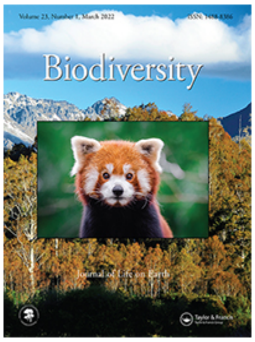

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A case study from the City Nature Challenge 2018: international comparison of participants' responses to citizen science in action

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ABSTRACT

Citizen and community science is an important approach for advancing research, education, and conservation, and currently, various projects are being implemented and trialled worldwide. We conducted surveys of participants in the City Nature Challenge, an international event in which participants engaged in monitoring wildlife and plants in their neighbourhoods. We received responses from 361 participants representing 12 countries including the United States, Japan, the United Kingdom, and Malaysia. There were significant differences in terms of socio-demographic attributes and participants' perceptions of citizen/community science activities. Regression analysis revealed that the more participants learned about the animals and plants in their areas, the more they self-reported their intention to participate in similar activities in the future in both the United States and Japan. This suggests that managers of citizen/community science projects could tailor the message and contents of the activities to enhance participants' learning about local biodiversity to increase their continued involvement in future events.

Key policy insights

- In both the United States and Japan, the more participants learned about the animals and plants in their local area through citizen/community science activities, the more they were willing to participate in similar activities in the future.
- Cross-cultural comparison of participants in citizen/community science activities revealed significant differences in terms of socio-demographic attributes (e.g. participants in Japan and Malaysia were younger than those in the United States and the United Kingdom).
- Survey results revealed differences in participants' perceptions of the citizen/community science activities (e.g. participants from Malaysia were more likely to be aware of the threats to animals and plants in their neighbourhood than those in the United States, Japan, and the United Kingdom).

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Introduction

Citizen science, the engagement of the public in a scientific project (Dickinson and Bonney 2012; Kobori et al. 2016), has recently gained worldwide recognition as a valuable approach for advancing research, education, and conservation (Bonney et al. 2014; McKinley et al. 2017). Citizen science is not necessarily a new concept. Its history goes back more than 1200 years, to when the timing of the cherry blossoms blooming began to be recorded by members of the public (who were not necessarily professional researchers) in Japan, a practice that continues today. Another example is the voluntary collection of specimens by naturalists in the seventeenth century in the United Kingdom (Kobori et al. 2016). However, developments in information technology and recent trans-disciplinary collaborations between conservationists and engineers have allowed citizen science projects to move to the next stage, with participants from all over the world collecting data that could address global conservation issues (Devictor, Whittaker, and Beltrame 2010; Bonney et al. 2014).

The City Nature Challenge (hereafter, CNC) is an international citizen/community science initiative in which participants engage in documenting the natural environment surrounding their home cities by submitting observations of species via a mobile app. (Since participants of CNC are not limited to those fitting the narrow definition of 'citizen' but include internationals living in host communities, we use the term 'citizen/community science' hereafter.) It started in 2016 when

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the citizen/community science teams at the Natural History Museum of Los Angeles County and the California Academy of Sciences implemented the first event, where more than 19,800 observations were made by over 1000 people in a week (City Nature Challenge (CNC) 2021a). Although the CNC was originally implemented in the United States in 2017 (with activities conducted in 16 cities involving more than 4000 participants), beginning in 2018, it became an international event. In 2018, activities were conducted in 68 cities worldwide, with more than 17,000 participants. Approximately 8600 species, including plants and animals, were recorded from over 441,000 observations (CNC 2021a).

Although there are numerous citizen/community science projects currently being conducted globally (Bonney et al. 2015; Kobori et al. 2016), the CNC is unique and original in the sense that participants worldwide observe species around their communities and submit the reports during the same period following a similar procedure (e.g. using one of a few platforms, most cities opting to use the mobile app 'iNaturalist'). Results, including data collected from each city, are shown on the website, and participants can check the data they submitted and compare them with those of other participants (CNC 2021b).

Previous literature has emphasized the importance of designing and planning citizen/community science activities carefully to gain optimal scientific and educational outcomes (Bonney et al. 2009b; Jordan et al. 2011; Bonney et al. 2015). However, because many citizen/community science projects focus on ecology and conservation and are initiated by naturalists, studies that look into the human dimensions and social aspects of the projects are lacking (Jordan et al. 2011, 167; Kobori et al. 2016; Lynch et al. 2018). To implement citizen science projects effectively and sustainably, it is important to understand the social dimensions such as the participants' outcomes and their motivation to continue to join them in the future.

While the number of citizen/community science projects is increasing and more activities are being conducted globally, research that looks into the cognitive aspects of participants is also increasing. Aivelo and Huovelin (2020) showed how citizen science projects could be combined with formal education, revealing that students from lower- and upper-secondary schools in Finland experienced an increase in their knowledge and interest towards the topic (rats) as well as the scientific process (e.g. collecting data) with participation. Lynch et al. (2018) found, from their interview studies, that participatory entomological citizen science projects improved participants' science self-efficacy and their attitudes towards insects; however, the quantitative data collected from the evaluation survey revealed no statistical differences between the participants and the control group. One study that investigated the educational effects of citizen science programmes about non-native species revealed that whereas participants increased their knowledge regarding invasive species, there was not much increase in their understanding of how scientific research is conducted and there was limited behaviour change after the programme (Jordan et al. 2011). Another study that examined effects of citizen science activities in terms of managing invasive species revealed that respondents' perceptions of problems caused by non-native birds predicted their engagement in management action (Phillips et al. 2021). Review research has also been conducted demonstrating that individual learning outcomes in citizen science can be classified into six categories: interest, self-efficacy, motivation, knowledge, skills in terms of of science inquiries, and behaviour/stewardship (Phillips et al. 2018).

Meanwhile, the heterogeneous conditions in which citizen/community science projects are conducted should be taken into consideration when evaluating the social aspects of the projects, especially if one wants to conduct global comparisons. Different countries have different social institutions, cultures, ecological conditions, etc., and international comparative studies could provide certain indications in terms of understanding such country-by-country perspectives (both global trends and national conditions). Citizen/community science projects also differ based on the way each project is implemented, including the method of participant recruitment. For example, the demographics of the participants could differ depending on whether the project is publicized mainly through university classes or on the radio. While it is important to recognize such differences, it would be difficult to globally standardize the conditions in which citizen/community science projects are implemented.

In this study, we conducted surveys of CNC participants worldwide (in 12 countries including the United States, Japan, the United Kingdom, and Malaysia) to understand their cognitive responses to the activities compared to the countries they represent. While there has been research conducted to examine participants' reactions to the same citizen science projects in two countries (e.g. a study in the US and Canada (Phillips et al. 2021), to the best of the authors' knowledge, little to no research has been published comparing the perceptions and reactions of participants from around the globe to the same citizen/community science project.

Methods and analysis

CNC participants worldwide were surveyed. The participants who joined the activities in 2018 answered an online survey after the events from April to September of the same year. In Japan, participants who joined the activities implemented in Tokyo on 28 and 30 April 2018 answered a paper-based questionnaire after the events. We understand that respondents to our survey are not representative of participants in the CNC projects of each country as a whole, because they were not randomly selected. Therefore, we emphasize that the observed differences may simply be caused by the random types of respondents who answered our survey and that there is a limitation in terms of making inferences and generalizations from these data.

The survey questionnaire was developed involving the European BioBlitz Network, a community of practice brought together by the European Citizen Science Association (DITOs Consortium 2019). Citizen science programme managers were consulted through a series of online meetings and provided their feedback on the initial version of the survey so as to obtain a common tool to assess the social outcomes of CNC events. The final questionnaire was then translated and administered by event organizers of the different countries.

Survey questionnaire items include socio-demographics (e.g. age and gender), past experience of participating in the related events, intentions to join future activities, and the degree of learning through participating in the programme (Table 1).

We first report the descriptive results – that is, the nationality (countries where respondents participated in the events) and demographic attributes of participants from the top four countries in terms of the number of respondents. Chi-square tests were conducted to determine any differences in the respondents' past experience participating in wildlife surveys and using mobile apps to collect data among the four countries. Analysis of variance (ANOVA) was conducted to understand whether there are differences in the respondents' intention to join future activities and their degree of learning among those four countries. Post hoc analysis was also conducted to determine whether there were significant differences among countries; the Tukey test was conducted on the items for which equal variances were assumed, and Tamhane's T2 test was conducted on those for which equal variances were not assumed.

We then conducted stepwise multiple regression analysis to identify factors that affect the respondents' willingness to participate in future activities. This analysis was conducted for countries with more than 100 respondents (to ensure sufficient sample size). We used 'I intend to take part in similar future events' as the dependent variable and the socio-demographics (two items), whether the participants had responded to a wildlife survey before (one item), their intention to join various activities (four items), and their degree of learning (four items) as independent variables. SPSS version 22 (IBM, Tokyo) was used for the statistical analysis, and p values of less than 0.05 were identified as significant.

Results

Among the 361 participants who responded to this international survey, 145 were from the United States, 113 from Japan, 34 from the United Kingdom, and 28 from Malaysia. Canada and Columbia had 10 participants each (for other countries, see Appendix 1).

To observe the trends in each country, we picked the top four countries in terms of participant numbers (the United States, Japan, the United Kingdom, and Malaysia) to conduct further descriptive analysis. In terms of age, in the United States and the United Kingdom, the majority of the participants were divided between the age bins of 30 to 44 years old (32.4% in the United States and 44.1% in the United Kingdom) and 45 to 59 years old (24.8% in the United States and 26.5% in the United Kingdom). By contrast, in Japan most of the respondents (88.5%) were between 18 and 24 years old, whereas in Malaysia most (75.0%) were 15 to 17 years old.

In terms of gender, the majority of the respondents were female in the United States (63.6%) and the United Kingdom (60.6%) and male (70.9%) in Japan. The proportion was equal in Malaysia.

Regarding their past experiences, the majority of the participants in the United States and the United Kingdom had carried out a wildlife survey before, whereas most participants in Japan and Malaysia had not (Table 2). The chi-square test showed that there were significant differences ($p < .01$) in this past experience among countries. For the experience of using a mobile app to collect data, most participants in Japan had never used the app (89.2%), whereas most in the United States, the United Kingdom, and Malaysia (>85%) had used it before (Table 3). The chi-square analysis revealed that there were significant differences ($p < .01$) among countries.

With regard to their intentions to join future activities, ANOVA revealed that there were significant differences among nationalities ($p < .01$) for four items (Table 4). Japanese respondents had significantly lower intentions ($p < .01$) to take part in similar future events, promote such initiatives, or encourage others to

Table 1. Questionnaire items.

Category	Question	Response scale
Socio-demographics	Age	1 = Under 12, 2 = 12–14, 3 = 15–17, 4 = 18–24, 5 = 25–29, 6 = 30–44, 7 = 45–59, 8 = 60–74, 9 = 75+
	Gender	1 = Male, 2 = Female, 3 = Other
Past experience	Have you carried out a wildlife survey before today?	1 = No, 2 = Yes
	Have you used a mobile app to collect your data?	
Intentions to join future activities	Do you intend to take part in similar future events?	1 = Very unlikely, 2 = Unlikely, 3 = Likely, 4 = Very likely
	Do you intend to join a wildlife group/charity/biodiversity project?	
	Do you intend to promote such initiatives and encourage others to participate?	
	Do you intend to encourage wildlife in your garden/your surrounding areas?	
	Do you intend to learn more about local wildlife?	
Degree of learning through participating in the programme	I have learned something new about the animals and plants in my local area	1 = Strongly disagree, 2 = Disagree, 3 = Not sure, 4 = Agree, 5 = Strongly agree
	I have learned something new about the threats to animals and plants in my area	
	I have learned about the organizations/projects working to monitor and protect animals and plants in my area	
	I have learned about different ways I can contribute to protect the local environment	

Table 2. Respondents' past experience in terms of carrying out wildlife surveys.

		Carried out a wildlife survey before			
		Frequencies (%)			
		No	Yes	Chi-square score	*p* value
Nationality	USA (n = 143)	64 (44.8)	79 (55.2)	29.113	<.01
	Japan (n = 113)	85 (75.2)	28 (24.8)		
	UK (n = 34)	16 (47.1)	18 (52.9)		
	Malaysia (n = 28)	21 (75.0)	7 (25.0)		

Table 3. Respondents' past experience regarding use of a mobile app to collect data.

		Used mobile app to collect data before			
		Frequencies (%)			
		No	Yes	Chi-square score	*p* value
Nationality	USA (n = 136)	17 (12.5)	119 (87.5)	179.978	<.01
	Japan (n = 111)	99 (89.2)	12 (10.8)		
	UK (n = 31)	2 (6.5)	29 (93.5)		
	Malaysia (n = 28)	3 (10.7)	25 (89.3)		

participate than did those in the other three countries. Japanese respondents also had lower intentions ($p < .05$) to encourage wildlife in their garden and surrounding areas or to learn more about local wildlife than did those of the other three countries.

With respect to the degree of learning through participating in the programme, ANOVA revealed significant differences between nationalities ($p < .01$) for two items (Table 5). Japanese respondents had significantly lower agreement regarding their learning outcome about the animals and plants in their local area ($p < .01$) than those in the United States and Malaysia. On the other hand, respondents in Malaysia were more likely to agree that they had learned about the threats to animals and plants in their area than those in the United States ($p < .01$), Japan ($p < .05$), and the United Kingdom ($p < .01$).

The stepwise regression analysis revealed that for the US respondents (n = 97), two independent variables had significant effects on the dependent variable. Those who intended to promote similar initiatives or encourage others to participate ($B = 0.460$, $p < .01$) and those who felt that they had learned about the animals and plants in their local area ($B = 0.199$, $p < .05$) were more likely to have an intention to participate in similar activities in the future. The adjusted R^2 is 0.285, indicating that more than one-

Table 4. Respondents' intentions to take part in activities, and results of the analysis of variance (results of the post-hoc comparison show items that had significant differences between nationalities).

		Mean (standard deviation)	F value	*p* value	Results of post-hoc comparison
Intention to take part in similar future events	USA (n = 135)	3.74 (0.52)	35.28	<.01	USA > Japan (<0.01)
	Japan (n = 111)	3.07 (0.64)			UK > Japan (<0.01)
	UK (n = 34)	3.82 (0.39)			Malaysia > Japan (<0.01)
	Malaysia (n = 28)	3.64 (0.49)			
Intention to join a wildlife group/ charity/biodiversity project	USA (n = 110)	3.15 (0.83)	0.67	.57	
	Japan (n = 111)	3.02 (0.70)			
	UK (n = 29)	3.10 (0.94)			
	Malaysia (n = 26)	3.19 (0.94)			
Intention to promote such initiatives (e.g. join a wildlife group) and encourage others to participate	USA (n = 118)	3.58 (0.59)	29.61	<.01	USA > Japan (<0.01)
	Japan (n = 111)	2.82 (0.70)			UK > Japan (<0.01)
	UK (n = 31)	3.45 (0.62)			Malaysia > Japan (<0.01)
	Malaysia (n = 27)	3.52 (0.64)			
Intention to encourage wildlife in your garden/your surrounding areas	USA (n = 107)	3.57 (0.67)	15.21	<.01	USA > Japan (<0.01)
	Japan (n = 110)	3.03 (0.78)			UK > Japan (<0.01)
	UK (n = 27)	3.74 (0.45)			Malaysia > Japan (<0.01)
	Malaysia (n = 28)	3.54 (0.51)			
Intention to learn more about local wildlife	USA (n = 108)	3.72 (0.56)	11.79	<.01	USA > Japan (<0.01)
	Japan (n = 110)	3.25 (0.68)			UK > Japan (<0.05)
	UK (n = 29)	3.66 (0.55)			Malaysia > Japan (<0.05)
	Malaysia (n = 27)	3.63 (0.49)			

Table 5. Respondents' degree of learning through participating in the programme, and results of the analysis of variance (results of the post-hoc comparison show items that had significant differences between nationalities).

		Mean (standard deviation)	F-value	*p* value	Results of post-hoc comparison
Learned something new about the animals and plants in my local area	USA (n = 145)	4.47 (0.73)	7.22	<.01	USA > Japan (<0.01)
	Japan (n = 103)	4.04 (0.91)			Malaysia > Japan (<0.01)
	UK (n = 34)	4.38 (0.92)			
	Malaysia (n = 28)	4.61 (0.50)			
Learned something new about the threats to animals and plants in my area	USA (n = 145)	3.64 (1.10)	4.50	<.01	Malaysia > USA (<0.01)
	Japan (n = 103)	3.45 (1.00)			Malaysia > Japan (<0.05)
	UK (n = 34)	3.24 (1.02)			Malaysia > UK (<0.01)
	Malaysia (n = 28)	4.11 (0.69)			
Learned about the organizations/projects working to monitor and protect animals and plants in my area	USA (n = 145)	3.86 (1.03)	0.40	.76	
	Japan (n = 103)	3.91 (0.78)			
	UK (n = 34)	3.82 (0.76)			
	Malaysia (n = 28)	4.04 (0.79)			
Learned about different ways I can contribute to protect the local environment	USA (n = 145)	3.77 (1.08)	1.90	.13	
	Japan (n = 104)	3.90 (0.85)			
	UK (n = 34)	3.68 (0.84)			
	Malaysia (n = 28)	4.18 (0.72)			

fourth of the dependent variable is explained by these two independent variables. The VIF (Variance Inflation Factor) is 1.075, indicating that multicollinearity was low (less than 2.0) (Vaske 2008).

The regression analysis revealed that two items had significant effects among Japanese participants ($n = 97$). Those who intended to join a wildlife group/charity/biodiversity project ($B = 0.675$, $p < .01$) and those who felt that they had learned about the animals and plants in their local area ($B = 0.214$, $p < .01$) had higher willingness to participate in similar activities in the future. The adjusted R^2 is 0.573, indicating that these two variables explain the majority of respondents' willingness to join similar activities in Japan. The *VIF* is 1.084, indicating low multicollinearity (less than 2.0) (Vaske 2008).

Discussion

Differences in participants' perceptions among countries

The first attempt to understand participants' perceptions of the CNC citizen/community science activities revealed several findings. Although we understand that there is a limitation in terms of generalizing our samples to the countries they represent, our respondents showed a certain trend. Depending on the nationality, there were significant differences in the participants' socio-demographic attributes, past experiences in related activities, and perceptions. In the United States and the United Kingdom, a majority of participants were in their 30s to 50s, whereas in Japan and Malaysia, the majority were students in the 15–24 age range. While it can be assumed that adult participants joined the events because they were interested in the contents of the activity, students in Japan more likely joined because it was a school or university activity. This might explain why only a limited number of participants had joined similar activities before in Japan and Malaysia. In addition, most of the participants in the United States and the United Kingdom had used the mobile app to collect data before, whereas Japanese participants had almost never used it.

The reason why the Japanese participants have significantly lower scores for their intentions to take part in similar activities than the others can be explained by their initial interest in the topic. Assuming that the participants (mostly students) in Japan joined the events because these were course activities, it is possible that the reason for participating in the events was passive or reactive; getting credit from the course was potentially the motivation for many of them. Previous studies have shown that behaviours caused by such extrinsic motivation would not be sustained in the long term compared to those caused by intrinsic motivation (Ryan and Deci 2000; Phillips et al. 2018). Continuously recruiting participants for citizen/community science projects is important for the sustainability and development of the projects, but it can be challenging (Bonney et al. 2009b). This is because participants have diverse interests or reasons to join such events (Bonney et al. 2014; Aivelo and Huovelin 2020). Whereas participants in many such projects are already interested in the subjects of the events or in science (Bonney et al. 2009b; Lynch et al. 2018; Phillips et al. 2018), reaching out to new audiences is critical because the goal of many citizen/community science projects is to increase the public awareness of science and nature conservation (Bonney et al. 2015; Kobori et al. 2016). In addition, the lack of young participants in these projects has been referred to in previous studies (Kobori et al. 2016). In that sense, getting university students to join citizen/community science activities by including such events as part of their formal education could be the first step to gaining new audiences (Aivelo and Huovelin 2020).

By contrast, when it comes to how much participants learned about threats to wildlife in the area, respondents in Malaysia had higher scores than the others. This might reflect the actual threats that the developing countries are facing; in countries like Malaysia, by participating in CNC activities participants might have observed and learned about real threats such as the destruction of the ecosystem.

As mentioned earlier, considering the limitation of the sampling procedure, the respondents in this study are not representative of the CNC participants of each country. In Japan, a total of 156 people participated in the activities of CNC2018, and therefore, we can assume that our samples (n = 113) could be representing the participants as a whole to some degree, since the response rate of this survey was 72.9%. On the other hand, less than 10% of the participants responded to our survey in Malaysia and the United Kingdom (number of participants and response rates: Malaysia = 682 and 4.1%, UK = 434 and 7.8%). In terms of the United States, among 14,364 people who joined the activities of CNC2018, only 145 responded to our survey (response rate = 1.0%). Thus, in order to increase the generalizability of the results to represent each country, future studies will require a coordinated effort to achieve a higher response rate.

Since citizen science programmes rely on volunteer participants, it can be argued that volunteering in general may be perceived in different ways from country to country, depending on historical, cultural, social, and political influences. The number of volunteers seems to differ among countries; nearly half the adult population in the United States and the United Kingdom engage in volunteering, as opposed to Japan where participation in volunteer activities is 'very low' (Anheier and Salamon 1999, 57–60). Furthermore, the meaning and pattern of volunteering are changing over time (Anheier and Salamon 1999, 46). Although it is beyond the scope of this study to discuss the historical trend in volunteering cross culturally, better understanding the background and cultural meaning of volunteering in each country will be necessary to further discuss the potential implications of a multicultural survey.

Motivation for joining citizen/community science activities, and potential future research

The importance of cultivating participants' identities as citizen/community scientists and understanding their motivation to join the projects has been mentioned in the literature (Land-Zandstra, Agnello, and Gültekin 2021); however, studies on how to cultivate this motivation are still limited (Jordan et al. 2011; Kobori et al. 2016). In our study, although participants' socio-demographic attributes and reactions to events were different among the countries, the regression analysis revealed a common factor affecting their intention to join similar activities in the future in two countries. For participants in the United States (mostly adults) and Japan (mostly students), the perception of learning about animals and plants in the area significantly increased their intention to join similar events. Our findings suggest that such a potentially common factor could encourage participants' engagement in and retention of CNC activities internationally. Programme managers of citizen/community science projects should consider how to increase participants' levels of learning about local animals and plants during the activity in order to enhance the retention of participants.

Further social science research is necessary to understand participants' motivation and the outcomes of participation. In addition, more front-end evaluation (or needs assessment) is necessary, especially when the project aims to recruit new participants or attract new audiences who are not necessarily interested in the topic (Kobori et al. 2016), similar to the case of Japan in our study. By assessing the motivations, needs, and expectations of new audiences, programme managers can tailor accordingly the activities and messages to meet the individual and community needs and to influence participants' satisfaction (Bonney et al. 2009a; Aivelo and Huovelin 2020; Phillips et al. 2021). In the case of Japan, a front-end evaluation survey could be included to understand students' concerns, demands, and expectations from the events. A needs assessments will be crucial to inform the development of relevant contents for the programme and communication strategies that will potentially increase the recruitment and level of engagement of students.

This study presents limitations in conducting analyses and interpreting results based on such limited samples from different countries (i.e. unevenly distributed samples in terms of nationalities). Our survey did not assess the motivations driving participation in CNC activities or how actively participants were involved (e.g. whether and how much data they collected). The critical goals of this research were, firstly, to conduct a coordinated evaluation of CNC participants from around the world using a common questionnaire and, secondly, to explore the opportunities and challenges of such cross-cultural citizen/community science initiatives. The results not only showed some similarities and differences among countries (based on the samples) but also provided insights on how participant surveys can be conducted for international citizen/community science activities, suggesting, for example, what questions can be asked.

Further improvements can be made to our survey. First, because one of the goals of citizen/community science projects is to increase public engagement in scientific activities, surveys could include items related to participants' understanding of the scientific process, science-related skills, attitudes towards science, and self-efficacy as potential scientists (Bonney et al. 2009a; Jordan et al. 2011). Citizen/community science projects can maximize their impacts if participants are engaged in the long term and if their level of engagement increases (i.e. they start their own conservation activities in the neighbourhood).

Second, assessing the duration of participants' involvement and their change in behaviour as a consequence of participation could be another interesting outcome to measure through the survey (Jordan et al. 2011; Kobori et al. 2016). For example, by tracking the activity logs (Aristeidou, Scanlon, and Sharples 2017), participants' actual behaviours during the activities could be monitored. A study that utilized the data of activity logs was conducted on participants of CNC and revealed their behavioural patterns changed during the COVID-19 pandemic in Tokyo (e.g. participants were more likely to conduct activities in their neighbourhoods during the pandemic; Kishimoto and Kobori 2021). By combining data from both survey questionnaire and activity logs, future research could explore the relationship between participants' cognitive factors (e.g. perceptions and motivations) and their resulting behaviours (e.g. the pattern of where and how intensively they engage in nature observation).

Third, measuring participants' self-efficacy, environmental stewardship, and sense of place would provide useful information to better understand their relationship with participants' engagement as well as the long-term retention and performance throughout their involvement in the projects (McKinley et al. 2017; Sakurai et al. 2017; Lynch et al. 2018). A framework developed for measuring individuals' learning outcomes (such as the one created by Phillips et al. 2018) could be used as a reference to guide the creation of survey items that represent important cognitive elements such as motivation and self-efficacy.

The biodiversity crisis is an urgent issue worldwide, and conservation efforts are being made internationally. International initiatives such as the CNC have been conducted using a standard procedure and format that can be used for ecological research and policy recommendations globally. While there are still a limited number of social survey items available to evaluate international citizen/community science projects, we believe that our research is one of the first steps in attempting to fill this gap.

Disclosure statement

The authors report there are no competing interests to declare.

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Appendix 1. Nationality (including region) of respondents

Number of respondents	Nationality (including region)
145	USA
113	Japan
34	UK
28	Malaysia
10	Canada
10	Columbia
4	Hong Kong
2	Italy
1	Argentina
1	Czech Republic
1	Indonesia
1	Pakistan
11	Unknown (nationality not answered)
Total: 361	