

RESEARCH PAPER

Butterfly Citizen Science Projects Support Conservation Activities among their Volunteers

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Citizen science has the potential to provide participants with information about conservation issues and to encourage additional conservation actions. In this case study, we describe the current state of conservation education among butterfly citizen science projects in the United States. To determine the extent to which these citizen science projects are promoting an understanding of, and engagement in, conservation among their participants, we used an online questionnaire to census project leaders and assessed their websites for the presence of educational conservation information. We found that the majority (91%, $n = 22$) of butterfly citizen science projects in the United States include a conservation focus, and that they are educating their participants about key conservation threats and action strategies. Many are also using personal appeals, behavioral incentives, and the social interactions among participants to encourage their participants to engage in butterfly conservation outside the project. We found room for improvement on educating participants, especially about indirect conservation opportunities such as financial donations and outreach activities. We also suggest more widespread and effective use of project websites to disseminate conservation information.

Keywords: conservation education; pro-environmental behavior; public participation in scientific research; engagement

Introduction

Citizen science is an increasingly common conservation tool, with participants playing a key role in biological monitoring (e.g., Devictor et al. 2010; Dickinson et al. 2012). However, nature-based citizen science has the potential to play an even larger role in conservation by educating and encouraging participants to engage in conservation activities outside of their citizen science projects. Many citizen science programs study or directly address conservation concerns, making conservation education and the promotion of conservation actions a natural part of training and educating participants.

Volunteer participants can play a number of roles in citizen science, ranging from data collectors to project creators and administrators, depending on both the project and the individual (Bonney et al. 2009). Here, we primarily focus on the education and engagement of volunteers outside the project leadership structure, such as those who collect and report data. **Figure 1** depicts the ways that nature-based citizen science projects can influence their volunteers' transitions from participating

in citizen science (left box) to engaging in conservation actions outside the project (right box). First, volunteers can interact with a project in three key ways (left box). For many volunteers, the primary interaction with their citizen science project is through collecting and submitting data. Additionally, many projects offer initial or periodic training events, either in person or via print and online materials. Projects also can provide their volunteers with educational content that is not strictly related to data collection or training; project websites, newsletters, handouts, and lectures all can be used in this manner. When volunteers interact with a citizen science project in any of these ways, there are opportunities to promote additional engagement in conservation outside the project activities, either by increasing volunteer knowledge and skills (top box) or by influencing volunteers via social factors (bottom box).

Previous research into environmentally responsible behavior suggests that knowledge of conservation threats, while important, will not alone guarantee conservation action (reviewed in Kollmuss and Agyeman 2002). Rather, as depicted in **Figure 1** (top box), an understanding of conservation action strategies and the development of action skills through experience also are necessary (see meta-analysis in Hines et al. 1987; Jensen 2002). Social factors such as personal appeals (direct requests for people to make a change), positive feedback, and behavioral incentives (bottom box) can influence the transition from being knowledgeable about an environmental issue to engaging in

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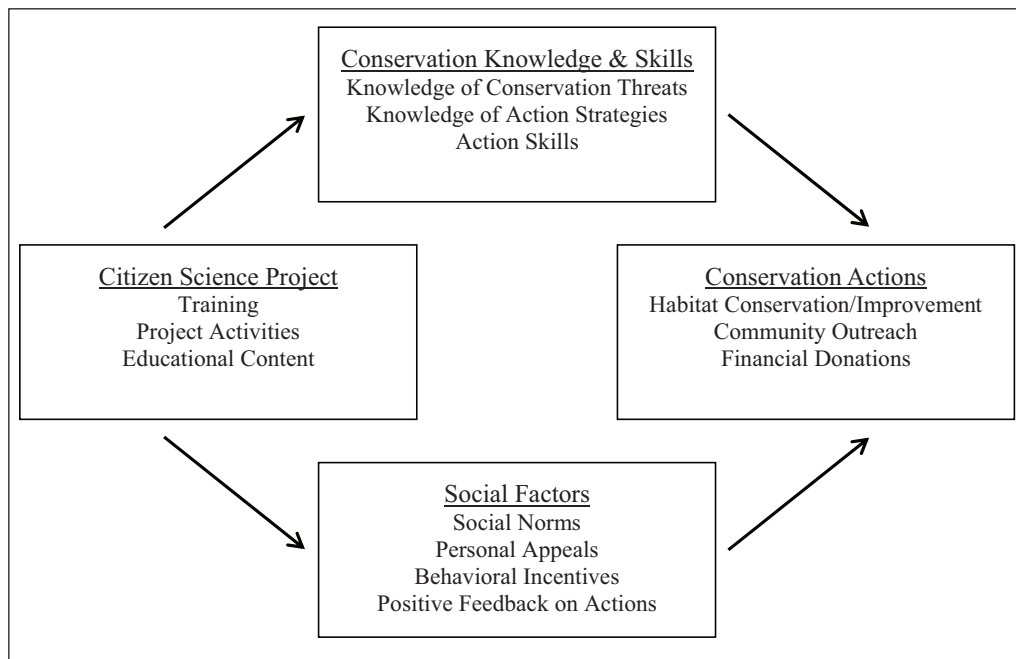


Figure 1: Model depicting a citizen science project’s influence on its volunteers’ transition from citizen science participation to conservation action.

conservation actions (reviewed in Kollmuss and Agyeman 2002). Social norms also can affect actions and behavior (meta-analysis in Bamberg and Möser 2007), and small groups of people who regularly interact can form their own social norms (e.g., McDonald et al. 2014). **Figure 1** does not include factors outside of the project’s control that might influence their volunteers’ engagement in conservation, such as initial motivation or self-efficacy.

While citizen science seems primed to serve as a powerful tool in conservation education, there is only limited evidence that citizen science volunteers increase their engagement in conservation outside of their participation in citizen science activities. More than half of the 45 volunteers surveyed in Neighborhood Nestwatch, a citizen science project that observes bird nests, indicated that they had changed their backyard behavior, for instance by making habitat improvements, after participating in the program (Evans et al. 2005). In Jordan et al.’s (2011) survey of 33 volunteers in an invasive species project, two thirds of the volunteers had changed their behavior related to invasive plants after their involvement with citizen science, with most behavior changes classified as passive, such as talking to others about invasive plants. Another study revealed that stream monitoring volunteers’ engagement in actions related to water quality increased with the length of time they had monitored, although the most commonly reported activities, reading and talking about water issues, again could be considered passive (Overdeest et al. 2004).

While this small group of studies explicitly examined the conservation outcomes of participating in specific citizen science projects, there has been no systematic assessment of the outcomes of conservation-focused education and outreach in citizen science, nor what specific strategies are being used. Here, we examine butterfly citizen science projects and the steps they are taking to

teach their volunteers about conservation and to invoke pro-conservation actions beyond engagement in citizen science. The general nature of the threats and action strategies involved in butterfly conservation, along with the popularity of butterfly citizen science, suggests that this case study is relevant to many nature-based citizen science projects, regardless of the taxa on which they focus.

Like many taxa, butterflies are facing serious conservation threats. Global climate change, habitat loss owing to development and pesticide-induced loss of host and nectar plants, and disease all have been suggested as threats to butterfly populations (e.g., McLaughlin et al. 2002; Bartel et al. 2011; Preston et al. 2012; Pleasants and Oberhauser 2013). These issues are not unique to butterflies. Climate change and habitat loss are common issues in conservation in general (Thomas et al. 2004; Lawler et al. 2006), and disease is often cited as a conservation concern (reviewed in Smith et al. 2009). To ameliorate these threats, members of the public are encouraged to engage in habitat conservation and creation by planting and maintaining native nectar and host plants, eliminating pesticides, and using other butterfly-friendly gardening strategies (Monarch Watch 2015; Vaughan n.d.). Others engage in conservation education and outreach activities (Oberhauser and Prysby 2008) and make financial donations. Habitat creation and protection, education, and financial donations are applicable conservation strategies for a variety of situations.

Many members of the public contribute citizen science data on the abundance, distribution, and infection by disease and parasites of butterflies (Breed et al. 2013; Ries and Oberhauser 2015). The conservation concerns facing butterflies and the active public involvement in butterfly citizen science present both a problem and a possible solution. Citizen science projects can teach their volunteers about relevant conservation threats and strategies

to mitigate those threats, and can actively encourage conservation behaviors among their volunteers. By providing information about conservation threats and individual conservation strategies—offering an opportunity to develop hands-on conservation skills—and by using social factors to encourage conservation, these projects have the potential to invoke conservation actions among their volunteers.

We used an online questionnaire of citizen science project leaders and an inspection of project websites to census and assess the current state of conservation education among butterfly citizen science projects. We determined the degree to which butterfly citizen science projects are teaching their volunteers about butterfly-related conservation issues and using social factors to encourage engagement in conservation activities outside the project.

Methods

Online census of project leaders

We compiled a list of 28 butterfly-related citizen science projects in the United States. Projects were found through the website SciStarter (scistarter.com), which provides a database of hundreds of citizen science projects, and a Google search using the keywords “butterfly citizen science” and “butterfly monitoring” on July 19, 2013. The Google search was restricted to the first 100 results. No additional projects were found after the first 50 search results, suggesting that our list included all the butterfly citizen science projects operating in the United States at that time. We emailed the leaders of the 28 projects and asked them to complete an online questionnaire that had been created in Qualtrics. The initial email request was sent on October 29, 2013, and we sent a second request on November 12, 2013. The questionnaire was closed on December 16, 2013.

The questionnaire contained questions about project characteristics and strategies and activities that could promote conservation activities among volunteers (see Supplementary Materials). We provided lists of key threats to butterfly conservation and actions that could be used to ameliorate those threats and asked respondents if, and through what media, they provided their volunteers with information on those topics. We also included a series of questions about social factors that could potentially influence participation in conservation. We asked if volunteers were encouraged to engage in conservation activities outside their project. To determine the extent to which personal appeals, positive feedback, and incentives were used to encourage conservation, we provided a list of strategies and asked respondents to select the ones they used. Finally, we asked questions designed to gauge if and how respondents attempted to create a sense of community among their citizen science volunteers and if they believed that their volunteers felt a sense of community as a result of their participation in the project. In an open-ended question, respondents were asked to describe how they fostered a sense of community among volunteers. We asked respondents if they provided volunteers with resources to help them contact one another, if their volunteers worked in groups, and how large those groups

were. The University of Minnesota IRB Human Subjects Committee declared this research exempt from ethical review.

Organization websites

Of our 28 butterfly-related projects, 25 had websites. We visited these websites on August 19–21, 2013 and recorded the basic information listed about the project's focus, scope, and activities, as well as what butterfly conservation threat and action strategy information was provided. When a reference to conservation threats or action strategies was found on a website, we labeled the occurrence as either having simply mentioned the topic or providing actual information on the topic. We also recorded if a website provided information on events or activities that would allow volunteers to engage in conservation and develop their conservation action skills, such as a day spent planting a butterfly garden. Projects that responded to the survey and the projects that had websites did not completely overlap; as a result, there are some differences between the two datasets.

Because our study was designed as a census, meaning that we attempted to collect data on all citizen science projects focused on butterflies in the United States rather than sampling a subset, using inferential statistics to analyze our data would be inappropriate. Instead, we rely on descriptive statistics to provide an in-depth examination of the projects' conservation education programming.

Results

Online census of project leaders

Basic project information

Twenty-three project leaders responded to the questionnaire (82%). One respondent completed less than 5% of the questions; this response is not included in data summaries or analyses. The remaining 22 respondents (79%) viewed the entire questionnaire, but not all respondents answered all questions. Questionnaire completion for these respondents ranged from 84 to 100% (mean = 97%, SD = 4.7).

Exactly half of respondents represented monarch citizen science projects and half represented general butterfly projects. Most (64%) projects were local (within one state), 9% were regional (within several states), 9% were national (within most or all of the United States), and 18% were international. All but one project reported an affiliation with a larger organization or institution, and some were affiliated with multiple organizations. Most (73%) were affiliated with a nonprofit organization, 45% with a college or university, 23% with a park or nature center, and 9% with a government agency.

The projects had been in existence from 1.5 to 27 years (mean = 12.9, SD = 8.0). The number of volunteers in projects ranged from fewer than 10 to 10,000, with some respondents unable to accurately estimate their number of volunteers. The number of months during which volunteers engaged with the project each year was variable, with some projects relying on volunteers for less than one month and others for all 12 months.

The projects used a variety of data collection activities: 73% involved repeated butterfly monitoring, 68% involved collecting habitat or environmental data, 64% involved individual or opportunistic butterfly observations (volunteers report butterflies that they observe without systematic sampling), and 27% involved conducting one-time butterfly counts. Many projects (41%) also reported other activities, such as rearing butterflies, testing for parasites, and tagging monarchs. The majority (91%) of projects included butterfly conservation as a part of their project’s mission or long-term goals.

Conservation information

The majority of respondents reported that they supply their volunteers with information about the threats to butterfly populations that we listed in the questionnaire; information was provided by more than two-thirds of projects about each of the listed conservation threats (**Table 1**). Respondents also reported that they provided their volunteers with information about many of the butterfly-related conservation action strategies that we

listed; information on contacting the media was the least frequently provided and information on habitat conservation the most (**Table 1**). In-person communication was consistently the most common method used to disseminate information, followed by print materials and websites (**Table 1**).

Social factors

When asked whether they actively encouraged volunteers to engage in conservation activities outside their project, 74% of respondents reported doing so. In-person appeals and incentives or positive feedback in the form of public acknowledgements were the most commonly reported methods used to encourage conservation among volunteers (**Table 2**).

The majority of respondents (74%) said that they attempted to create a sense of community among their volunteers, and 86% believed that their volunteers felt a sense of community as a result of their participation in the project. Project leaders fostered community through group work, newsletters or online communications with

Conservation Threats	Total	Print	Website	Email	In Person
Climate Change	91	32	32	32	59
Breeding Habitat Loss	86	54	50	36	68
Pesticide Use	77	50	32	32	59
Overwintering Habitat Loss	73	50	36	32	54
Disease and Parasites	73	32	27	32	54

Conservation Actions	Total	Print	Website	Email	In Person
Habitat Conservation	91	54	46	23	68
Plant Host Plants	86	64	46	32	73
Plant Nectar Plants	82	59	41	27	73
Gardening Strategies	82	46	36	27	64
Give Public Talks	68	32	32	32	36
Financial Contributions	54	36	41	23	41
Contact Media	27	13	9	14	14

Table 1: Percentage of project leaders who report supplying their volunteers with information on conservation topics, by format and overall total, n = 22. Formats are not mutually exclusive.

Encourage Conservation	%
In-person requests at trainings or other events	68
Acknowledgment of people who engage in conservation activities in newsletters, on the website, at project meetings or trainings	59
Written requests via email or mailings	36
Contests or prize drawings for individuals who engage in conservation	0
Other (responses included social media and partnering with conservation organizations)	18
None	23

Table 2: Percentage of project leaders using specific strategies to encourage conservation actions among their volunteers, n = 22.

volunteer stories, in-person training sessions, and group t-shirts. Most project leaders reported providing volunteers with at least one way to contact one another: 36% provided some form of online discussion forum or list-serve, 32% provided a list of volunteers' email addresses, 9% provided a list of volunteers' phone numbers, and 46% provided other ways for their volunteers to contact each other, including meeting at training sessions and introducing volunteers on a case-by-case basis (options were not mutually exclusive). Only 14% provided no means of contact between volunteers. All projects reported that their volunteers either sometimes (86%) or always (14%) worked in groups. Most (53%) stated that volunteer groups remained mostly or completely unchanged over time, while the remainder of respondents reported that their volunteer groups changed over time. Volunteer groups of fewer than five people were the most commonly reported (82%), with 27% reporting some volunteer groups of six to ten people, and 27% reporting some volunteer groups of more than ten people.

Organization websites

Basic website information

Of the 25 butterfly citizen science project websites assessed, 68% were focused on multiple species of butterflies or on butterflies in general and 32% were focused on monarchs. Most (60%) of the projects were local, 4% were regional, 4% were national, and 32% were international. A majority (60%) of the projects listed conservation among their goals or in the mission statement on their website, compared to the 91% of online questionnaire respondents who listed conservation among their project's goals or mission.

Conservation information

Fewer than one-third of the websites provided information on each of the butterfly conservation threats we included (Figure 2), but 40% provided information on at least one threat. The percentage of websites offering information

on specific butterfly-related conservation actions ranged by topic from 0% to 40% (Fig. 3), with 40% providing information on at least one action. In addition to providing concrete information about butterfly threats and conservation action strategies, many websites also briefly mentioned one or more of these topics without expanding upon them (Figures 2 and 3). The percentage of websites offering information on or mentioning specific topics was similar to the percentage of project leaders who reported that their websites offered information on these topics, with the exception of information on how to give public talks or presentations. No websites that we examined provided this information, but 32% of project leaders stated that they offered it online. Only 28% of websites contained information on conservation opportunities outside the project's data collection.

Discussion

More than 90% of our respondents listed conservation as one of the goals of their project or organization, making it clear that butterfly citizen science projects are appropriate vehicles for teaching about conservation and encouraging conservation action. Butterfly citizen science also has access to tens of thousands of existing volunteers. While this study did not include the volunteers themselves, other research indicates that citizen science volunteers engage because they are interested in nature, want to become involved in their community, and want to meet like-minded people (Bell et al. 2008, Rotman et al. 2012). Conservation volunteers are similarly motivated, and they have a desire to help the environment and engage in conservation (Van Den Berg et al. 2009). Taken together, these findings suggest that butterfly citizen science participants, who also can be considered conservation participants, are likely to be people with a prior interest in nature and conservation and who interact with those who share similar interests. Many citizen science volunteers are already familiar with some aspects of the conservation threat, organism, or ecosystem that their project studies; however, volunteers also

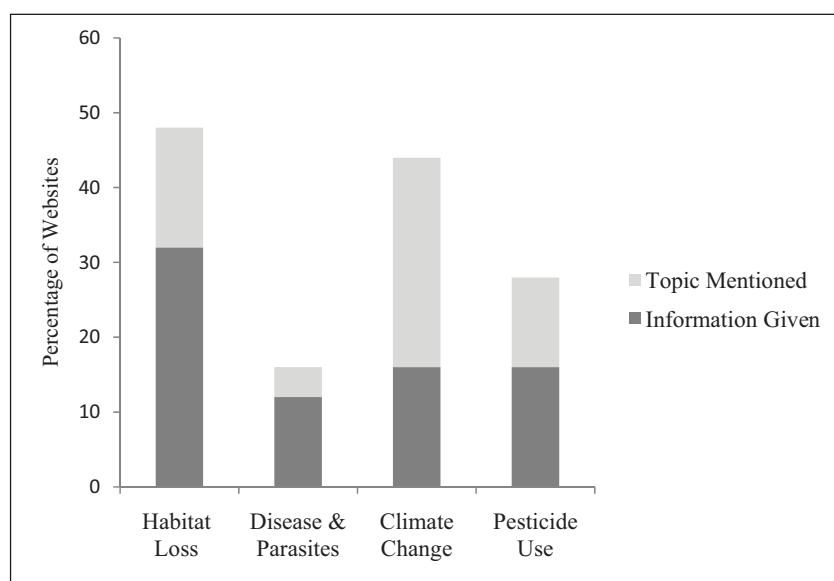


Figure 2: Percentage of project websites providing information on or mentioning butterfly conservation threats, n = 25.

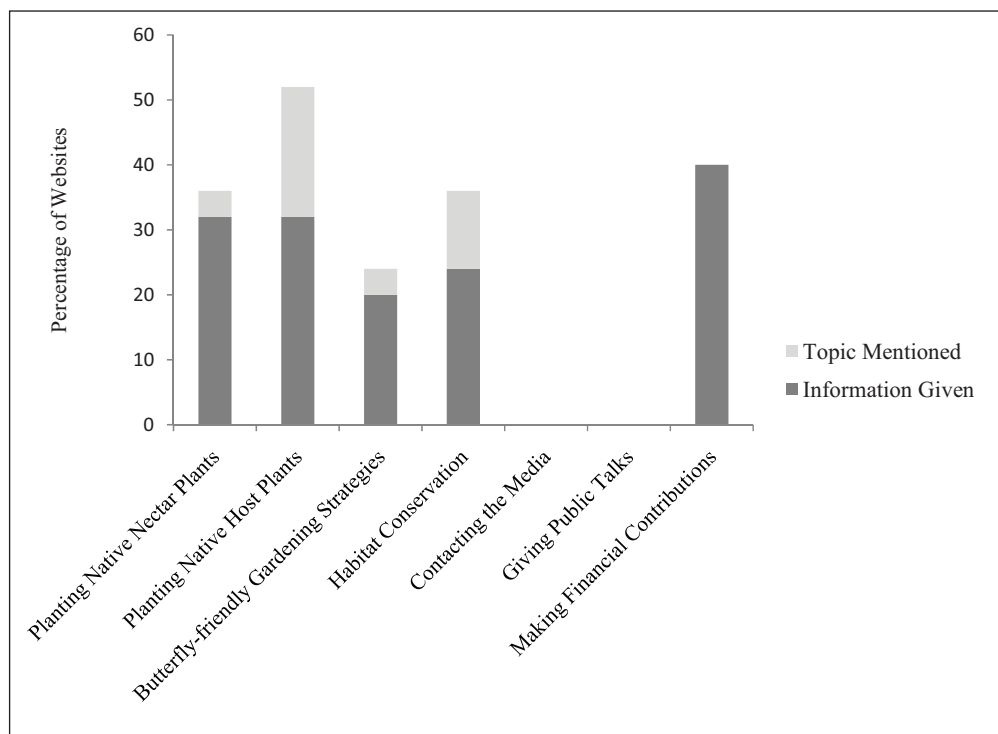


Figure 3: Percentage of project websites providing information on or mentioning butterfly conservation actions, $n = 25$.

gain biological, ecological, and environmental knowledge while participating in citizen science (Brossard et al. 2005; Evans et al. 2005; Jordan et al. 2011). Therefore, the strong conservation focus of butterfly citizen science, coupled with the interests of their volunteers, indicates that conservation education and outreach that targets volunteers is a logical step for most projects.

Conservation information

While all of the project leaders that we censused reported engaging in at least some activities that could promote butterfly conservation, many projects did not provide their volunteers with information on more indirect, but still important, forms of conservation actions. For example, there remains great potential for projects to offer donation opportunities, directed either to themselves or to related conservation organizations. Similarly, there is much untapped potential for projects to share information on how volunteers can engage in conservation outreach and education by giving public talks or by contacting the media to initiate a news story. We recommend that citizen science projects provide their volunteers with information on donations and outreach opportunities in addition to direct habitat conservation.

Providing people with an opportunity to practice and develop action skills is also a key component of fostering conservation behaviors (Hines et al. 1987). Less than one-third of project websites promoted opportunities to engage in and practice conservation, although it is possible that projects provide additional such opportunities that are not advertised on their websites.

Almost all butterfly citizen science projects had an informational website, but their use for disseminating conservation information was relatively low. Furthermore, most

of them contained far less information on conservation issues and strategies than our project leader census suggested. There are two possible explanations for this discrepancy. First, not all project leaders responded to our questionnaire, so overlap between respondents and the websites we assessed was not exact. Because the questionnaire was anonymous, we were unable to look for congruence between individual project leader and website results. Second, there could be differences of opinion regarding what constitutes information about a topic. Given the higher percentage of projects that reported providing conservation information on their website compared to our own examination of websites, it is likely that some projects may have reported providing information when their website provided only a brief mention of a topic. We encourage project leaders to ensure that they are in fact providing volunteers with information to help them truly understand conservation issues and the ways in which they can address these issues. Because volunteers are likely to interact with websites many times (to enter data or access project updates), and because people who are not directly participating in the project also may visit the websites, project websites appear to be key, but underutilized, venues for disseminating conservation information.

Social factors

In addition to providing volunteers with more information on conservation activities, there is also room for growth in directly encouraging volunteers to engage in conservation. There is consistent evidence that incentives and direct personal appeals for behavior change are correlated with pro-environmental behaviors (e.g., Hines et al. 1987; Bator et al. 2014). Many of the projects we studied used appeals and acknowledgement opportunities to promote

conservation. However, almost one-quarter of the projects did not use these techniques, despite the fact that they are relatively inexpensive and simple, which suggests that this is a potential area of improvement.

The promotion of a sense of community among projects suggests a favorable environment for the development of social groups, but as with the other aspects of promoting conservation, there is still room for improvement. Many of the community-building activities that project leaders described, such as encouraging group work and providing ways for volunteers to contact one another, are easily achievable for most projects. Other options, such as providing project t-shirts or in-person training sessions, might be more resource-intensive than some projects can accommodate. Projects should choose the community-building strategies that are most appropriate for their circumstances. Given that social norms can exert a powerful influence on behavior (Bamberg and Möser 2007; Bator et al. 2014), and that some citizen science volunteers stay in contact with each other and potentially share environmental information (Johnson et al. 2014), citizen science projects could invoke conservation actions among their volunteers by encouraging the creation of a social group among those volunteers.

This case study indicates that butterfly citizen science projects across the United States are teaching their volunteers about conservation and encouraging them to engage in conservation outside of citizen science. Butterfly citizen science is widespread, focused on conservation, and has access to a large number of volunteers already interested in nature and conservation. By targeting these volunteers for conservation education, projects have the potential to invoke positive conservation actions among volunteers throughout the country. Many of the outreach strategies utilized by our respondents and the conservation actions that they encourage are not unique to butterfly citizen science or butterfly conservation, and all nature-based citizen science projects have opportunities to provide their volunteers with high quality information about conservation threats and action strategies that are relevant to their project. Future research is needed to determine the effect that specific education and outreach strategies have on volunteers and the extent to which citizen science projects can influence conservation actions. Given the room for growth among butterfly citizen science projects in providing educational websites, providing information on conservation outreach strategies, and encouraging financial donations, we suggest that it would be useful for other conservation-oriented citizen science projects to assess their programming in those areas. Citizen science has the potential to inform and encourage conservation beyond citizen science participation, but we argue that this is more likely to occur when projects invest time and effort in promoting conservation behaviors.

Supplementary Materials

Survey data is available at <http://dx.doi.org/10.7910/DVN/BM8FSC>

Competing Interests

The authors declare that they have no competing interests.

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