at the top of the climbing

TABLE 3 Thematic barriers mentioned by interviewees and definition of barriers from twelve semi-structured interviews at Red River Gorge Rocktoberfest 2023.

Barriers	Definition	Number of references**
Lack of awareness*	Knowledge of the existence of CBC	5
No time	Not enough time in schedule, making the time to report	4
Inconvenience	Ease of reporting	4
Forgetfulness	Not remembering to report	4
Fear of closures	Worry that identifying bats will result in closures like raptor closures	4
No phone access	Climbers mentioned both not having cell phone service or purposely not bringing phone to crag	4
Apathy	Don't care about reporting, bats, or the environment	3
Inaccurate knowledge	Misinformation on what CBC does as an organization	3
Care for bats	Caring for the wellbeing of bats or feeling unsettled by bats	3
Lack of importance	Questioning whether the information is of value	3

*Interviewees were asked, besides awareness of CBC, what may stop you from reporting a bat? Yet, awareness still emerged as a theme in the interviews. See discussion section for thoughts on this theme. **The number of references in this column do not equal 12 as each participant stated several barriers.

route; sport climbers, who clip the rope into fixed bolts along the route for protection; and traditional climbers, who place temporary protective gear in the rock while free climbing. Carter (2021) found that those who identify as traditional climbers were more likely to volunteer, donate, and join a local climbing organization. Our semi-structured interview results demonstrated a connection to place and belonging also influenced climber identity. The local identity aligns with the work of Rickly (2017) who found that Red River Gorge climbers can be grouped into different climbing identities including leisure climbers, lifestyle climbers (which includes locals), and professional climbers. Rickly also found that climbers who identified as local were most active in community organizations and events. Local climbers may be more engaged with their local climber's coalition and therefore may have better knowledge of CBC and less fear of route closures. More data is needed to understand how barriers align with climber identities and how together they may impact reporting behavior.

There are several overlapping participant reported themes within the two methods of data collection presented in this study. Consistent among both methods was an issue of convenience or ease of reporting. This is demonstrated by the simplicity of the top three pieces of information suggested in the world café and in the third barrier of convenience mentioned in the interviews. Making a more convenient reporting form would be a way to alleviate these issues as well as potentially address the second barrier of time discussed in the interview data. The semi-structured interview data revealed awareness of CBC to be a barrier even though participants were asked to specifically not consider it. This could be interpreted in two ways. Interviewees were primed to discuss awareness by the concept being specifically mentioned by the researcher. Alternatively, it is a major barrier interviewees chose to emphasize. Regardless, it is obvious that awareness of CBC is required to report bats to the organization. Similarly, Carter (2023) found that familiarity with a civic recreation organization was positively related to rock climbers engaging in volunteer behavior. A local liaison as suggested by the world café data may be able to not only increase the awareness of CBC but also correct any misinformation regarding the organization. Given that membership in an LCO such as the RRGCC may influence perspectives, as suggested by the interview data, having a member of the RRGCC fill this role may be important to the continued success of CBC.

As demonstrated in this paper, the Red River Gorge climbing community offers a unique opportunity for collaborative conservation between local landowners, area biologists, and rock climbers. To continue building upon the current collaborative process, it is suggested that the results of this research be incorporated into a behavior change campaign rooted in CBSM. With additional interview data, a survey could be constructed to better represent the population of climbers within this and potentially other climbing areas. Though this research is a community case study, and the results are highly contextualized, the findings help to corroborate previous results from other studies and may be valuable to similar citizen science programs that utilize outdoor recreationists. Of the findings, the authors recommend that future, similar citizen science programs utilize a liaison (e.g., trained ambassador) who can serve as an intermediary between scientists and community members, engage in ongoing face-to-face advocacy where possible, and provide accessible education related to the project's structure, purpose, data needs, and important findings.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants for the semi-structured interviews were reviewed and approved by Colorado State University IRB Protocol 3864. The studies involving human participants for the world cafe process were reviewed and approved by Slippery Rock University IRB Protocol 2021-074-71-A. The patients/participants provided their verbal informed consent to participate in this study.

Author contributions

MS wrote the first draft of the manuscript. EG contributed the semi-structured interview data and associated section, the

context, and Table 3. SD contributed to the world cafe data, the associated section and tables, and Figure 2. RS, SD, EG, JS, and MS contributed to the introduction. RS contributed Figure 1. EG, JS, and SD contributed to the discussion. JS contributed to the conceptualization and design of the semi-structured interview study and the interpretation of data. JS and SD served as reviewers and editors of the entire manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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