



Research article

How do marine and coastal citizen science experiences foster environmental engagement?



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ABSTRACT

Citizen science programs enable community involvement in scientific research. In addition to fostering greater science literacy, some citizen science programs aim to foster engagement in environmental issues. However, few data are available to indicate whether and how citizen science programs can achieve greater environmental engagement. We survey individuals choosing to attend one of seventeen reef citizen science events and examine the extent to which attendees reported three indicators of greater environmental engagement: (i) willingness to share information, (ii) increased support for marine conservation and citizen science, and (iii) intentions to adopt a new behavior. Most participants reported being willing to share information about reef conservation (91%) and described increased support for marine science and conservation (87%). Half of participants (51%) reported intentions to adopt a new conservation behavior. We found that key elements of the citizen science experience associated with these outcomes were learning about actions to protect reefs and coasts (procedural learning), experiencing surprise, and experiencing negative emotions about environmental problems. Excitement was also associated with positive outcomes, but only in participants who were less likely to see themselves as environmental, or were less frequent visitors to reefs and coasts. Importantly, the association between factual learning and environmental engagement outcomes was limited or negative. These findings suggest that the way citizen science experiences make people feel, may be more important for fostering future environmental engagement than factual-based learning. When designing citizen science programs for community members, these findings provide a reminder to not focus on provision of factual information alone, but to highlight environmental impacts while providing meaningful experiences and building environmental skills.

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1. Introduction

1.1. Citizen science and environmental management

Citizen science is a participatory model of science, where non-professionals are involved in diverse aspects of scientific research (Dickinson et al., 2012; Theobald et al., 2015). Within the environmental context, most citizen science projects involve environmental monitoring, also referred to as “community based environmental monitoring” (Conrad and Hilchey, 2011; Dickinson et al., 2012). Citizen science programs are diverse, and may

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comprise: biological monitoring initiatives, such as biodiversity monitoring or monitoring species range shifts; monitoring environmental processes such as water quality; or monitoring impacts of global change, such as coral bleaching (Cigliano et al., 2015; Dickinson et al., 2012; Schläppy et al., 2017; Scyphers et al., 2015). Citizen science has the potential to contribute to a range of management outcomes: existing programs have assessed effectiveness of marine reserves (Cigliano et al., 2015), provided a basis for restoration funding (Jordan et al., 2016), and identified sources of marine debris and enabling pollution source reduction initiatives (Hastings et al., 2015).

1.2. Can citizen science foster environmental citizenship?

Many citizen science programs emphasise education (Hobbs and White, 2012), with research suggesting that citizen science may increase content (factual) knowledge (Jordan et al., 2011; Haywood, 2016), build literacy in scientific processes related to the project (Cronje et al., 2011), and build skills (procedural learning) (Johnson et al., 2014). In addition, many programs also aim to foster engagement in environmental issues (Hobbs and White, 2012; Johnson et al., 2014; Marshall et al., 2012), where engaged individuals are conceptualized as those that understand, value and act to promote environmental outcomes (Dean et al., 2016c). Behavioral outcomes indicating greater engagement could include private-sphere behaviors such as reduced plastic consumption, and public-sphere behaviors, such as stewardship activities or petitioning for improved policy approaches (Jordan et al., 2011; Stern, 2000). In addition, the Diffusion of Innovations theory (McMichael and Shipworth, 2013) highlights the importance of sharing information with others as an important conduit for changing community norms and practices. This is becoming recognized as an important pathway for environmental change (Dalrymple et al., 2013; Dean et al., 2016a; Johnson et al., 2014).

A number of studies highlight the potential for citizen science to promote environmental engagement. For example, one case study in the area of natural resource management, reported that 39% of citizen science participants described a change in their management decisions as a result of participation. However, many of these participants were also professionally involved in natural resource management (Chase and Levine, 2018). Participants in wildlife monitoring programs report that their involvement influenced their intentions to adopt a range of other conservation behaviors (Toomey and Domroese, 2013). Other programs indicate that citizen science experiences may elicit information sharing about environmental issues (Johnson et al., 2014; Jordan et al., 2011). Despite these encouraging findings, there remains an evidence gap regarding whether citizen science can provide an entry point to environmental engagement (Groulx et al., 2017; Schläppy et al., 2017), and if so, *how* participation may elicit this change. Specifically, what elements of the citizen science experience are associated with change, and can these elements influence all participants, or only certain types of individuals?

1.3. What types of citizen science experience are necessary to foster environmental citizenship?

It has been argued that citizen science can lead to personal transformation and subsequent behavior change (Groulx et al., 2017). Transformative Learning Theory describes how certain experiences challenge existing perspectives or frames of reference—which then lead to new perspectives, and new actions (Chao, 2017; Groulx et al., 2017; Mezirow, 1997). Within this framework, there are many elements of citizen science experiences which may provide an impetus for change. For individuals with limited nature

experience, being in nature or close to wildlife may trigger reflection and transformation (Chao, 2017; D'Amato and Krasny, 2011). Hands-on procedural learning experiences in a social setting may provide opportunities for learners to incorporate and reflect on new perspectives (Diduck et al., 2012; Nohl, 2015). There is also increasing recognition that emotions are a central element of transformative experiences (Maiese, 2017). For example, evoking surprise may challenge perspectives (Nohl, 2015). Positive emotions, such as feeling awe (D'Amato and Krasny, 2011), and negative emotions related to seeing environmental degradation (Diduck et al., 2012), may both trigger transformative learning.

Research demonstrates that citizen science can generate experiences that are central to transformative learning—skills development and empowerment, emotional experiences, connecting with natural environments, reflecting on experiences, and socially-focused activities (Cigliano et al., 2015; Groulx et al., 2017; Haywood et al., 2016). However, it remains unclear which of these elements are most associated with transformation, as conceptualized by increased environmental engagement.

1.4. How do experiences influence different types of people?

Experiences that challenge existing perspectives have the greatest potential to be transformative (Mezirow, 1997). This raises the possibility that individuals with different perspectives or experience may exhibit differential responses to distinct elements of citizen science experiences. Two issues of relevance to this study are frequency of visiting marine ecosystems, and the psychological construct of environmental identity—the extent to which someone sees themselves as an 'environmental person' (Dresner et al., 2015; Fielding et al., 2008). It is possible individuals with limited experience of marine ecosystems or who do not see themselves as an environmental person may experience emotions such as surprise or excitement during marine citizen science experiences, which may be transformative. However, many citizen science participants have an established interest in nature recreation, and conservation (Chase and Levine, 2018; Hobbs and White, 2012; Martin et al., 2016; McKay and Johnson, 2017). This raises the question of whether there is scope for citizen science programs to elicit transformation for these 'more engaged' participants. And if so, what elements are transformative for this group compared to less engaged participants?

1.5. The current study

We examine how attending marine citizen science events influences engagement in environmental issues. First, we quantify the degree to which attending a citizen science event is associated with three self-report measures of environmental engagement: willingness to share information with others, increased support for marine conservation and citizen science, and intentions to adopt a new behavior. We then examine the relationships between different elements of the citizen science experience and these measures, and whether these relationships are moderated by environmental identity and frequency of marine visits. We anticipate that this study will enable citizen science programs to foster behavior change and environmental citizenship, and assist these programs in targeting activities to social groups or types of experiences that generate the greatest impact.

2. Methods

2.1. Citizen science events

The Reef Citizen Science Alliance is a collaborative network of 13

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