UKEOF
ENVIRONMENTAL OBSERVATION FRAMEWORK

Understanding Motivations for Citizen Science

Final report on behalf of the UK Environmental Observation Framework by:

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The UK Environmental Observation Framework is a partnership of the major public funders of environmental science and was launched in 2008 to address issues of fragmentation, data access and a lack of strategic direction in environmental monitoring.

'Changing the way the UK perceives , values and uses environmental observations'

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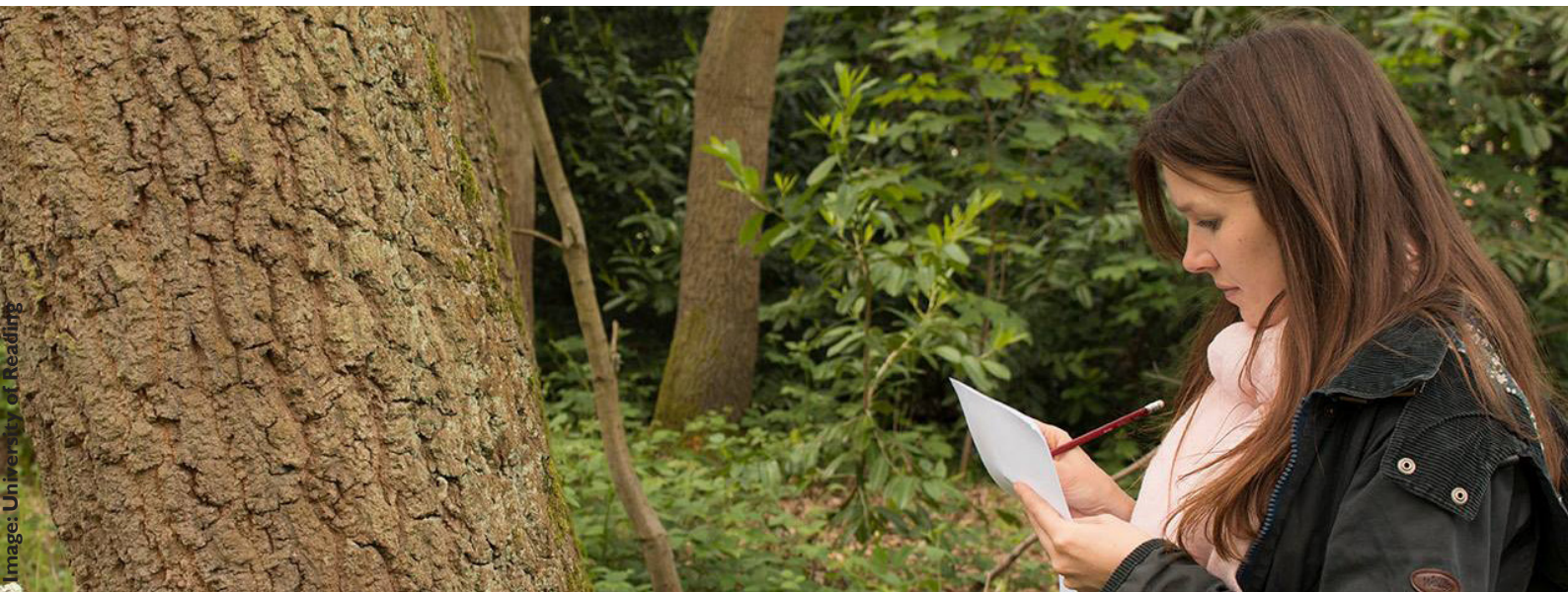

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We asked citizen science survey respondents – what encourages or discourages their participation in a project, the following responses were given:

"To start with it was an acknowledgment but now I understand how important [the project] is I am more than happy to do it for no thanks at all."
(Citizen science respondent)

"Firstly it is an activity which is enjoyable in its own right. By dint of walking a transect route each week you learn in detail how the environment changes from week to week across the season and this massively increases your knowledge and awareness of the species and plants you see and their phenology. It is like internalizing a textbook. Your local work feeds into a regional and a national picture which gives a snapshot of what is happening in the environment."
(Citizen science respondent)

Asked by the interviewer – do you take citizen scientist motivations into account in your citizen projects, the following responses were given by stakeholders:

"Yes we do. We do, because we know that they are, how can I put it? I don't know, precious to us. And to upset these key citizen scientists, they're integral to what we're doing. If we couldn't use the [data], use is a bad word but I'm afraid it does get used. If we couldn't work with citizen scientists, what would we put in its place? How could we cope without them? Therefore, we don't want to demotivate them. So we do have to think about what [their] motivation might be."
(Scientist, monitoring, policy)

"It sounds very cynical doesn't it? It's always better to have better data."
(Scientist, data only)

Report summary

Citizen science plays an important role in delivering environmental data at local and national scales, and can form the basis of scientific research, as well as evidence for policy and management. Citizen science is also an important way of connecting people with nature, and has been used to help organisations communicate the importance of their work in the area of nature conservation. However, without an understanding of why and how people (non-professional volunteers) participate in citizen science, some initiatives could miss their mark and fail to provide the expected benefits to science and society. These social drivers of evidence-gathering by citizen scientists are often overlooked by stakeholders in favour of discussions around the need for and quality of the resulting data. This study explores the motivations of environmental-based citizen science participants and stakeholders from 'science', 'policy' and 'practice'.

Researching motivations (Chapter 2)

This study takes a three-phased approach to researching motivations in citizen science: (1) a desk based study of existing literature on motivations of stakeholders and participants in environmental citizen science, and moving into other disciplines where appropriate to fill gaps in understanding. The literature identified focussed on motivations together with benefits of and barriers to the use of citizen science as an approach; (2) an online survey of citizen science participants (147 respondents) and environmental volunteers (47 respondents) allowed areas of motivations that are neglected in the literature to be addressed, and particularly the motivations of those currently involved in environmental volunteering who might be potential participants in citizen science; and (3) telephone interviews with stakeholders in citizen science, across scientists (both those using and not currently using citizen science and those using citizen generated data in their work) and filling gaps in understanding of the motivations of other stakeholders in citizen science working in policy and practice communities.

Defining citizen science (Chapter 3)

The results of the online survey and stakeholder interviews revealed multiple definitions of citizen science. The most widely accepted definition of citizen science by stakeholders involved the collection of data by citizens for use by scientists with an acknowledgement that citizens must also benefit. Many other elements also contribute to a broader definition that incorporates widening participation and harnessing emotional attachment, involvement of people and movement of data across different skill levels and the prioritisation of science leading to academic output or other use.

The use of the term citizen science by stakeholders appears to be primarily inward facing, with the term 'citizen science' rarely used in communications directed towards participants. This is reflected in the results of the environmental volunteering online survey, who did not identify as citizen science participants, but were often engaged in activity that might be classified as recording. Furthermore, stakeholders must consider how they are using the term citizen science in relation to their project to avoid confusion and mixed messages.

Citizen scientist motivations (Chapter 4)

The environmental volunteering literature frequently categorises motivations for participants as intrinsic (or inherently valuable or satisfying) or extrinsic (or leading to some other benefit, such as future career prospects). Citizen science literature provides more detail on these types of motivations, with categories such as: egoism, where the motivation is personal growth or gain; altruism, where others benefit; collectivism, where a particular group benefits; or principalism, where individual principles are upheld. Digitally mediated citizen science projects frequently use motivations of competition or reputation to encourage (continued) participation. Of course, participants vary individually and will not necessarily conform to type. The literature shows evidence that motivations vary between types of project, with some environmental-based citizen science projects finding environmental values to be the most

important motivation, digitally mediated citizen science projects finding contributing to science most dominant, and environmental volunteering projects finding enhancement or personal gain values as most important.

An earlier study (West et al. 2015) of motivations in data submission to environmental citizen science projects found that the most commonly held motivations of participants were wanting to help nature in general, followed by a desire to contribute to scientific understanding, followed by the purely intrinsic motivation, 'it's a valuable thing to do'. A desire to please others by participating and a category of 'other' motivations came next. The results of our online survey are broadly in agreement with West et al. Further definition of intrinsic values were elucidated through comments on enjoyment of the activity. Differences occurred in those who identified themselves as environmental volunteers in that learning, spending time outdoors and helping future careers had greater importance and contributing to scientific knowledge lesser importance.

Motivations for beginning and continuing in citizen science (Chapter 5)
The volunteering literature gives some insight into dispositional (personal motivations) and organisational (logistical) variables that influence initial participation with the addition of awareness that the opportunity exists. The environmental volunteering literature suggests that continued participation is motivated by the fulfilment of initial motivations to participate, while poor organisation frequently contributes to fall off in participation. The majority of participants apart from those involved in science-led projects, said that their motivations had not changed across time. Participants in science-led projects said that they were now more motivated by contributing to science, sharing knowledge and a stronger concern for conservation.

Whilst the majority of respondents to the online survey who were encouraged to continue participation had had their initial motivation satisfied, there were respondents to the online survey who were still encouraged to continue participation in projects despite being dissatisfied, which suggests that other variables are also involved. Two other potential incentives for continued participation identified via the online survey were skills development, and feedback and communication.

In sum, shared motivations and the importance of communication and feedback to worthwhile participation in environmental volunteering projects suggest that citizen science may appeal to many environmental volunteers.

Motivations for stakeholders in citizen science (Chapter 6)
This chapter reviews the motivations of stakeholders in citizen science, across science, policy and practice communities. The literature focuses mainly on scientists rather than other stakeholders, and mentions motivations such as to inform science, to inform policy, inform conservation and land management, improve buy in, awareness raising and engagement, building partnerships and improving communication. Not surprisingly, for scientists, the most common motivation is in advancing scientific knowledge, using citizen science approaches to collect data on a temporal and spatial scale that would not otherwise be possible. The stakeholder interviews found a much richer picture, with both institutional and personal motivations such as institutional promotion and publicity, education, a need for open data and managing public engagement in a constructive way. Most revealingly a new category of 'personal satisfaction' brought out very individual motivations around enjoyment and fulfilment in work and the satisfaction of personal commitments. Stakeholders were also personally motivated by providing benefit for others through enabling equity and self-determination for participants and generating impact for others' lives.

Matching participant and stakeholder motivations (Chapter 7)
Few studies address whether matching participant and stakeholder expectations contributes to the success of citizen science projects, though one study has found that recognition of the interests of participants by stakeholders can increase participation. In some cases an only partial fulfilment of motivations may be enough to ensure that the contributory project satisfies both participants and stakeholders. Where participants have a more immediate interest in the implications and impact of the results of the project on themselves or their communities, namely a more co-designed approach, stakeholders will need to take greater account of ensuring that the data is useful to participants as well as themselves.

Barriers and challenges for stakeholder participants (Chapter 8)
Existing literature on stakeholder barriers and challenges is confined to scientific and land manager communities, and identifies barriers such as data quality and biases, peer review and mistrust of citizen generated data, the need for specialist equipment or knowledge, time and resourcing issues and lack of skills for working with the public and the potential for political ramifications. The interviews identified some new barriers in relation to data, including scalability and patchiness and specialist data needs beyond the scope of citizen science. Technology can also be perceived as a barrier as advancements are difficult to keep up with and have generated a crowded marketplace. At the same time, enabling participants to use technology can be difficult. While some stakeholders have found communication with participants to be very rewarding, this is also very time consuming. The stakeholder interviews also revealed that citizen science must be promoted at a high level within institutions to maintain profile and resourcing. The needs of participants were also acknowledged in that stakeholders recognised that more attention needs to be paid to the citizen science audience both to recruit appropriate volunteers and to ensure that surveys are designed in a way that works for the participants. Despite the number of barriers identified, stakeholders frequently commented that solutions had been found to many of the issues, for instance using statistical techniques to overcome issues with data. Showing the value of citizen science within institutions has also been effective, whether by raising the profile of their work by concentrating on key findings or by using citizen science work to contribute to academic metrics on impact.

Technology in citizen science (Chapter 9)
The stakeholder interviewees felt that the use of technology has transformed the potential of citizen science, making it possible to collect and then analyse large quantities of data, and importantly, to share that data. The expectation is now that technology will be integral to citizen science projects, but also that there will be some participants who will continue to use paper based recording. Considerable effort has gone in to long term projects to encourage a digital switchover. Stakeholders also voiced caution, that technologies need to be appropriate for participants to use and to deliver successful outcomes. Stakeholders working with disadvantaged communities were particularly aware that participants might not have access to the internet or a mobile phone data plan, or have time and the skills for technological solutions. Several of the stakeholder interviewees work on air quality projects, which make a particularly good example of some of the issues with technological solutions. Air quality sensors offer the potential to collect data from more areas than the official sensor network, but ‘low cost’ sensors still have cost and data reliability issues and some interpretation is needed to ensure that the data collected is relevant.

Evaluation of citizen science (Chapter 10)
Many of the stakeholder interviewees demonstrated awareness that evaluation was necessary and useful to the on-going improvement of the project and understanding of its impact. They also identified barriers around resourcing which make this difficult to achieve, specifically staff with appropriate skills and expertise, time for evaluation (not just among practitioners but also participants) and funding to carry out evaluation. As a result, the majority of monitoring is only of outputs, where the evaluation checks that participants are contributing

the data that the project requires and perhaps that participants are happy with their participation. Deeper levels of evaluation, considering outcomes (such as learning and attitudinal change) and impact (such as behavioural change or difference in management or policy) is rarely undertaken, perhaps because in order to achieve this kind of evaluation, it needs to be integrated in the project design.

Conclusions: proposed further work (Chapter 11)
In addition to the findings relayed in the previous sections and recommendations, our research has led to a number of proposals for further work: (1) whilst evaluation and monitoring are recognised as important by stakeholders, further training is required to move from outputs-based evaluation to outcomes and impacts; (2) to fully understand what it means to participate in citizen science, a longitudinal study would reveal the significance of participation in citizen science to people's everyday lives; (3) as citizen science takes an increasingly participatory turn, there needs to be a greater focus on participant motivations for collaborative and co-designed projects; (4) social and environmental challenges do not respect national borders, further work needs to understand how motivations differ in/between developing and developed nations.

Useful resources and tables for stakeholders
At the beginning of each chapter, there is a detailed summary of the key findings. The table below offers details of useful diagrams and lists to help stakeholders.

Use	Title	Location
To understand what encourages and discourages participation in citizen science (quick view)	Summary of what encourages and discourages participation	Table 32
To understand what motivates people to participate in citizen science	Primary and top 5 motivations, other responses	Tables 14-16
Current methods for communicating with citizen science participants	Stakeholder communication and feedback mechanisms	Table 31
To understand the motivations of science, policy and practice communities in citizen science	Stakeholder motivations	Table 33
Scenarios for identifying shared motivations between participants and stakeholders	Recognition of motivations scenarios	Figures 4
To understand the barriers and challenges surrounding science, policy and practice community involvement in citizen science	Barriers and challenges to stakeholder participation in citizen science	Table 37
To integrate evaluation into your project at all stages	Stage-by-stage inclusion of evaluation	Figure 7

Table 1 Useful resources for stakeholders in this report

Chapter 1: Introduction: understanding motivations for citizen science

Chapter highlights
* Without an understanding of why and how people participate in citizen science, some initiatives could miss their mark and fail to provide the expected benefits to science and society
* Social scientists agree that people's motivations are broad, that individuals can hold multiple motivations and that these can change over time
* This project adopts a robust social scientific approach in order to provide evidence-based knowledge of the human dimensions of participation in citizen science

Citizen science is broadly defined as the participation of non-professional volunteers in professional science projects (Dickinson et al. 2010). As a scientific method, it is widely acknowledged to have an important role in delivering valuable environmental data from local to national scales (Roy et al. 2012, Haklay 2015a, see also Table 33 on stakeholder motivations in this report). However, without an understanding of why and how people (non-professional volunteers) participate in citizen science, some initiatives could miss their mark and fail to provide the expected benefits to science and society (Roy et al. 2012). These social drivers of evidence-gathering by citizen scientists are often overlooked by stakeholders in favour of discussions around the need for and quality of the resulting data. This report, supported by the UKEOF, balances this with an approach based on social science in order to understand the personal needs, motivations, benefits and barriers which affect participation in environmental-based citizen science, both in terms of the citizen scientists themselves and other stakeholders, including a range of scientists (university, monitoring, policy, education, not using /data only), policy/evidence specialists and practitioners (science, engagement, education, community). Importantly, this study also incorporates the opinions of those volunteers who self-identify as environmental volunteers, in order to understand the motivations of those already engaged in the environment in some way, and how they might be persuaded to participate in citizen science, if they are not already involved.

The report is structured around:

1. an extensive desk-based study of literature surrounding citizen science and environmental volunteering;
2. an online survey of environmental-based citizen scientists and environmental volunteers;
3. interviews with citizen science stakeholders, including scientists (university, monitoring, policy, education, not using/data only), policy/evidence specialists and practitioners (science, engagement, education, community);
4. information regarding project evaluation; and
5. conclusions and key findings regarding participant and stakeholder motivations and suggestions for further investigation.

In the remainder of this section, we outline the rationale behind the study, the importance of a social science approach, and the research questions that framed this study.

1.1 Rationale and who is this study for

Citizen science can deliver robust data to meet the needs of stakeholders from the local to the national scale (POSTnote 2014). However, in order to maximise the amount and quality of data that is returned, the human aspects of citizen science, which so far have been relatively

understudied, need examining. The research presented here is therefore timely and original, providing a wide range of stakeholders in the UK and beyond, including scientists, informed citizens, data users, practitioners such as Government agencies carrying out environmental monitoring, policymakers, social scientists, educators and the media, with insights into: why people participate in citizen science; what benefits they gain from it; and how motivations can be evaluated as part of citizen science projects. This study consolidates and improves current understandings of motivation and participation in citizen science in the UK, so that new and existing initiatives can be (re-)designed to take these factors into account, making them more likely to succeed, and easier to evaluate.

1.2 Social science approach

Social science is the study of the relationships between people and their connections with the social and natural worlds that surround them (ESRC 2016). Social scientists agree that people's motivations are broad, that individuals can hold multiple motivations and that these can change over time (for an introduction to social science, see: della Porta and Keating 2008). Yet, these motivations need to be acknowledged and met by citizen science projects in order to maximise the return rates of participants (Roy et al. 2012). Citizen science is an ever-expanding field with projects varying in their levels of sophistication and demands on participants. Understanding how and why citizen scientists, environmental volunteers and stakeholders (including scientists (university, monitoring, policy, education, not using/data only), policy/evidence specialists and practitioners (science, engagement, education, community)) are motivated to participate in citizen science projects demands a social science approach. To date, projects on the social dimensions of citizen science have tended to be an addition to natural science projects, or rather narrow in focus. This project adopts a robust social scientific approach in order to provide evidence-based knowledge of the human dimensions of participation in citizen science.

1.3 Objectives and research questions

The project objectives were three-fold:

1. To conduct a desk-based review of existing literature on motivations and evaluation for citizen science;
2. To design, implement and analyse (a) an online survey of existing and potential citizen scientists and (b) interviews around the motivations of stakeholders in scientific, policy and practice communities (namely, scientists (university, monitoring, policy, education, not using/data only), policy/evidence specialists and practitioners (science, engagement, education, community));
3. To deliver a final report and online materials to share the findings of the project, and make recommendations for future studies, especially to explore methods of citizen science project evaluation, as well as reinforce the vital role of the social sciences to citizen science, environmental monitoring and surveillance.

The research presented in this report seeks to answer 8 important questions identified by the authors and UKEOF partner organisations. Table 2 overleaf outlines the questions and the places where they have been discussed in this report.

Two further chapters emerged as a result of this study. Chapter 3 on definitions of citizen science and Chapter 9 on technology and citizen science.

1.4 Outline of report

In the remainder of the report, Chapter 2 gives an account of our methodological approach and our analysis of some basic data on our online survey respondents. Chapter 3 examines the

varying ways in which citizen science has been defined in this study. Chapters 4-10 combine material from the desk-based review, online survey and stakeholder interviews to answer our research questions, as well as a discussion on the role of technology in citizen science. Chapter 11 is our conclusion and recommendations for future work. There is an extensive bibliography at the end of this report.

Research question	**Review**	**Surveys**	**Interviews**	**Chapter**
What are citizen scientists and environmental volunteers motivations?	■	■	■	4
What would encourage citizen scientists and environmental volunteers to participate for the first time or again?	■	■		5
How do citizen scientist and environmental volunteer motivations vary over time?	■	■		4 & 5
How do citizen scientists and environmental volunteers benefit from participation?	■	■	■	5
What are the key motivations for stakeholders in citizen science projects?	■		■	6
What are the barriers for stakeholders in citizen science projects?			■	8
Do participant motivations match stakeholder motivations?		■	■	7
How are citizen science projects evaluated by stakeholders?	■	■	■	10

Table 2 Research questions by data source and chapter

Chapter 2: Researching motivations

Chapter highlights
* Focussed review on environmental-based citizen science literature and work on environmental volunteering
* 147 citizen science respondents to our online survey, with few aligning with our priority areas of pollination, air quality, weather & climate change, and tree health. The majority undertook traditional recording activities for over 3 years. 47 environmental volunteering respondents to our online survey
* In comparison to West et al.'s (2015) study revealing that citizen science participation is biased towards white, middle aged men with high incomes, our survey respondents were more likely to be male, in the age categories of 25-34 and 55-64, and a smaller proportion from BME groups. The majority of respondents had participated in citizen science/environmental volunteering for more than three years, and were regular contributors to projects (i.e. more than once per month)
* 18 stakeholder interviews were conducted across science, policy and practice communities

To realise the potential of social science to understanding the human dimensions of citizen science, we adopted a mixed methods approach combining quantitative and qualitative methods. The research involved three distinct research phases, which are discussed below in turn.

2.1 Phase 1: desk-based study

We conducted a desk-based review of existing academic literature on motivations for citizen science in order to fill the gaps in our knowledge. Our approach has been to search for existing literature around each of the research questions. It is important to note that we have concentrated primarily on motivation in the environmental-based citizen science literature with the exception of where papers from other disciplines fill large gaps in understanding. We have reviewed the current academic literature relating to:

- the motivations of citizen science participants and stakeholders in science, policy and practice communities;
- the barriers to using citizen science as an approach; and
- the benefits to participants of citizen science.

Papers were found using a Web of Knowledge search for the terms "citizen science" AND scientist OR policy OR motivation/s. We also present some data from a recent study by West et al. (2015) which examined the motivations of a large number of citizen science participants. This review enabled us to identify some key findings and data gaps that could be further addressed by our online survey and stakeholder interviews.

Rather than offer our review as a stand-alone chapter requiring regular cross-referral to other sections, it forms part of each of the following chapters relating to our research questions.

2.2 Phase 2: online survey

For Phases 2 and 3 of this research, we focussed on 4 priority areas (Table 3) where citizen science is widely used and which are current policy priorities. We adopted this approach due

to the broad nature of the citizen science field and we wanted to concentrate on environmental-based citizen science.

Priority area	Participation-type	Policy priority
Pollination	Number of current contributory citizen science projects involving unskilled volunteers but also has a history of highly skilled recorders of particular groups of pollinators	Outlined in Defra's (2014) *The National Pollinator Strategy: for bees and other pollinators in England*: "Develop and test a new systematic and sustainable monitoring framework for pollinators to be implemented by professionals and by using a 'citizen science' approach involving volunteers logging observations and gathering other evidence."
Air quality	Often at a local scale and sitting across research and activism agendas, involving collaborative and co-designed citizen science projects	Since 2013 SEPA have been interested in monitoring local air quality through citizen science: http://www.sepaview.com/2015/04/learning-about-air-quality/
Weather & climate change	Some of the longest running citizen science projects, such as those recording phenological events	JNCC have a long-term relationship with amateur naturalists, recorders and citizen scientists to gather evidence via monitoring. 3-4 million records are submitted annually: http://jncc.defra.gov.uk/page-5549
Tree health	Volunteers across a range of skill levels and geographical scales	Outlined in Defra's (2014) *Tree Health Management Plan*: "We are also using citizen science to contribute in a number of key ways – increasing public awareness of the risks posed by tree diseases; supporting existing networks of individuals with an interest in plant health, and; enhancing public capability and capacity to identify outbreaks of pests and undertake surveillance activities."

Table 3 Justification of priority areas by participation type and policy prioritisation

We conducted an online survey of citizen scientists (regardless of skill level) and environmental volunteers in order to access current non-participants in citizen science. Whilst this quantitative method offers a largely static view, with little evidence of citizen science and environmental volunteering in everyday life, it enabled us to ask specific questions of our target groups. Futhermore, an online survey allowed us to gain access to the greatest number of participants across a wide reach of the country and within the permitted budget (Van Selm & Jankowski 2006). This strategy was deemed optimal because there was no direct connection with or contact details for the target audience in the first instance (this related to data protection issues associated with each individual project). Social desirability bias issues were considered (Kreuter, Presser, & Tourangeau, 2008), but it was decided that given the anonymity of the survey, such potential considerations would not be relevant to data gathered. Noting Galesic and Bosnjak's (2009) observations regarding survey length and participation dropout and quality, the survey was streamlined as much as was possible to keep the survey to a 10-minute anticipated maximum.

Sampling

We adopted a non-probability sample, i.e. non-random, which is therefore not representative of citizen scientists and environmental volunteers on the whole. We chose to target

participants in 4 key citizen science areas: pollination; air quality; weather & climate change; and tree health. A preliminary list of contact details for citizen science organisations working across the four areas of interest was drawn up. Each project was emailed and agreement was sought that they would send the survey invite out to their participants. An invitation to forward on the survey link more widely ensured some snowball sampling, further widening coverage. Qualtrics software was used to create and administer the survey. The system is aesthetically appealing and allows for ease-of-use on either a computer or a mobile device.

Survey questions

A full version of the survey can be founded in Appendix 1. The survey began with two initial screening questions to ask firstly for consent to use respondents' submitted data, and then whether they had taken part in a citizen science project, an environmental volunteering project or neither. This then directed respondents to the appropriate set of following questions and ensured the data could be easily processed and analysed.

For citizen scientists, the next set of questions asked about the type of project they had undertaken, frequency and duration of participation, types of activities (data collection, data submission, organising, etc.) and whether activities had been carried out alone or in a group. The third section asked about initial motivations and their satisfaction, skills development, and whether or not these had motivated further involvement. Respondents were then asked about data submission, the means available, feedback, satisfaction with the process and whether this had affected motivations. For those who had not submitted their data, reasons for this and effects upon motivations were asked about. Overall historic and current enthusiasm (for specific projects and contributing to science more generally) were then raised, before moving on to a broad range of high-level demographics to facilitate breaking down the data (age, gender, region, education, income and ethnicity).

The volunteering stream worked similarly, covering motivations, skills development, the importance of feedback and enthusiasm. Both volunteers and non-participants were then asked whether they were aware of citizen science projects, whether they were interested and any barriers that they felt prevented them from becoming involved.

Respondents

We received 147 valid citizen science entries, and 47 for environmental volunteering. We received over 100 further survey attempts, however these were non-valid entries, or the respondent had submitted only demographics and no further information. We've identified several reasons for a low response rate in our four target areas:

(1) There was a proliferation of similar research work around volunteer and biological recorder motivations at the same moment, including the NBN Biological Recording Survey[1] and Bournemouth University Volunteer Motivations Survey.[2] This could have produced 'survey fatigue' meaning that potential respondents did not want to complete another survey on the topic;
(2) Some of the projects we targeted had recently circulated their own feedback forms and were concerned about bombarding their participants with emails (this is a challenge identified by the stakeholders during the interviews in Chapter 10 on evaluation); and
(3) There was considerable overlap between projects and the focus on particular species, rather than issues such as pollination. This meant that some participants may have chosen not to attribute their project to our categories but instead select 'other'.

Analysis: quantitative and qualitative answers

[1] http://nbn.org.uk/news/nbn-recorder-motivation-research-summary-findings/

[2] PhD project at Bournemouth University looking into how to enhance human well-being and project outcomes through volunteer engagement. Contact: gitte.kragh@bournemouth.ac.uk

We have conducted both (1) univariate analysis of the responses, namely frequency tables; and (2) bivariate analysis, namely contingency tables. However, our non-probability sampling approach, low response rate, and some instances of 'outliers' have meant that we have not been able to conduct any multivariate analysis or tests for statistical significance. Instead, we have been able to offer some interesting descriptive statistics throughout the report.

As indicated earlier, we asked our respondents some open-ended questions, for example what makes their participation worthwhile and how do they feel their motivations have changed over time. Their answers have proved invaluable for identifying in their own words how citizen scientists and environmental volunteers value feedback and communication for example (answers are reported in full in Appendix 3).

2.2.1 Basic data on respondents by project and involvement

In this section, we offer some basic data on our respondents. As indicated earlier we targeted 4 citizen science priority areas: pollination; air quality; weather & climate change; and tree health. We received the most responses in the category of 'other'. We re-coded this field as 'biodiversity'. It was clear from the project names listed and their objectives that these were largely traditional recording projects. We attempted to break these down again by subject area, using species or activity relevant codes (see Table 4) below.

Subject area	**Number of respondents**
Pollination	5
Air quality	1
Climate Change & Weather	4
Tree Health	5
Biodiversity	114
Soils	6
Other	12
Total	147

Table 4 Number of respondents by subject area

However, respondents remained clustered around biodiversity. We decided to re-code our citizen science respondents again (Table 5), this time based upon the purpose of the project they contributed to and we identified the following 4 categories:

Citizen science type	**Number of respondents (% of total respondents)**
Recording (traditional biological recording/monitoring)	108 (73%)
Science-led (hypothesis-driven research by university scientists)	17 (12%)
Surveillance (early-warning and detection)	7 (5%)
Other (e.g. citizen panels on environmental decision-making)	15 (10%)
Total	147

Table 5 Number of respondents by citizen science type

Once again citizen science respondents remained clustered, this time around 'recording'. Initial analysis also revealed that the majority of our participants (citizen science and environmental volunteering) had participated for more 3 years (Table 6), more than once per

month and at least more than once per year (Table 7) and that over half were involved in more than one citizen science or environmental volunteering project (Table 8). We can conclude that our survey attracted the most active participants as is often the case when respondents are required to self-select.

	Number of respondents (% of those who responded)				
Length of participation	**Recording**	**Science-led**	**Surveillance**	**Other**	**Environmental volunteering**
<6 months	13 (12%)	5 (33%)	1 (14%)	3 (20%)	1 (2%)
1-2 years	0	0	0	0	3 (7%)
3-5 years	28 (26%)	5 (33%)	1 (14%)	6 (40%)	7 (16%)
>5 years	62 (59%)	5 (33%)	5 (71%)	6 (40%)	34 (75%)
No reply	3	2	0	0	2

Table 6 Number of respondents and length of participation in citizen science or environmental volunteering

	Number of respondents (% of those who responded)			
Type	**Recording**	**Science-led**	**Surveillance**	**Other**
>1 per month	58 (54%)	8 (50%)	3 (43%)	11 (73%)
>1 per year	42 (39%)	6 (38%)	2 (29%)	3 (20%)
Less often	0	2 (12%)	0	0
Other (seasonal)	8 (7%)	0	2 (29%)	1 (7%)
No reply	0	1	0	0

Table 7 Number of participants and frequency of participation in citizen science

	Number of respondents (% of those who responded)				
	Recording	**Science-led**	**Surveillance**	**Other**	**Environmental volunteering**
Yes	68 (65%)	6 (35%)	4 (57%)	9 (60%)	32 (73%)
No	37 (35%)	11 (65%)	3 (43%)	6 (40%)	12 (27%)
No reply	3	0	0	0	3

Table 8 Number of participants and participation in more than one citizen science project

Whilst it has been useful to report on any possible differences in citizen science involvement by citizen type, we have decided to largely combine all citizen science respondents in the following tables and charts rather than separate them as the sample sizes are small. Where appropriate the numbers for environmental volunteers accompany them.

2.2.2 Basic demographic data on respondents

Having adopted a non-purposive sampling strategy our demographic data cannot be viewed as representative of the citizen science population on the whole. However, in their study, West et al. (2015) asked a stratified sample of 8220 people in the UK if they had taken part in a citizen science project, 613 (7.5%) responded that they had. Demographic data collected as part of their questionnaire revealed that citizen science participation is biased towards white, middle aged men with high incomes. In what follows, we compare our online survey respondents to those who participated in West et al.'s survey which did involve a purposive sample. There are some differences between both the citizen science respondents and environmental volunteering respondents. The comparison data is set out in Table 9. While the purposive sample obtained by West et al. serves for comparison with the online survey, there is no data obtained from a purposive sample of environmental volunteers, therefore the

comparison table (Table 9) serves only to illustrate the differences between the samples of citizen scientists and environmental volunteers in the online survey.

	West et al. study 2015[3]		**Our study**		
	% of total sample	**% of citizen science respondents**		**% of citizen science respondents**	**% of environmental volunteering respondents**
Gender					
Male	48	53		56	62
Female	52	47		44	38
Age					
16-24	15	14		2	3
25-34	17	9		14	5
35-44	15	18		17	5
45-54	15	16		17	8
55-64	12	15		31	28
65+	26	27		20	51
Ethnicity					
White	86.2	93		97	95
BME	13.8	7		1	0
Social grade			**Income**		
AB	17	38	£75K+	8	5
C1	26	31	£60-75K	3	10
C2	21	15	£45-60K	12	15
DE	35	16	£30-45k	20	26
			£15-30k	29	10
			<£15k	7	13

Table 9 Demographic comparison with West et al.'s study

The primary differences in the citizen science sample are:

- Citizen science and environmental volunteering respondents to our survey were both more likely to be male than in the purposive sample;
- There was a smaller proportion of respondents in the youngest age category, but a greater proportion in the 25-34 category and a significantly greater proportion in the 55-64 category;
- There was a significantly smaller proportion of participants from BME groups;
- While there is no directly comparable data on social grade from the online survey, if social grade is taken as a proxy for income, the income data from the online survey suggests that a greater proportion of respondents were on lower incomes than in the purposive sample.

Some of these difference may be explained by the fact that the online survey is less likely to have captured those who were encouraged to carry out citizen science activities by someone

[3] Demographics of survey respondents. Table 9 shows the percentage of all survey respondents in each demographic category and the percentage of each group that had taken part in the citizen science project. BME = black and minority ethnic groups. Social Grades are AB: higher & intermediate managerial, administrative, professional occupations; C1: supervisory, clerical & junior managerial, administrative, professional occupations; C2: skilled manual occupations; DE: semi-skilled & unskilled manual occupations, unemployed and lowest grade occupations (Market Research Society 2015). No Social Grade information was available for participants in the Survey Monkey survey.

else, and so may have missed younger respondents. The online survey is also more likely to have captured data from keen and engaged citizen scientists rather than those who have participated to a lesser extent (as identified in section 2.2.1).

The primary differences in the sample of environmental volunteers were:

- Significantly more likely to be male than the citizen science sample
- The age distribution of environmental volunteers was very much skewed towards older age groups
- Environmental volunteers were both more likely to be on high incomes (60-75K) and low incomes (under 15K).

It is important to note, that our desk-based study revealed that similar patterns have been observed in other studies of citizen science participants. Trumbull et al. (2000), for example, found that participants in a citizen science project run by the Cornell Laboratory of Ornithology were older and more highly qualified that the general population. Crall et al. (2013) examined participants in an invasive species citizen science project and found that participation was biased towards highly educated, middle-aged females from higher income households. Johnson et al. (2014) studied participants of wildlife conservation citizen science projects in India and found 91% of respondents had completed at least 12 years of education (the average in India is 5.7 years); and that participants had higher than average income. Wright et al. (2015) examined contributors to the Southern African Bird Atlas Project and found that there was a bias towards white males who are highly educated, high earners over the age of 60. Within wildlife recording schemes in the UK, unemployed and low-income people are under-represented (Hobbs and White 2012). Raddick et al. (2013) found a particularly strong bias towards men participating in the online citizen science project Galaxy Zoo, with over 80% of participants being male.

Furthermore, similar patterns are seen more broadly in environmental volunteering (Ockenden 2007, West & Pateman in press) and other information science education programmes (Nicholson et al. 1994, Overdevest et al. 2004, Brossard et al. 2005, National Science Board 2008). It is important to note that under-representation and exclusion, although related, are not the same thing (OPENspace 2003). Groups may be under-represented but not actually excluded from taking part, i.e. they may not want to be involved. Some reasons why certain groups are underrepresented have been identified, however. For example, some people from black and minority ethnic groups do not feel that they belong in the countryside (OPENspace 2003) and there is a common perception that such habitats are landscapes inhabited by white people (Agyeman and Spooner 1997). Possible barriers amongst black and minority ethnic groups are that free time tends to be devoted to ‘intra-community’ activities, or educational activities. In addition, access to the countryside can be difficult and costly (Agyeman and Spooner 1997).

2.3 Phase 3: Telephone semi-structured interviews with stakeholders

The team conducted 18 stakeholder interviews (including scientists (university, monitoring, policy, education, not using/data only), policy/evidence specialists and practitioners (science, engagement, education, community)) in order to facilitate more detailed discussions of motivations for involvement (or lack of) in citizen science and the evaluation methods currently used to investigate participant motivations. Interviewees were selected using a matrix of criteria including each of the four topic areas mentioned above and a range of stakeholder types from science, policy and practice communities – with one interview with each type of stakeholder in each of the four focal areas (see Table 10 outlining the stakeholder types interviewed in our study). Please note that many of our stakeholder respondents also self-identified as biological recorders, environmental volunteers and/or citizen scientists. This is important as stakeholders are also citizen scientists and/or environmental volunteers in their

spare time. We also conducted interviews with scientists who are active in one of our four topic areas but are not involved in running citizen science projects. Instead they may be using citizen science data. In order to maintain the anonymity of our respondents we have not included any identifying materials in this report. This approach allowed us to conduct interviews across a breadth of different types of citizen science project allowing for the identification of commonalities and discrepancies between both project focal areas and stakeholders as part of the analysis. Interviews were preceded by a request for information from interviewees, allowing them time to reflect and also to gather relevant data.

Interview plan

In order to be consistent during our interviews, we developed an interview sheet (see Appendix 2) that was used in all interviews. Questions focussed on: the interviewee's career, projects and how citizen science is defined within their organisation; institutional/personal and participant motivations and how they've evolved over time and how citizen motivations are accommodated within their projects; the benefits, challenges and barriers to citizen science institutionally, personally and for their participants and how they overcame them; and the role of communication, feedback and technology in their projects, and the place of evaluation.

Analysis

The telephone interviews were transcribed and analysed using an interpretation framework (Ritchie & Lewis 2013) based on the interview topic guide, drawing out interviewees references to practices and opinions from institutional, personal and participants' perspectives, together with motivations and barriers and challenges identified in the literature. As the interviews were coded, additional motivations, barriers and challenges were identified and also coded, allowing themes across the interviews to be identified and drawn out.

2.4 Ethics

The project was submitted to and approved by the University of the West of England Faculty of Environment and Technology Research Ethics Committee (FET-REC). This approval was then passed to the Universities of Reading and York to gain approval at those institutions, ensuring ethical clearance across all involved parties. Beyond this, the team worked to ensure good *micro-ethics* of research in practice (Guillemin and Gillam 2004), especially with the interviews, ensuring transparency with participants and sensitivity to their needs or what they felt they could or could not say, going beyond the 'procedural ethics' of University committees to ensure respect was shown to those who had kindly volunteered their time (Israel and Hay 2006). All interviewees were requested to complete consent forms and gave their permission for us to record, transcribe and analyse their responses.

Stakeholder group	Participant category[4]	Description
Science	Scientist/university	Scientists funded by university and/or research council funding, often interested in applied research, running citizen science initiatives, using citizen data, sometimes advocating for public engagement and advising on policy
	Scientist/monitoring	Scientists employed by government agencies and working with policy stakeholders, delivering improvements through policy mechanisms, sometimes commissioning citizen science, sitting on advisory boards, sometimes using citizen generated data but no first-hand experience of citizen science
	Scientist/policy	
	Scientist/education	Scientists working in science education (e.g. with young people), only part of job, also involved in science/policy
	Scientist/not using /data only	Scientists working in university or government agency but not currently hands on in citizen science but may be using citizen generated data
Policy	Policy/evidence	Policy/evidence specialists working for government department or agency. Key users of citizen science outputs, thinking about how citizen science projects can support policy development work and support wider initiatives. Sometimes funding
Practice	Practitioner/science/ engagement	Practitioners involved in recruiting citizen scientists for charitable organisations and agencies with science remit. Role ranges from promoting citizen science, public engagement, communicating with participants and institution, using data and initial analysis, project management, sharing best practice, recruiting and managing volunteers
	Practitioner/community	Practitioners working with and in a variety of different communities utilising citizen science approaches to understand what's going on in different locations, and seeing if this process can enable people to push for change at the local level
	Practitioner/education	Practitioners working in the education sector with remit for citizen science, e.g. university citizen science project manager

Table 10 Description of stakeholder groups and participant categories

[4] Used to identify verbatim responses throughout report

Chapter 3: Defining citizen science

Chapter highlights
* Citizen is subject to multiple definitions
* The most widely accepted definition by stakeholders involved the collection of data by citizens for use by scientists with an acknowledgement that citizens must also benefit
* Stakeholder use of term citizen science appears to be primarily inward facing, with the term rarely used in communications directed towards participants
* Most projects are contributory, but collaborative and co-designed projects are gaining followers
* Environmental-based citizen science activities in the UK must be considered in relation to the long-term tradition of biological recording
* Stakeholders must consider how they are using the term citizen science in relation to their project to avoid confusion and mixed messages

As outlined in Chapter 1, we have defined citizen science in this study as the participation of non-professional volunteers in professional science projects. However, as our survey results and interviews with stakeholders revealed, citizen science is subject to multiple definitions. There is no one size fits all (UKEOF 2011; Haklay 2015a). In this chapter, we highlight some of the challenges surrounding the definition of citizen science revealed by this study and some points for consideration by readers who are contemplating citizen science for the first time or who are already using the term. We begin by considering the different ways in which the term citizen science has been used by stakeholders.

3.1 Stakeholder definitions of citizen science

> *"So [citizen science] has to be something that excites and interests members of the public and really gets them thinking about environmental science and learning about it … It also strikes up a conversation between researchers and members of the public so that they're talking about what they're doing and why it's valuable and members of the public are able to input into that process. ... science can benefit from having non-expert input as well." (Practitioner, science, engagement).*

This quote from a stakeholder indicates the challenges surrounding the definition of citizen science. For them, it has to interest and excite participants, engage them in science and learning, involve dialogue between professionals and the public, and allow citizens to input into science. This is just one definition. We asked all of our stakeholder interviewees: "How do you define citizen science?" Interviewees suggested this was a difficult question and a subject that they could spend ages talking about. Table 11 (overleaf) indicates the common ways in which citizen science was defined by our stakeholder respondents.

The two most widely accepted definitions by stakeholders were 'people have to get something out of it' and the collection of data by citizens for use by scientists. Whilst the latter echoes our existing definition, the former indicates the increasing value placed upon supporting participants.

Definition of citizen science	Scientist/university	Scientist/monitoring	Scientist/policy	Scientist/education	Scientist/not using /data only	Policy/evidence	Practitioner /science/engagement	Practitioner /community	Practitioner/education
Collection of data by citizens for use by scientists (often in partnership, sometimes working with community scientists)	■	■	■		■		■		■
Widening participation beyond the usual suspects (e.g. inclusion of young people)				■				■	
People have to get something out of participation (e.g. learning, interaction with data, empowerment)	■	■	■	■	■		■	■	■
Collection of data by citizens for analysis and use by citizens to inform individual and collective activities	■							■	
Other attributes									
People who love their subject		■	■					■	
People with skills from basic identification to expert taxonomic skill (e.g. amateur naturalists)	■	■	■			■	■		
People undertaking a range of activities from running schemes, quality control checking to BioBlitz activities and school projects						■			
People mobilised and engaged around particular issues looking, monitoring and feeding back						■			■
Involving non-specialist volunteers in science who are giving their time free of charge							■		
Citizen science has to have some measurable scientific output	■						■		
Citizen science has to be science, not purely engagement on an issue	■						■		
Citizen science and traditional science are not separate		■	■				■		
Citizen science is a subset of public engagement							■		

Table 11 Citizen science definitions by stakeholder type

The inclusion of a wider group of stakeholders from policy and practice communities shows how in the table above a broader definition of citizen science is emerging around the following principles:

1. Widening participation in science;
2. Recognising benefits of participation to citizen;
3. Leading to measurable academic output and/or being used by citizens;

4. Harnessing emotional attachments to particular subjects;
5. Carrying out activities across a range of skills levels;
6. Sharing data between experts (paid and voluntary);
7. Prioritising science over engagement; and
8. Talking about 'science' only without separating citizen science and traditional science.

It is also important to consider the type of project being discussed here. The majority of projects and stakeholders being considered within our study form part of what has been described by Bonney et al. (2009, 11) as "(1) Contributory projects, which are generally designed by scientists for which members of the public primarily contribute data". However, the principles above suggest an increased interest in citizen science beyond a simple data collection exercise, with thinking (but not yet action) moving projects towards more collaborative and co-designed frameworks: "(2) Collaborative projects, which are generally designed by scientists and for which members of the public contribute data but also may help to refine project design, analyse data, or disseminate findings" and "(3) Co-created projects, which are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all of the scientific process" (Bonney et al. 2009, 11).

Definitional issues were also evident when we consider the types of projects/organisations that the stakeholders that we interviewed represented:

Stakeholder	**Institutional Experience**	**Main projects**	**Origins**	**Key activities**
*Practitioner /Science/ Engagement *Scientist/ Monitoring *Scientist/ Policy	50+ years	Long-term surveillance	Established institutional commitment to delivering evidence	Partnership working to deliver long-term monitoring through citizen science; support and advice; facilitation
*Practitioner /Science/ Engagement	20+ years	Weekly recording	Recorders had data; institution wanted to communicate; scientists needed people management	Recruiting and maintaining long-term volunteer recording projects
*Policy/ Evidence	10 years	Monitoring and surveillance	Foot and Mouth disease changed evidence need	Advisory boards, using citizen data
*Practitioner /Community	<10 years	Community-led projects	Inclusion of public in planning decision-making	Participation of local people, create dialogues, engage in discourses around issue

Table 12 Stakeholder involvement in citizen science

Here long-term engagement with people through environmental monitoring programmes, follows a largely contributory model of citizen science. However, more recent additions to the sector, in particular the policy/evidence and practitioner/community respondents are using the language of citizen science to enrol the public in dialogue and feeding back on issues (see Chapter 6 for more information on stakeholder motivations in these areas).

As highlighted by Table 12, it is possible to discern that the term citizen science is not widely used in the environmental-based citizen science sector to label projects. In the UK, the definition of environmental citizen science is compounded yet further by the long and successful history of amateur naturalism and biological recording (Silvertown 2009, Sparks & Carey 1995, Pocock et al. 2015). As Roy et al. (2012, 8) suggested in an earlier UKEOF report: "Volunteer participation with environmental science and natural history has a long history, especially in Britain, long before it was termed 'citizen science'". This is significant because whilst citizen science may be familiar terminology to some stakeholders this is by no means universal, nor is it used universally. Words such as volunteers, amateurs, amateur naturalists, natural historians and biological recorders have all been used to indicate similar recording and monitoring activities by our stakeholder interviewees. However, as Haklay (2015a, 6) notes, in 2014, the term citizen science was added to the Oxford English Dictionary as "scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions". This marks a significant milestone in the acceptance and current definition of citizen science. Nonetheless challenges remain around the use of the term citizen science, as one respondent explained: *"We don't necessarily make a distinction between different levels of citizen science, I still think that within the organisation there's a lot of belief that all citizens are equal and I've spent a lot of time trying to say, well no, it's like science, not all scientists are the same, and not all citizens are the same" (Scientist, monitoring, policy).* This was echoed by another practitioner stakeholder who said: *"I think some people see citizen science as people are robots, they are just blindly collecting data, blindly taking a photo or blindly measuring some air quality or something" (Practitioner, science, engagement)*. There remain issues around the 'type' of citizen scientist involved in projects and their treatment by project teams, for example as mere sensors collecting data or as highly trained specialists who are unpaid.

Furthermore, from our interviews, several stakeholders mentioned their involvement in national, European and global citizen science working groups (such as the UKEOF Citizen Science Working Group or the Tree Health Citizen Science Network, European Citizen Science Association and the Citizen Science Association) and/or their attendance at citizen science conferences and workshops (for example events hosted by the British Ecological Society Citizen Science Special Interest Group or the European Citizen Science Association) to share and develop good practice surrounding citizen science. This indicates the involvement of a broad range of stakeholders in the emergence of citizen science as a field, not just scientists, but also policy/evidence specialists and practitioners, as well as the national, regional and global networks connecting stakeholders from science, policy and practice communities. Indeed, one participant (scientists, monitoring, policy) used a definition of citizen science from the academic literature to define what it means to them, showing the engagement stakeholders are having with academic literature.

3.2 Defining citizen science projects

As identified in Chapter 2, the majority of our respondents defined themselves as undertaking citizen science relating to biodiversity and more traditional forms of biological recording projects. It is useful to consider further the activities involved in the citizen science projects discussed in our online survey. The majority of citizen science participants were undertaking data collection (90%), recording species (88%) and data submission (85%), with 51% contributing to supporting others' involvement (see Table 13). Less than half were involved in leading and organising activities, and a much smaller proportion were involved in developing survey tools (18%), designing the overall research questions (12%) and moderating forums (8%). This suggests that the majority of respondents were involved in projects in a contributory way, rather than as part of a collaboration or co-designed form of citizen science. However, of those who responded 'other', activities included: software design for data collection; attending local/regional networking events; analysis of data; liaising with

land management bodies; designing and mapping out new transect routes; editing regional atlas of butterflies; annual contribution to annual reports; and beta testing a biological recording app.

Citizen science activity (respondents were able to select more than one activity)	**Number of citizen science respondents (% of those who responded)**
Data collection	131 (90%)
Recording species	130 (88%)
Data submission	125 (85%)
Supporting others' involvement	76 (51%)
Leading activities	69 (47%)
Organising activities	61 (41%)
Developing the survey tools	27 (18%)
Designing the overall research questions	17 (12%)
Moderating forums	12 (8%)
Other	4 (3%)

Table 13 What citizen science activities do you undertake?

The complexity surrounding the definition of citizen science was highlighted again by the ways in which our online survey respondents decided to classify their participation. All respondents were asked whether they had participated in environmental-based citizen science, 147 responded the survey as citizen science participants. Those that did not select this option were asked whether they undertook environmental volunteering activities, 47 responded the survey as environmental volunteers. Whilst these surveys asked different questions to reflect that distinction, upon closer inspection of the environmental volunteering projects listed by survey respondents, there is considerable overlap between those projects identified as citizen science by our citizen science respondents. This warrants further investigation, whilst we do not have the space to interrogate this further here, it is important to note that this suggests there is some confusion surrounding how both projects and their participants identify themselves.

3.3 Considerations for stakeholders when using the term 'citizen science'

Stakeholders should consider the following questions when using the term 'citizen science':

(1) What does the term citizen science mean to your project?
(2) Is your project contributory, collaborative or co-designed citizen science?
(3) What are the implications of each approach?
(4) Will citizen science help attract participants or dissuade more traditional recording audiences?
(5) Are you being consistent in your use of the term?
(6) What role might amateur naturalists/biological recorders/exiting communities play in your project?

See also Haklay 2015a for a report on Citizen Science and Policy.

Chapter 4: Citizen scientist motivations

Chapter highlights
* Stakeholders need to understand participant motivations in order to recruit participants, achieve sustained participation and enhance the quality of the outputs
* Little has been written about environmental-based citizen science motivations, but a lot has been written about motivations for environmental volunteering
* Motivations can be intrinsic (or inherently valuable or satisfying) or extrinsic (or leading to some other benefit, such as future career prospects)
* Participants vary individually and will not necessarily conform to type
* Top motivations for citizen science and environmental volunteering respondents to our survey: "To help wildlife in general" and "To contribute to scientific knowledge"
* Shared motivations suggest that citizen science projects may appeal to many environmental volunteers

It is important to understand participant motivations, (1) for practitioners wishing to recruit people to their projects and (2) as being a key factor in the success of projects (in terms of both achieving sustained participation and enhancing the quality of the outputs of participants' activities). In this section, we consider the existing academic literature relating to the question of participant's intrinsic and extrinsic motivations, before detailing the results of our online survey of citizen scientists and environmental volunteers, specifically their motivations and how they vary over time.

4.1 Existing work on motivations for environmental volunteering

Very little has been published in the academic literature regarding what motivates people to participate in citizen science projects. This is despite its importance for practitioners wishing to recruit people to their projects and hence it being a key factor in the success of projects (Wright et al. 2015, West & Pateman in press). In their review of the wider volunteering literature, however, West and Pateman (in press) outline the attempts that have been made to identify and categorise what motivates volunteers in general. The many parallels between volunteering and citizen science participation mean that lessons can be drawn from this wider body of literature (West & Pateman in press). Volunteer programmes that acknowledge the importance of volunteer motivations and incorporate them into their projects fare better in attracting and retaining volunteers (Grese et al. 2000). The same would be expected to be true of citizen science projects.

Considering volunteering in general, Finkelstein (2009) identifies intrinsic and extrinsic motivations: intrinsic motivations describe the desire to volunteer because it is in some way inherently interesting or satisfying; extrinsic motivations, however, describe the willingness to volunteer because it leads to some other outcome, such as getting a new job. Clary and Snyder (1999) developed a functional approach to volunteering, originally introduced by Katz (1960), to describe motivations which lead to individuals beginning and continuing volunteering. This approach has identified six motivation categories:

1. Understanding: where people want to learn new things.
2. Values: where people have an altruistic concern for others.
3. Social: where people are motivated by the desire to meet new people and because volunteering is a socially desirable thing to do.

4. Enhancement: where people wish to improve themselves personally through their volunteering.
5. Career: where people hope to gain experience that will benefit their future careers.
6. Protective: where people volunteer to reduce negative feelings or to address personal problems.

All of these, apart from career motivation, would be classified as intrinsic motivations. Some studies have looked more specifically at motivations in environmental volunteering and have found all of Clary and Snyder's motivation categories to be present, although in some cases the protective motivation was absent (Bruyere & Rappe 2007, Van Den Berg et al. 2009). Different types of values motivations have also been identified in this context; for example, an altruistic concern for the environment rather than people (Bruyere & Rappe 2007); and users of a site (e.g. for recreation) wanting to work in or improve that site (Bruyere & Rappe 2007, Measham & Barnett 2007, Jacobson et al. 2012). 'Project organisation' has also been identified, with people being motivated to be involved in a well-organised project (Bruyere & Rappe 2007, Jacobsen et al. 2012). Bell et al. (2008) found that some volunteers were motivated by wanting to share their knowledge with others.

4.2 Existing work on motivations in citizen science

A small number of studies have looked at the motivations of participants in citizen science projects. Studies so far have largely concentrated on individual case studies. However, inconsistent methodological approaches mean that there is a lack of understanding of how motivations vary between different types of project.

In the context of biological recording and monitoring, Hobbs and Wight (2012) questioned participants of a national and a local recording scheme and invited open responses to the question "What was the main reason(s) for you to get involved in the scheme". They categorised responses as follows: interest in wildlife; saw the wildlife; as a response to a request; learning; to provide data for/help conservation; social reason/asked by a friend or a family member; was doing activity anyway/to give purpose to recording. Wright et al. (2015) studied the motivations of volunteers involved in creating a bird atlas of South America using a modified version of Clary and Snyder's categorisation. They found the following motivations to be present (in order of importance): (1) recreation or nature-based, which they define as people wanting to spend time with nature and/or engage in the atlas work for recreational purposes; (2) personal values; (3) personal growth; (4) social interactions (5) project organisation.

Some studies have also looked at motivations in computer-based citizen science projects. In their study of volunteers involved in the astronomy citizen science project, Galaxy Zoo, Raddick et al. (2013; see also Nov et al. 2011 and Jennett et al. 2016) found additional motivations to those that have already been identified, including: contributing to science; the opportunity for discovery and sense of wonder; to use the resources for teaching; and fun and enjoyment.

Rotman et al. (2012) looked at the motivations of participants in a variety of ecological citizen science projects and divided these into:

- egoism, where people participate to increase their own welfare;
- altruism, where people participate to increase the welfare of another individual or a group;
- collectivism, where people are motivated to increase the welfare of a group of which the participant is a part; and
- principlism, where people volunteer in order to uphold their personal principles.

With the rise of increasingly sophisticated online platforms for citizen science, 'gamification' is being used by some projects to appeal to some participants' motivation to compete with others. This can include reputation points, leader boards, digital badges, and individual or team challenges (Azavea & SciStarter 2014). A survey of the popular protein-folding citizen science project Foldit found that many players wanted to contribute towards science, but others were specifically attracted by the competitive nature of the game (Cooper et al. 2010, Curtis 2015). Hochachka et al. (2012) report that after adding a competitive element (of leader boards) to the eBird website, where people record bird distributions, participation in the network increased. Massung et al. (2013) is one of the few studies which has empirically tested the efficacy of gamification for motivating participants. This was a small study but they found that although gamification increased data return rates, this difference was not significant, and some participants were actually de-motivated by the competitive element if they felt they were not able to compete with those leading the competition (see also Chapter 9 on Technology in citizen science). Again, this highlights the point that different people have different motivations for participating.

Using the motivation categories identified in the literature, West et al. (2015) asked a sample of 613 people who have participated in citizen science projects what their motivations for taking part were (Figure 1). The most common responses were altruistic motivations; either people wanted to help wildlife in general, to contribute to scientific knowledge or because they felt that participating is a valuable thing to do. Another altruistic motivation, to help a specific site, was a far less common response, which could be due to the type of project people were participating in. Personal development motivations were second most common, including the motivation to learn something new, to help future careers and to enhance development. Other personal motivations, not related to development – to get exercise/fresh air and to meet people/for fun – were less common responses. To share personal knowledge was also uncommon, as was being asked by someone else to participate. Open-ended responses to "Other" did not add any additional categories.

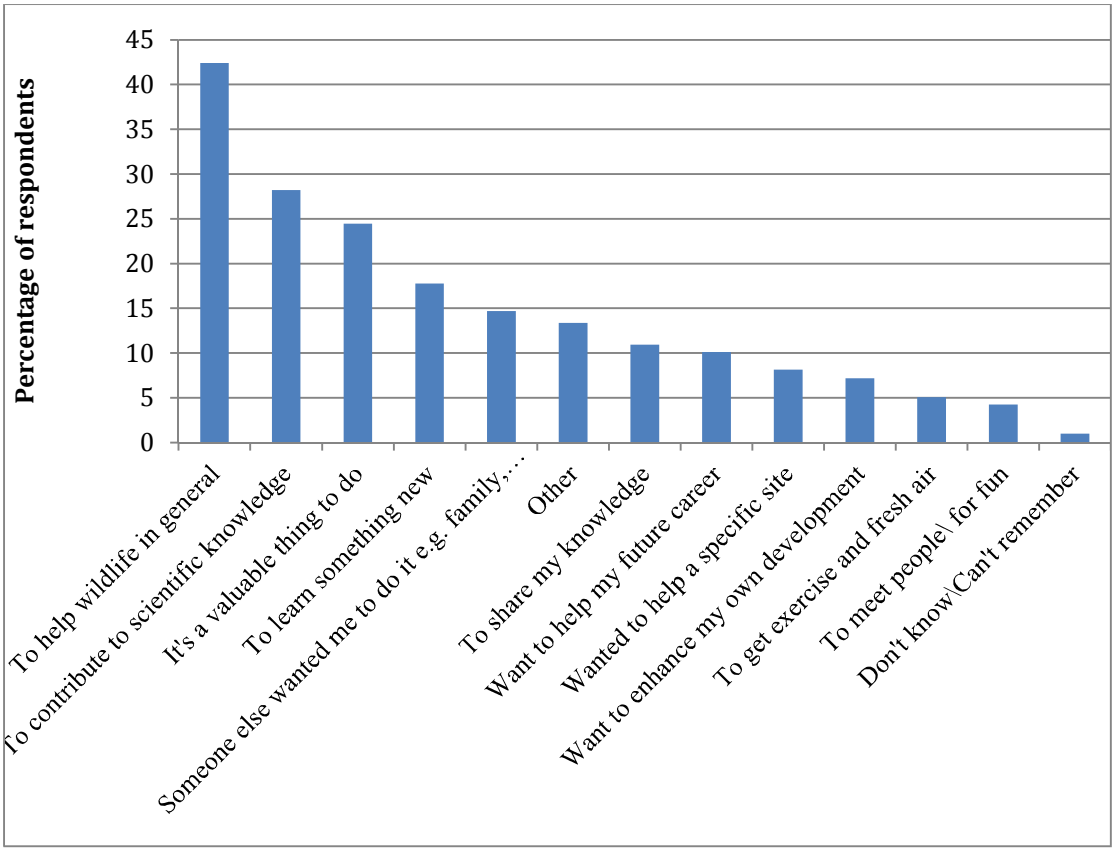

Figure 1 Motivations of participants in citizen science projects (West et al. 2015)

4.3 Existing work on variations in motivations

The importance of different motivations appears to vary between projects. For example several studies of both environmental volunteers and citizen scientists have found environmental (values) motivations to be the most important (Hobbs & White 2012, Bruyere & Rappe 2007, Jacobsen et al. 2014). Similarly, Raddick et al. (2013) found the altruistic motivation of wanting to help science to be the most dominant in their sample of Galaxy Zoo volunteers. On the other hand, Asah et al. (2014) studied volunteers who were working on landscape restoration and conservation, and found that socio-psychological (enhancement) motivations such as wanting to learn and help future careers were mentioned nearly twenty times more than environmental motivations.

In addition, volunteers should not be seen as a homogenous group of people, rather they can have a variety of different motivations (Asah et al. 2014). The same volunteering activity may engage people for very different motivations (Clary & Snyder 1999), and participants may hold multiple motivations at once (Clary & Snyder 1999, see also Bell et al. 2008, Asah et al. 2014). It is also important to note that a person's motivations for participating can shift over their lifetime (Ryan et al. 2001), and there is some evidence to suggest that age may be important here. Clary and Snyder (1999) and Jacobsen et al. (2012) note that career related motivations may be particularly important for younger people, who may be volunteering to gain skills, whereas older volunteers may be more likely to want to share their skills and pass on their knowledge to others (Unell & Castle 2012). These studies emphasise the importance of longitudinal studies to examine people's motivations over time.

4.4 Participant motivations for citizen science and environmental volunteering

We used our online survey to consider our participants' motivations. Using categories identified by West et al. (2015) in their study of motivations in citizen science, we asked our participants 'What motivated you to take part?' Table 13 and Figure 2 indicate the primary motivations for citizen science and environmental volunteering participants.

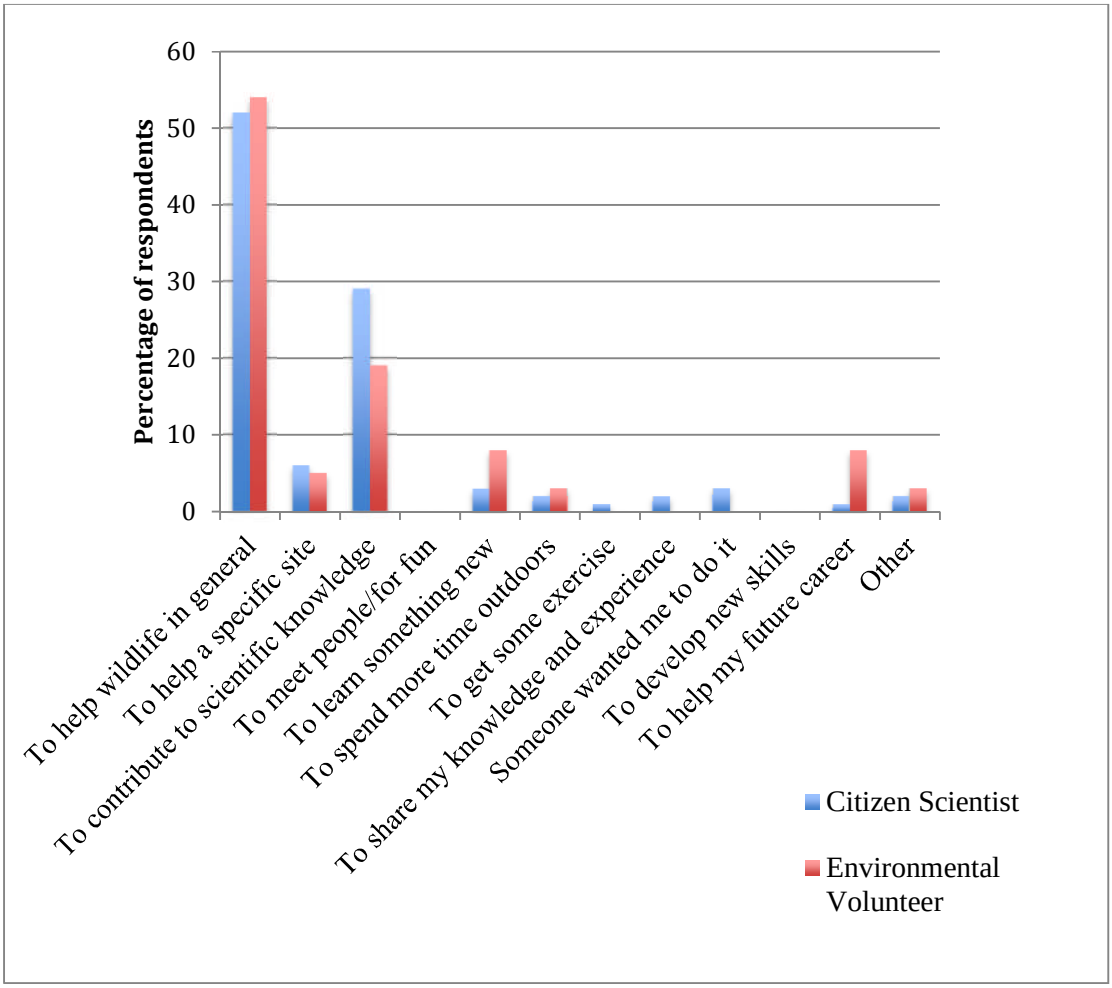

Figure 2 % of primary motivations by citizen science and environmental volunteering

Primary Motivation	Number of respondents (% of those who responded)	
	Citizen Science	Environmental Volunteering
To help wildlife in general	66 (52%)	20 (54%)
To help a specific site	7 (6%)	2 (5%)
To contribute to scientific knowledge	37 (29%)	7 (19%)
To meet people/for fun	0	0
To learn something new	4 (3%)	3 (8%)
To spend more time outdoors	3 (2%)	1 (3%)
To get some exercise	1 (1%)	0
To share my knowledge and experience	2 (2%)	0
Someone wanted me to do it (e.g. family,	4 (3%)	0

teacher)		
To develop new skills	0	0
To help my future career	1 (1%)	3 (8%)
Other	2 (2%)	1 (3%)

Table 14 Primary motivations for citizen science and environmental volunteering

'To help wildlife in general' was the most common primary motivation for citizen science participants, followed by 'To contribute to scientific knowledge'. These findings are in agreement with West et al.'s findings, in particular the acknowledgement that people were not particularly motivated by 'To help a specific site'. It is useful here to compare these findings with the results from the environmental volunteer survey. Whilst the numbers participating in this survey are small, the highest scoring motivation is 'To help wildlife in general', followed by 'To contribute to scientific knowledge', echoing the findings for the citizen scientists. However, as indicated in Chapter 3, the distinction between who identified as a citizen science respondent and environmental volunteering respondent is not a simple one.

	Number of respondents										
Ranking	**To help wildlife in general**	**To help a specific site**	**To contribute to scientific knowledge**	**To meet people/for fun**	**To learn something new**	**To spend more time outdoors**	**To get some exercise**	**To share my knowledge and experience**	**Someone wanted me to do it (e.g. family, teacher)**	**To develop new skills**	**To help my future career**
1	66	7	37	0	4	3	1	2	4	0	1
2	18	16	46	7	18	3	0	8	0	5	2
3	10	8	18	5	21	12	2	17	2	10	6
4	7	3	6	5	13	15	4	15	2	13	6
5	2	2	2	2	11	9	6	9	1	11	3
Total	**103**	**36**	**109**	**19**	**67**	**42**	**13**	**51**	**9**	**39**	**18**

Table 15 Top 5 motivations for citizen scientists

We asked our citizen science respondents to rank their top 5 motivations from our list (based upon West et al. 2015). As evidenced in Table 15, following 'To help wildlife in general' as the primary motivation for the majority of citizen scientists, this was followed by 'To contribute to scientific knowledge', 'To learn something new', 'To spend time outdoors/To share my knowledge and experience' and 'To learn something new/To develop new skills'.

We also gave respondents the opportunity to identify 'other' motivations, as per West et al.'s (2015) study. 30 citizen science survey respondents selected this option, echoing some of the motivations identified above, but stating that sharing their enthusiasm, career objectives, contribution and enjoyment as significant motivations.

Motivation	**In their own words…**
Sharing enthusiasm	*"To encourage others to take an interest"; "I did the recording at lunchtimes with a friend and we liked to take a walk in the open air. We were a "group" of two"; "To motivate children to take part; It's fun to do, especially if it helps*

	get the children involved"; "To meet up with like-minded people around the country"
Career	*"I am a professional academic it is part of my research; some work was through grant funded research projects"; "I wish to publish from this work; part of my work"; "To help my future career"; "It is my job"; "To understand more about citizen science projects with a view to helping develop a citizen science project (as an academic)"*
Help wildlife	*"To help British birds"; "To help bats and to learn more about them"; "Particular interest in bats"; "To help a specific species"; "Because nature is amazingly awesome?!"; "To help butterfly conservation and to help the management of my local nature reserve"*
Contribution	*"To contribute to scientific knowledge"; "To contribute to my community"; "To help to fill in 'white holes' in recording effort"; "Feeling of responsibility to use knowledge"; "I think it is a good thing to do"; "To feel part of something worthwhile"; "I was originally asked by one of the wildlife Trust Rangers to help monitoring at some of their sites"*
Enjoyment	*"Because it's what I enjoy doing"; "Because it is interesting and fun"; "Enjoyment"*
New knowledge	*"To understand more about a new local neighbourhood"; "To improve species identification skills"; "Learning"*
Engage others	*"As a home educator it is a useful project to engage the children with"*

Table 16 Citizen science responses to 'other'

The findings from our survey reveal that notwithstanding the definitional issues surrounding the project types, it is possible to conclude that there are similar motivations across the citizen science and environmental volunteering 'divide' and as such citizen science projects may appeal to many environmental volunteers.

4.5 Variations in motivation over time

In addition to identifying the primary motivations of citizen science participants, it is important to understand whether motivations change over time and whether this might influence their continued participation in a citizen science project. Only 1 in 4 of our citizen science respondents said that they felt their motivations had changed over time (Table 17). When asked to elaborate, a number of people commented upon becoming more interested in the science and contributing to this, as well as moving from gaining knowledge to passing it on. This did not suggest that their motivations would lead them to leave a project, although it did indicate that they might take on additional responsibilities within a project – a point echoed in Section 5.5 on participant careers and what encourages participation.

	Number of respondents (% of those who responded)	
	Citizen science	**Environmental volunteering**
Yes	36 (26%)	8 (20%)
No	84 (62%)	31 (76%)
Not sure	16 (12%)	2 (4%)
No reply	11	6

Table 17 Did you motivations change over time?

We also asked our respondents in what ways they thought their motivations had changed. Of the 37 people who responded to this open-ended question, the majority stated they are now motivated by knowing that they are contributing to scientific knowledge, followed by sharing knowledge and having a stronger concern for conservation, for example observing

environmental destruction/species decline: *"As I've got older, I've become more aware of the decline in British Wildlife caused by people and it infuriates me to see our wildlife and countryside taken advantage of and viewed as a non-essential commodity that gets in the way of our 'progress'"*. Some respondents acknowledged they were motivated because of the importance of their involvement due to their career and professional roles. Others stated that they had now moved from contributing to leading projects. The social aspects and meeting people were also strong motivators, and now they felt they had the skills, they were no longer motivated by the aspect of learning. Furthermore several respondents commented on the responsibility they feel to take part: "*Initially awe/wonder. Increasing sense of responsibility."* Other individual responses included: *"no longer just motivated by their career"; "now motivated by it being practical/they are spending time outdoors"; "finding it difficult to keep up others' motivation"; "now motivated by the physical exercise they gain from involvement"; "they are now more interested";* and *"they are now involved in developing new project"*. These responses indicate the complexity surrounding individual motivations for citizen science participation. Beyond an initial desire "To help wildlife in general" and "To contribute to scientific knowledge", respondents to this open-ended question indicated an enhanced sense of ownership and responsibility for their involvement, participation and contribution to science. Extrinsic motivations shifted from career and learning motivations to become more intrinsic with an enhanced experience as a result of participation.

Chapter 5: Motivations for beginning and continuing in citizen science

Chapter highlights
* Existing literature indicates that dispositional (personal motivations) and organisational (logistical) variables influence initial participation with the addition of awareness that the opportunity exists
* Poor project organisation frequently contributes to a fall off in participation
* Two potential incentives for continued participation that were identified in the online survey were skills development, and feedback and communication. The latter was also identified by stakeholder interviewees and the literature
* Long-term participation often transcends the initial involvement and becomes a deeper enthusiasm for the subject
* Feedback, knowing their impact and contribution, enjoying the project, being involved in a good project, skills development, and support were identified as factors that encourage continued participation by citizen science respondents
* Citizen science participants felt their involvement had been worthwhile if they knew their participation had an impact, received feedback and communication, knew their data was useful, and had enjoyed their participation. Environmental volunteering participants concluded that they needed their involvement to have an impact, lead to new skills and receive feedback
* Shared reasons for feeling fulfilled suggest that citizen science projects may appeal to many environmental volunteers
* More awareness raising is required to attract environmental volunteers to citizen science projects
* Barriers to increased volunteering by environmental volunteers include: already doing as much as they can; lack of time; access; shortage of people to do it with; lack of funding; lack of time; age; work/family commitments; poor health; and the weather
* To be useful, feedback must be immediate, specific to the locale or individual, interpretable, and offer online and offline options

For many environmental-based citizen science projects, successful fulfilment of project objectives requires long-term/continued participation. In this chapter, we consider what encourages people to participate in citizen science projects for the first time and then maintain their involvement. We combine material from our desk-based study, online survey and stakeholder interviews to understand what encourages and discourages continued participation. We begin with our literature review findings.

5.1 Existing work on factors for participation in citizen science

West and Pateman (2015) have developed a model which summarises the key factors for participation in citizen science. This highlights the three distinct stages to participation: the decision to participate; the initial participation in the project; and sustained participation. This model (Figure 3) was originally based on Penner (2002), taken from the volunteering literature, and was adapted using the citizen science and environmental volunteering literature in order to make it more relevant to citizen science.

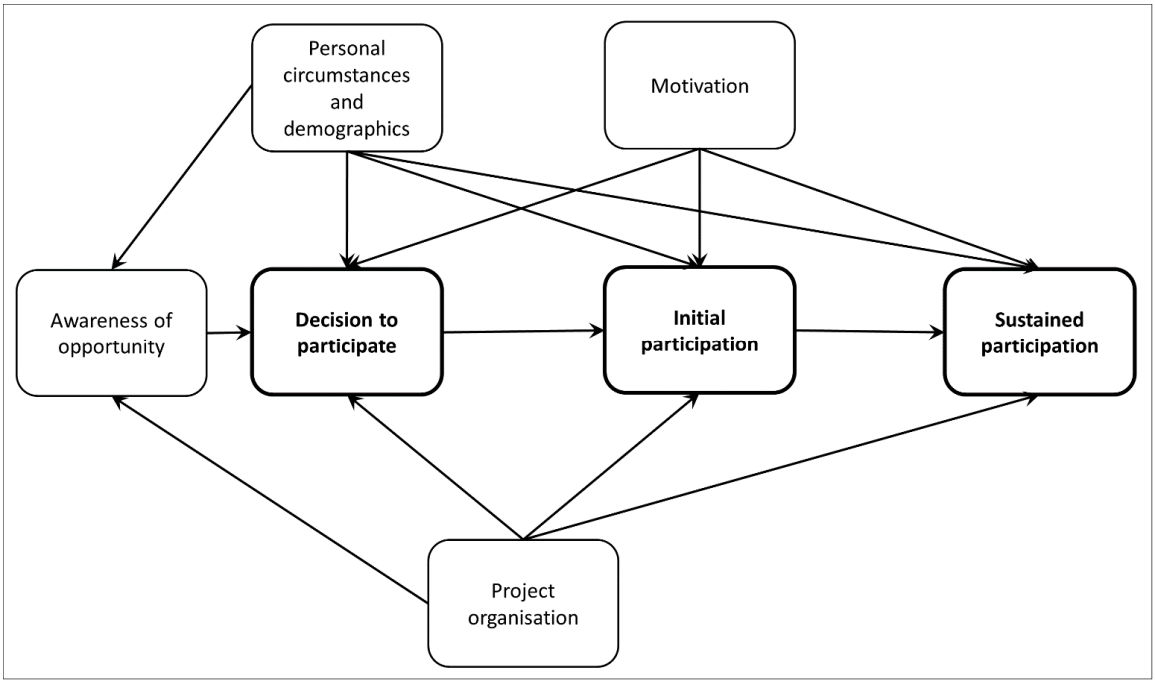

Figure 3 Model of influences on participation in citizen science (from West & Pateman 2015, based on Penner)

Penner (2002) states that there are two types of variables which affect a person's involvement in volunteering, namely dispositional variables and organisational variables. Dispositional variables are the attributes of individuals, such as motivation, personal circumstances and demographics (see top of Figure 3). Organisational variables are the attributes of the organisation leading the project, the most important of which are project organisation and communication. In their study of volunteers involved in biological recording projects, Hobbs and White (2012) identified three main factors which influence a person's decision to participate: they need to be motivated, the volunteering opportunity needs to be appropriate for them, and they need to be aware that the opportunity exists. These are shown in Figure 3 as 'Motivation', 'Personal attributes, circumstances and demographics' and 'Awareness of opportunity'.

Missing from existing studies is a focus on the emotional dimensions behind participation in citizen science. Drawing on literature from the fields of serious leisure (Stebbins 1992) volunteering (Smith et al. 2010) and enthusiasm (Craggs et al. 2013), it is possible to discern the importance of enthusiasm, specifically an emotional affiliation towards a particular activity or thing, in participation in group projects (Geoghegan 2013), and more recently citizen science (Everett & Geoghegan in press, Fradera et al. 2015).

Relatively few studies have looked at motivations of citizen science participants over time, or the experience of volunteers more generally once they are in place (Wilson 2012). One that has is Jackson et al. (2015), although this was in the astronomy rather than the environmental citizen science field. They explored the motivations of just three volunteers who were involved in tasks which were peripheral to the main project, such as moderating forum comments, welcoming newcomers, etc. They found that such tasks helped people move from initial participation to sustained participation, and as they became more engaged, they became more central to the community and understood its culture, language, organisation, etc. This helped the participants form an identity as a volunteer (Jackson et al. 2015), which, as highlighted by Penner (2002), is one of the key factors leading to sustained volunteering. In the context of environmental volunteers, Ryan et al. (2001) looked at the motivations of long-term volunteers and found that new volunteers tended to be motivated by wanting to help the

environment and learn new things, but that social factors were more important for retaining them in the long term. This has also been shown to be the case in citizen science projects (Couvet & Prevot 2014) and research with other enthusiast communities (Geoghegan 2013).

Peachey et al. (2014) note that, in general, volunteers are more likely to continue participating if their initial motivations for volunteering are fulfilled, and their satisfaction with their role is a good predictor of their intention to continue (Wu et al. 2015). Therefore, it is important to provide participants with the opportunity to reflect on their work and discuss their motivations (Ryan et al. 2001). Newton et al. (2014) have shown that people's motivations for initial involvement are an important factor in how long they volunteer for, with McDougle et al. (2011) finding that young people involved in environmental volunteering who were motivated for social reasons spent more time volunteering than those who volunteered in order to learn. This highlights the importance of providing opportunities for social interaction (Locke et al. 2003, Van Den Berg et al. 2009, Jacobsen et al. 2012, Asah et al. 2014).

Poor organisation is often cited as a reason for dropping out of volunteering (Ryan et al. 2001, Lock et al. 2003, Jacobsen et al. 2012), and therefore it is important to give participants the opportunity to provide feedback (Garner & Garner 2011, Unell & Castle 2012). Participants need to feel that their time is being used well (Bruyere & Rappe 2007), so monitoring the impacts of their work and regularly communicating it to them can help to retain them (Van Den Berg et al. 2009, Unell & Castle 2012).

5.2 What encourages continued participation in citizen science?

In the following sections, we reveal the factors relating to disposition and organization that encourage/discourage participation in environmental-based citizen science. We focus on both the dispositional variables identified above, as well as the organizational variables relating to leadership, feedback and communication as discussed in the stakeholder interviews, identifying how important communication and effective feedback is to stakeholders in the process. Whilst the review above indicates the benefits of evaluation and monitoring, we discuss these separately in Chapter 10.

5.2.1 Dispositional variables

We asked our citizen science survey respondents whether their motivations had been satisfied. The following table (Table 18) shows if there motivations were satisfied overall did their involvement motivate them to do more.

		Number of participants (% of those who answered)		
Did your involvement in the project motivate you to do more Citizen Science?		**Dissatisfied**	**Neutral**	**Satisfied**
	Discourage	0	0	1 (1%)
	Neutral	0	0	17 (16%)
	Encourage	2 (100%)	3 (60%)	60 (55%)
	Strongly Encourage	0	2 (40%)	31 (28%)

Table 18 Satisfaction and increased involvement in citizen science

With exception of two participants who felt their motivations to help wildlife and a specific site were dissatisfied, the majority of participants felt their primary motivations had been satisfied. The majority of participants were encouraged or strongly encouraged to participate further. We continued this line of enquiry by asking respondents whether they felt their skills had developed over time. For both citizen science and environmental volunteering, the majority of respondents felt their skills had developed over time and this had encouraged over half of them to do more citizen science/environmental volunteering (Table 19).

	Number of respondents (% of those who responded)	
Type	**Citizen science**	**Environmental volunteers**
No difference	34 (25%)	20 (50%)
Encouraged	66 (49%)	17 (43%)
Strongly encouraged	36 (26%)	3 (7%)
No reply	11	7

Table 19 If you felt your skills had developed over time, did your involvement encourage or discourage you to do more?

5.2.2 Organisational variables

In order to examine the importance of organisational variables such as communication and feedback we asked our citizen science respondents whether they received feedback and how important feedback was to their continued involvement (Table 20). With exception of 15 respondents who received 'no feedback', emails, online maps and graphics and project reports were identified as the most used forms of feedback.

Feedback method	**Number of citizen science respondents (% of those who responded)**
Received an email	55 (37%)
Received a text	1 (1%)
Data was displayed on an online map or graphic	65 (44%)
Received a copy of a project report	48 (33%)
Other	15 (10%)
No feedback	15 (10%)

Table 20 Did you get any feedback?

We asked our citizen science and environmental volunteering respondents about the importance of communication and feedback to their continued participation (Table 21). With the exception of 5 environmental volunteer respondents, the majority of our citizen science and environmental volunteering respondents found communication and feedback to be important to their continued participation. This tallies with the suggestion in our desk-based study that people are motivated to be involved in a well-organised project (Bruyere & Rappe 2007, Jacobsen et al. 2012).

	Number of citizen science respondents (% of those who responded)	
	Citizen Science	**Environmental Volunteers**
Very unimportant	0	2 (5%)
Unimportant	4 (3%)	3 (8%)
Neutral	12 (10%)	5 (13%)
Important	11 (9%)	5 (13%)
Very important	94 (77%)	23 (61%)
No reply	26	9

Table 21 How important is communication and feedback to your continued participation in the project?

The importance of other organisational variables such as leadership, project management, evaluation and monitoring is emphasised throughout this report.

We also extended our survey here to include the free text option for participants to let us know in their own words: "What encourages or discourages your further involvement in citizen science?" 91 citizen science respondents answered this question. Whilst these opinions were diverse, it is useful here to list the many ways in which people felt encouraged or discouraged to participate as this is fundamental to the success of any citizen science initiative (see Appendix 3 for detailed answers). Feedback was the overwhelming factor, followed closely by contribution and impact.

What encourages involvement?	***In their own words…***
Feedback	*"Some evidence of the data being used to extend scientific knowledge and this informing policy change"; "See the end result, the report, hear about the findings and whether this has resulted in changes being made"; "Receive some feedback even if it is the first year of the project. Data analysis can wait but a general outline of coverage and initial observation sis very welcome"; "Response from the organisers"; "To feel that my sightings information and site data have been recognised and used"; "Evidence that the data is being used intelligently"; "FEEDBACK! :-) (but I'm now one of the converted and self motivated anyway)"; "Affirmation from professionals"; "A copy of the report where I could see the general results and, perhaps, find out how my contribution fitted in"; "Knowing that my data has been included in reports, charts and maps and that these are available for me to see"*
Impact and contribution	*"To see the impact that it has had"; "know and understand how the data is contributing to ecology and conservation and how it will be used for positive change"; "That I'm making an important contribution which would not otherwise be made"; "not just feedback, but feeling that the general project is doing some good ie at policy making level"; "See outcomes that reverse loss of biodiversity or could do so in the future"; "To see that the whole is greater than the sum of the parts i.e. that by contributing data from a specific area, you are contributing to a national perspective";*
Enjoyment	*"Enjoy doing it. My area of interest and knowledge. Confidence I know enough to report accurately"; "It has to be an enjoyable process"; "Happy participants and a completed survey!"; "I think it is the intrinsic enjoyment of identifying wildlife and being outside";*
Good project	*"A feeling that the project is well organised, with serious scientific intent, and that the results are of regional/national importance."*
Skill development	*"Learning"; "New skills, helping others."*
Involvement	*"Deep involvement in all aspects, not participating as a sensor."*
Support	*"Clear instructions, support if needed, access to a forum to discuss with other citizens."*

Table 22 Open-ended answers to what encourages or discourages your further involvement in citizen science

We also asked our citizen science survey respondents: "What do you need to get out of a citizen science project for you to feel your participation has been worthwhile?" We received 103 responses. In Table 23 we list the answers in order of frequency mentioned.

What makes participation worthwhile?	Specifically	Examples from open-ended responses
Knowing their participation had an impact	Evidence that their participation had an impact or had led to positive change	"*Robust scientific analysis and reports leading to conservation action where required." "The knowledge that the data is being disseminated and used to inform policy"*
Receiving feedback and communication	Feedback, acknowledging receipt of data and seeing results based upon their data in papers or reports	*"To start with it was an acknowledgment but now I understand how important it is I am more than happy to do it for no thanks at all"*
Knowing their data has been useful	Evidence that their data is useful or has been used, and in some cases how the data would be used.	*"To know that data is of value to organisations and others and that it will be used to aid conservation / further research / education etc."*
Enjoying participation, and achieving a deeper involvement	Respondents wanted to feel they enjoyed the project	"*Deep involvement in all aspects, not participating as a sensor"*
Other one-off responses included:	Clear instructions, support from professionals, well-organised project, understanding relevance of project, developing new skills, helping others.	*"Seeing the project succeed and more people join in"*

Table 23 Examples of what made citizen scientists' participation worthwhile

5.2.3 Continued participation from environmental volunteers

We also asked anyone identifying as an environmental volunteer the question: "What do you need to get out of a volunteering project for you to feel your participation has been worthwhile?" 31 respondents answered the question (for full responses see Appendix 3). The responses indicate a common need to know that their participation in the project has had an impact, and evidence that their participation was useful through papers/reports. Less frequent answers related to receiving feedback, thanks and acknowledgement, meeting people and networking, well-organised project, good instructions, tools and training and increased public awareness of the issue.

What makes participation worthwhile?	***In their own words…***
Impact	*"I want to know that something useful has happened, from which people or wildlife will benefit"; "See obvious improvements in species numbers and distribution"; "The feeling that I'm doing something worthwhile"; "To make some improvement over what went before, or to feel I'm adding to the body of knowledge about a particular site"; "That we have done the best we can, that a site is in great condition and the species we have worked for will use it"*
Publication	*"An output"; "A report that says clearly what was achieved";*
Networking	*"Get good connections"; "meeting likeminded people"*
Skill development	*"Learn new skills"; "Clear understanding of what is required, appropriate tools and training (if necessary),"*
Getting job done	*"A satisfactory end result. Something has been completed which may be*

	anything from planting a tree to recording moths over the whole year"; "seeing benefits of work e.g. Coppicing increasing woodland flora and bird habitats; partly the feeling that I am able to make a worthwhile contribution without suffering from the cold and dampness of winter working parties"
Data collection	*"Collecting useful data"*
Feedback	*"Occasional thanks always welcome"; "Feedback from the organisation(s) you volunteer with and from people that use your material";*

Table 24 Examples of what made environmental volunteers' participation worthwhile

The shared responses between citizen scientists and environmental volunteers for what makes their participation worthwhile suggests that citizen science may appeal to environmental volunteers. We consider this in more detail in the following section.

5.3 Encouraging environmental volunteers to participate in citizen science

As outlined in the introduction and methodology, we were also interested in responses from people who had not participated in a citizen science project before, but already had an interest in the environment. We targeted those people who self-identified as environmental volunteers and asked them what might motivate them to participate in citizen science in the future, or what had discouraged them from participating at this present time. An important question that we posed to environmental volunteers is: "Are you aware of any citizen science projects?" Of those that answered the question, the response was an almost even split between being aware and unaware of citizen science projects (Table 25). Of those who were aware of the citizen science projects, 52% of respondents were interested in participating (Table 26). Furthermore, 56% of volunteers would like to do more volunteering (Table 27). The overwhelming reason preventing respondents for doing more volunteering was 'lack of time' (Table 28).

	Number of respondents (% of those who responded)
Yes	17 (44%)
No	18 (46%)
Not sure	4 (11%)
No reply	8

Table 25 Are you aware of any citizen science projects?

Type	**Number of respondents (% of those who responded)**
Not at all	9 (26%)
Neutral	3 (12%)
Very much	13 (52%)
No reply	22

Table 26 If you are aware of citizen science projects, have you ever been interested in participating?

	Number of respondents (% of those who responded)
Not at all	9 (20%)
Neutral	11 (24%)
Absolutely	25 (56%)
No reply	2

Table 27 Would you like to be able to do more volunteering?

Reason	**Number of respondents (% of those who responded)**
Lack of time	29 (54%)
Difficulty getting to activities	1 (2%)
Shortage of other people to do it with	4 (7%)
Lack of money (for travel, materials, food etc.)	5 (9%)
Other	15 (28%)

Table 28 If you would like to do more volunteering, what prevents you?

Those who responded 'other' also indicated 'lack of time', as well as the following factors:

What prevents your participation	***In their own words…***
Lack of time	*I already do all I can; Fully committed already; Spend all my spare time working on wildlife projects; I go on every work party that is organised. I do a huge amount in the background too.*
Advancing age	*Age; Lack of physical strength to do sawing and for using brushcutter (largely due to advancing years!); My age; Old Age!*
Bureaucracy	*Red tape and unwillingness of local authorities to work together.*
Family	*Family not happy if I spend too much time away moth recording.*
Knowledge	*Lack of knowledge*
Inclination	*Need to make myself do it.*
Health	*Poor health*
Job	*Inflexibility of employer*
Weather	*The weather!!*

Table 29 Other reasons preventing environmental volunteers from doing more

5.3.1 Benefits of environmental volunteering

The desire of volunteers to do more suggests that there are multiple benefits gained by participating in environmental volunteering *and* citizen science. According to the existing literature, the benefits that people derive from participation have not been rigorously assessed (Crall et al. 2013). Those studies that have examined outcomes for participants from engaging in citizen science projects have done so in the context of the project initiator's expectations or hopes for their participants. For example, some case studies show that participants have learnt something as a result of participation (Bonney et al. 2009, Sirbu et al. 2015), shown increased scientific literacy (Bonney et al. 2009), have changed their behaviour (Bonney et al. 2015, Couvet & Prevot 2014) and shown advocacy by spreading their new knowledge (Johnson et al. 2014). However, the perspective of the participant is not taken into consideration i.e. studies have not asked what participants hoped to gain from participating and what they felt they actually gained from participating. Furthermore, there is the potential for bias in the literature towards scientists reporting on what they consider to be successful projects (Riesch & Potter 2014).

We asked our environmental volunteer respondents how they currently benefit from volunteering, 85% of our respondents stated "I feel I am helping the wildlife", 72% stated "I develop new skills" with spending time outdoors, getting some exercise and sharing knowledge and experience also rated highly. Respondents were able to select as many options as applied to them.

Benefit	Number of respondents (% of total number of environmental volunteers who participated in the survey)
I feel I am helping the wildlife	40 (85%)
I develop new skills	34 (72%)
I spend more time outdoors	30 (64%)
I get some exercise	29 (26%)
I get to share my knowledge & experience	31 (66%)
I feel I am helping a specific site	27 (58%)
I meet people & have fun	27 (58%)
I feel better about myself	20 (43%)
I am helping my future career	3 (6%)
Other	9 (19%)

Table 30 How do you currently benefit from environmental volunteering?

9 respondents answered 'other' and identified contributing to science, fulfilling their personal enthusiasms, institutional affiliation and making the world a better place for future generations as key benefits they derive from volunteering.

More work needs to be done to understand two key areas. Firstly, the differences in benefits between projects. There is some evidence to suggest that people need to be involved in more collaborative or co-created than contributory projects, and over a long term rather than short term to benefit (Couvet & Prevot 2014). It has also been noted that it is currently difficult to compare between projects because of the different methods used and there has been a call for common questions and indicators to be used in project evaluations (Crall et al. 2013). Secondly, the lifetime of these benefits. This is unknown, perhaps due to the difficulties in tracking participants in the long-term after they have finished their involvement with a project.

5.4 Importance of communication and feedback for continued participation

The literature review and the online survey revealed the importance of communication and feedback to the continued success of citizen science projects, specifically the continued participation of citizen scientists and environmental volunteers (which as we know involve considerable overlap). We asked our stakeholder interviewees about the importance of communication and feedback to their projects and roles. We outline below our findings:

5.4.1 Communication and feedback

All stakeholder respondents recognised the importance of communication with participants in citizen science. As one practitioner respondent suggested:

> *"[Communication is] absolutely essential because you have to motivate people to keep going. They have to be reminded that their records are useful, how they're being used" (Practitioner, science, engagement).*

Feedback and communication allow participants to understand their contribution:

> *"what people want, is to get that kind of feel for the bigger picture and how they've contributed" (Practitioner, science, engagement)*

It also enables citizen science projects to build rapport with their participants:

> *"[Communication allows] citizens to engage over a longer period of time to build trust and to understand each other because what scientists think the public needs is quite often not what the public thinks they need and vice versa" (Scientist, university)*

Whilst it was acknowledged by some as a time-consuming activity requiring considerable resource, as well as an activity that is apportioned to one area of a larger citizen science project team (e.g. some government agencies had devolved responsibility of communication to the frontline organisations dealing with the public), all respondents expressed the need to communicate and feedback to participants who volunteer their time and expertise to their projects. Respondents agreed that feedback must be immediate, specific to the locale or individual, interpretable, and offer online and offline options.

The following reasons for, and benefits of, communication were identified by stakeholders:

- Keeping participants in touch with the project;
- Offering participants local, personal and quick feedback;
- Sharing intellectually interesting content;
- Opportunity for face-to-face feedback offering a personal touch/link with the project;
- Able to share what the data is telling participants;
- Able to treat people as social creatures (e.g. it's not a club, but there can be interaction);
- Target individual requirements (e.g. daily for some, others not bothered);
- Sharing how data is used in scientific papers to communicate what their data is able to do; and
- Educate participants by sharing top tips, what to look for, advice, answers to letters.

5.4.2 Communication methods

Stakeholders identified methods they have used within their own projects to communicate with their participants, and methods they had experienced through their own volunteering. Table 31 highlights possible communication methods and their usefulness. A more detailed discussion of the technologies surrounding feedback is offered by Roy et al. (2012).

Method		**Reasons for use and associated challenges**
Online/Offline Communication (the role of technology is discussed in more detail in Chapter 9)	Websites	Allows quick and easy updates, using maps and pictures to visualise results
		Enables all partners to contribute/share content
		Allows for dedicated research findings websites (e.g. BTO BirdTrends)
		Host forums for discussion and chat, moderation of the forum is often by volunteers
	Newsletters	Online: PDFs enable projects to save money, printing and posting
		Offline: importance of materiality acknowledged (e.g. newsletter to flick through), particularly for those who have been involved long-term (i.e. older participants)
	Social media (e.g. blogs, Facebook and Twitter)	Allows easy information sharing (e.g. retweets)
	Emails	Two-way communication with individuals
		Must be careful not to bombard participants

		Can be time-consuming with direct contact
	Media (e.g. press, radio, TV)	Opportunity for mass communication with participants
Face-to-face communication	Annual conference, workshops, community meetings	Meeting in person (e.g. annual get together)
		Offers talks (e.g. first look at data, researchers talk directly to participants)
		Involves some training
NOTE: Communication and feedback were also linked to monitoring and evaluation processes – for more on these see Chapter 10.		

Table 31 Stakeholder communication and feedback mechanisms

5.4.3 Face-to-face with the community

The majority of our stakeholder respondents are involved in citizen science for academic research, long-term monitoring, surveillance and education. However, one respondent was heavily involved in community-led science, whereby the participants set the research questions and are supported by a team of experts to develop a methodology based upon scientific protocols. Working 'in' the community, led to the need for increased face-to-face communication with the community, as this practitioner interviewee explained:

> *"But there was another portion, there was an older demographic who didn't have email, or didn't really use email and, so we'd call them, so we'd actually phone them up. So we knew the list of people that we needed to phone and speak to over the phone. And then we'd go to their houses." (Practitioner, community)*

> *"We would have like[d] a community meeting in a location which is in the heart of the community so it's accessible to them, and say this is what you did and this is the results that we found and this is what it looks like, and what do you want to do now that you've got this and how do you want to move forward with this. So we would always have that." (Practitioner, community)*

Whilst we are not advocating that every citizen science project should involve face-to-face communication with all participants, for many projects this would be impossible, but these examples alert us to the need to consider alternative ways of communicating with participants. Technology is only part of the solution here, and techniques involving co-presence are often vital for developing long-term rapport with participants. This becomes increasingly important in the context of collaborative and co-designed projects.

5.4.4 Good practice in communication

Unsurprisingly, practitioner stakeholders working in science, engagement, education and community had the most knowledge to share on good practice for communication and feedback. Drawing on over 10 years experience of working with citizen science projects, two practitioners identified the following top tips for those looking to communicate effectively with their citizen science audiences:

> *"I think the more you can get under the skin of your recorders[5] and understand what inspires them. We have quite good analytics on our email so I can check and see what stories people have responded to and which ones have rather left them cold. So over the years I've discovered … the majority are very passionate about birds. So if I can find bird stories, that is useful. The most popular story we ever ran was a silly one I found, I think on the BBC website, and it was called, blue tit nests in ashtray. And it sent the email absolutely wild" (Practitioner, science, engagement).*

[5] Note the use of the term 'recorder' to identify their citizen science participants. This reinforces the challenge of definition.

> *"It is about recognising the fact that people enjoy learning and recognising the fact that they want to do something that makes a difference. And both of those things really underpin everything that we do in [our project]„… if we can give people new information about what they're seeing, … they want to know more information about it, which can be very practical information about what kind of food to put out, … what to do to help [species] on a basic level. But also thinking that by sending us information about [the target species], they're actually helping to build up information about garden wildlife, urban wildlife. More generally which is then used for, you know, to increase scientific knowledge, which down the line can hopefully be used for things like urban planning and to find out how we can design maybe towns and cities, how we can design gardens, you know [our organisation] may be able to … work with developers. Or even if we don't work with developers, the information we can put out there for it to be used by government or developers to actually help [the target species] in general, so I think that is where the motivation comes from for our [participants] and that's where the, that's why our feedback is effective because … we're telling people this information" (Practitioner, science, engagement).*

It is possible to identify three important messages from this advice. First, project organisers need to understand what inspires and motivates their participants; second, organisers must commit to sharing information consistently on what participants are interested in (practical and science-related); and third, project teams should take advantage of communication analytics to determine which 'communications' received the most traffic from participants and tailor their communications accordingly.

Finally, during one interview with a policy/evidence stakeholder, it was suggested that a future mode of offering feedback to participants could involve the consolidation of data into a central citizen portal:

> *"We would be quite interested in a universal data solution where all the data is being pooled into a shared database that has the functionality to allow people to say, well, what are the trends in my local area, what can I find on this particular site, what occurs within X kilometres from my house? … that's the sort of open data solution that potentially brings a lot of benefits. Data can flow directly to it. You can have your quality control partially automated and people can then access, download, visualise large chunks of data from multiple sources" (Policy, evidence).*

5.5 Summary of what encourages and discourages participation in citizen science

Encourages		Discourages
		
Organisational		
Immediate, specific and interpretable; detailed, local/individual, accessible data; explains usefulness of participants records	**Feedback**	Slow or late feedback; inconsistent; not saying thank you or acknowledging receipt of data
Online, Updated websites, online forums, newsletters, social media. Offline: meetings in person, printed newsletters	**Communication**	Bombarding participants; one-way communication only; inaccessible
Dedicated websites with research findings; highlighting bigger picture and contribution; sharing that data made a difference	**Impact and outputs**	Incomprehensible
Training sessions, skills development, feeling skilled/prepared	**Training/education**	Left feeling unprepared; being a sensor; little support
Knowing their interests, what people love, feeling valued/useful	**Knowing your participants**	Feelings of being used
Measure benefits/impacts on participants terms	**Participant benefits**	Too focussed on stakeholder benefits
Good advertising and marketing, people have heard of project	**Awareness of opportunity**	Unaware that citizen science is an activity
Well-organised	**Organisation**	Disorganised
Able to move from passive to more active role	**Participation career**	Few opportunities to progress within the project
Dispositional		
Satisfied	**Motivations**	Unsatisfied
Access to resources	**Funding**	Not enough money to travel to sites or access technology
Accommodate diverse personal barriers through tailored project	**Personal circumstances**	Already over-committed; weather; inflexible employer; health; inclination; family commitments; bureaucracy; age; lack of time
Becomes about being in the company of others	**Enthusiasm**	Little opportunity to share interest
Meeting like-minded people	**Networking/social factors**	Doing activity alone; no opportunities to meet people (even if only occasionally or online)
More time spent participating more likely to continue	**Length of time**	One-off involvement (although not always)

Table 32 Summary of what encourages and discourages participation

Chapter 6: Motivations for stakeholders in citizen science

Chapter highlights
* Existing literature on stakeholder motivations focuses only on scientists. This study is the first to include the motivations of a range of scientists (university, monitoring, policy, education, not using/data only), policy/evidence specialists and practitioners (science, engagement, education, community)
* As would be expected, advancing scientific knowledge is the most common motivation given for scientists to be involved in citizen science. This was found in both the academic literature and through our stakeholder interviews
* Other scientist motivations include: informing policy; informing conservation and land management; education; improving buy in for decisions; raising awareness and engaging people; building partnerships and improving communication
* In addition to those mentioned above, gaining personal satisfaction from participation was revealed as a significant motivation across all groups
* Personal satisfaction included: enjoying their work; commitment/enthusiasm; equity and self-determination for participation; fulfilling career objectives, ambitions, building on previous education; generating impact for people's lives; working with unpaid experts and harnessing their enthusiasm for science
* Changes in stakeholder motivations over time related to increases in: institutional commitment to citizen science; technology; bottom up approaches; public engagement; media reports; sophistication of activities

In this chapter, we examine the motivations and actual/perceived benefits for stakeholders of participating in citizen science. This is followed by a later chapter on some of the associated barriers and challenges. We begin here with a search of the existing literature on motivations for stakeholders getting involved in citizen science. Interestingly, we were only able to find research relating to scientists, this includes both scientists who have established their own citizen science projects and those who have used data collected by citizen scientists. There was no information on the motivations of other stakeholder types. Using scientist motivations as our starting point, we explore through our stakeholder interviews the motivations of those involved in science, policy/evidence and practice. First, we outline the motivations of scientists identified in the literature.

6.1 Existing work on scientist motivations

(1) To contribute to science

As would be expected, advancing scientific knowledge is the most common motivation given for scientists to be involved in citizen science. Citizen science projects tend to fall into two categories: hypothesis testing and monitoring. In both cases, the primary motivation for using a citizen science approach is often to collect data on a temporal or spatial scale that would not be feasible using traditional methods and within the funding available (Bonney et al. 2009, Devictor et al. 2010, Dickinson et al. 2010, Gardiner et al. 2012, Crall et al. 2013, Hardisty et al. 2013, Anderson & Alford 2014, Bone et al. 2012, Casanovas et al. 2014, Duputie et al. 2014, Fairclough et al. 2014, Winfield 2014, Kampen et al. 2015, Sirbu et al. 2015, Wright et al. 2015) or to collect data from areas otherwise inaccessible to scientists such as private land (Ferster et al. 2013, McClintock et al. 2015). The assumed cost-saving element is also more likely to make projects sustainable in the long term (Danielsen et al. 2005). More specifically, in some cases, the motivation is to collect data on a scale that is relevant to the question that is being asked (Sullivan et al. 2009, Kaartinen et al. 2013, Bird et al. 2014) or across multiple

scales which can be helpful for answering specific questions (Lottig et al. 2014, Loss et al. 2015). The motivation may also be the ability to respond rapidly in response to global changes and emerging questions (Theobald et al. 2015) and to use findings to prioritise further research (Bone et al. 2012) and develop new hypotheses to be tested (Sullivan et al. 2009). In some cases it is also recognised that by engaging with citizens, researchers can gain valuable local or traditional knowledge (McKinley et al. 2013). Furthermore, some researchers have suggested that engaging in citizen science could help to meet the requirements of funding bodies to demonstrate impact (McKinley et al. 2013). Indeed, a recent review found that for 97% of citizen science projects surveyed, advancing scientific understanding was an explicit primary goal (Theobald et al. 2015). An analysis of 133 scientific papers which use data collected by volunteers found that nearly 75% had "extractive" aims of increasing the amount of useful data available to them (Lawrence 2009). A much smaller proportion had motivations relating to educating volunteers (19%), fostering stewardship (6%) and promoting cooperation between citizens and government (3%).

(2) To inform policy

Beyond collecting data for purely scientific purposes, another motivation identified by scientists for engaging citizens in data collection is to inform policy making (Bonney et al. 2009, Bone et al. 2012, Isaac et al. 2014, Lottig et al. 2014, Hollow et al. 2015, Hyder 2015). It has been noted that professional scientists on their own are not capable of delivering the volume of data, analysis and interpretation needed to match the speed at which policy decisions are made (Theobald et al. 2015 and references therein, White et al. 2015). More specifically, it has been recognised that citizen science can help to provide the data needed to present the scientific evidence to justify biodiversity conservation initiatives at a political level (Braschler 2009, Anderson & Alford 2014, Johnson et al. 2014). Vast amounts of data are also needed to report against policy targets and citizen science has been recognised as a way of achieving this (e.g. Aichi targets, Braschler et al. 2009, Arvanitidis et al. 2011, Danielsen et al. 2014; EU Habitat and Birds Directives, Isaac et al. 2014).

(3) To inform conservation and land management

Scientists may also be motivated to use a citizen science approach to inform land or conservation management (Bonney et al. 2009). The purpose may be to generate the data (Gollan et al. 2012, Lottig et al. 2014, McClintock et al. 2015, White et al. 2015) or ecological understanding (McKinley et al. 2013) needed to inform environmental management. Data can be used, for example, by local authorities to inform planning and development activities (Jansujwicz et al. 2013) or to support agencies and organisations to address environmental management issues (Rosevelt et al. 2013). In some cases, the topic lends itself in particular to a citizen science approach. For example, the presence of new nuisance species in an area is usually detected initially by members of the public and so establishing effective communication between communities, scientists and authorities may contribute to early detection and action (e.g. mosquitos, Kampen et al. 2015; invasive plants, Jordan et al. 2011).

The advantage of engaging people at a local level has also been recognised as this is often operational level of resource management and so can improve the speed of decision-making (Danielsen et al. 2014). Locally-based monitoring schemes are also likely to focus on issues of greatest concern to stakeholders and so has the potential to influence on-the-ground management activities. Action takes place at a local level (Loss et al. 2015) to advance locally-relevant and practical conservation goals and strategies (Haywood & Belsey 2014).

(4) To educate

Beyond data collection to inform science, policy and conservation and land management, education appears to be the next most commonly mentioned motivating factor for scientists to use a citizen science approach. Often, this is education about the topic of the project (Trumbull et al. 2000, Bonney et al. 2009, Bone et al. 2012, Groffman et al. 2010, Ferster et

al. 2013, Kaartinen et al. 2013, McKinley et al. 2013, Casanovas et al. 2014, Lucky et al. 2014, Winfield 2014, Sirbu et al. 2015). In many cases, however, there is a general aim to improve scientific literacy in participants, that is to improve their understanding of the scientific process (Trumbull et al. 2000, Bonney et al. 2009, Braschler 2009, Bone et al. 2012, Groffman et al. 2010, Casanovas et al. 2014, Varner 2014).

(5) To improve buy in

Getting buy in from participants for policy decisions (Bone et al. 2012) and land management decisions (McKinley et al. 2013) is also stated as a reason for involving the public in scientific projects.

(6) *To raise awareness and engage people*

Raising awareness, for example of environmental and conservation issues, is often stated as a reason for adopting a citizen science approach (Jansujwicz et al. 2013, Bird et al. 2014, Liu et al. 2014, Kampen et al. 2015, Loos et al. 2015, Sirbu et al. 2015, Wright et al. 2015). Related to this are the motivators to foster a sense of ownership, shared responsibility, concern and stewardship (Bone et al. 2012, Ferster et al. 2013, Anderson & Alford 2014, Danielsen et al. 2014).

Wanting to change participants' behaviours is also given as a reason for engaging citizens in scientific research. The motivation may be to change behaviour related to specific activity, for example, to engage the public in helping to prevent the spread of mosquitoes (Kampen et al. 2015), invasive species (Jordan et al. 2011, Crall et al. 2013) or wildfires (Ferster et al. 2013).

Alternatively, the motivation may be not just to inform participants of a particular issue, but also to help citizens to understand problems and concerns so that they can make informed decisions of their own (Liu et al. 2014). It has also been suggested that by engaging people in monitoring against policy targets, this could help to engender on-the-ground action and hence help to achieve targets (Danielsen et al. 2014). Involving people in citizen science could also empower and build capacity in participants to make change at a local level (Danielsen et al. 2005) which could in turn improve their livelihoods (Danielsen et al. 2014). Related to this is the motivation to inspire activism in participants and to identify "opinion leaders" who can spread messages and action through communities (Groffman et al. 2010).

(7) To build partnerships and improve communication

Building partnerships and improving communication between different stakeholders (including scientists, amateur experts, local interest groups, the public, land managers, agencies and authorities, community organisations, government officials, educators and policy-makers) is also stated as a motivation for scientists taking a citizen science approach (Bone et al. 2012, Liu et al. 2014). The purpose may be: to share data between these different groups (Kampen et al. 2015); to help with decision-making (Rosevelt et al. 2013); to promote cooperation (Lawrence 2009); and to build trust, for example between scientists and the public (Grand et al. 2012) or between the public and decision-makers (Ferster et al. 2013), for example by increasing transparency in the scientific process and having data that is accessible to everyone. Improving communication and building partnerships between different stakeholders can also assist in the process of democratisation of science and policy and land management decision-making (Couvet & Prevot 2014). This is also mentioned as a motivation for a citizen science approach, usually in the context of co-created rather than contributory projects (Haywood & Belsey 2014, Liu et al. 2014).

This literature review only revealed the motivations of 'scientists' and their involvement in citizen science. Several areas warrant further investigation. First, the need for further work with other stakeholders to accommodate the motivations of 'others' involved in citizen science, including: scientists working outside of academia in monitoring, policy and wider education; policy and evidence stakeholders commissioning, facilitating and using citizen

data; and practitioners involved in working with citizen scientists through science, engagement, community work and education. Second, our literature review identified the need to consider the relative importance of these different motivations. Third, the review suggested the need to consider stakeholder motivations in relation to the type of project being led, for example do different types of project (e.g. with different topics, geographies, modes of engagement, skill level required, one-off or long term, contributory / co-designed / co-created projects, sphere of influence of the project) tend to have different motivations? It should also be noted that there are biases in the types of project on which publications are based (i.e. there are more publications related to long running large scale data collection projects, Theobald 2015, Danielsen et al. 2014). As such, this review may be missing motivations from other types of project. Finally, it was identified that there needs to be a consideration of how motivations change as a project evolves. Whilst changes in motivations over time have been noted from some projects, such as eBird (Sullivan et al. 2014), this question is relatively under-explored.

In order to access the motivations of a wider group of stakeholders, we conducted interviews with them to ask about both their institutional and personal motivations, how they take into account participant motivations in their citizen science projects, and how the motivations for the projects they have worked with have evolved over time. We present the findings below in two parts: first, new and emerging stakeholder motivations (6.2) and how they vary between stakeholder groups (6.3); and second, how stakeholder motivations change as projects evolve (6.4).

6.2 New and emerging stakeholder motivations

Taking the categories of motivations for scientists involved in citizen science from the academic literature outlined above, we expanded on this for other stakeholder groups and were able to identify new and emerging motivations across a range of stakeholders. Table 33 (overleaf) reveals those categories of stakeholder motivations and will be useful for stakeholders setting up projects and those doing it on behalf of others, for example practitioners working with policy/evidence teams.

Our stakeholder interviews revealed motivations relating to all of the aforementioned ‘scientist’ motivations in the literature. However, no new or additional motivations were added to the categories of

- To inform conservation and land management; and
- To raise awareness and engage people.

It is important to note that policy/evidence and practitioner stakeholders were also motivated by these causes. A new category of ‘To gain personal satisfaction’ was added as a motivation as a result of our interviews with practitioner stakeholders, and new motivations were incorporated into ‘To contribute to science’; ‘To inform policy’; ‘To educate’; ‘To improve buy in’; and ‘To build partnerships and improve communication’.

Motivation (* indicates newly identified)		Scientist/university	Scientist/monitoring	Scientist/policy	Scientist/education	Scientist/not using/data only	Policy/evidence	Practitioner/science/ engagement	Practitioner/community	Practitioner/education
		Science					Policy	Practice		
To contribute to science	Increase temporal and spatial scale of data collection	■	■	■	■	■	■	■		
	Cost saving		■	■			■			
	Collect data from inaccessible areas	■	■	■		■		■		
	Collect data on a scale relevant to the question being asked	■	■	■		■		■		
	Collect data across multiple scales	■	■	■		■		■		
	Respond quickly to new questions	■						■		
	Prioritise future research	■						■		
	Develop new hypotheses	■								
	Meets funders requirements									
	* Need for open data (e.g. access to existing data sets declined)	■								
	* Work unrestricted by UK academic funding landscape	■							■	
To inform policy	Inform policy-making	■	■	■			■	■	■	
	Generate data at spatial and temporal scales required for policy-making	■	■	■			■		■	
	Report against targets		■	■			■			
	Help justify conservation initiatives at a political level		■	■			■			

		Science					Policy	Practice		
	* Develop a sustainable solution for monitoring									
	* Fulfil specific evidence need									
To inform conservation and land management	Generate data needed to inform management									
	Generate understanding needed to inform management									
	Supply the right people with data									
	Enable rapid decision-making at a local level									
To educate	Educate participants about the topic of the project									
	Improve scientific literacy of participants									
	* Connect people with nature (e.g. cultural ecosystem services, harness people's love of nature)									
To raise awareness and engage people	Raise awareness of issues									
	Instil a sense of shared ownership, responsibility and stewardship									
	Change specific behaviour of the public e.g. to help control spread of invasive species									
	Help the public make informed decisions									
	Empower and build capacity in local communities to make a change at a local level									
	Inspire activism and spreading of messages through communities									
To improve buy in	Get buy in from the public for policies and management									
	* Facilitate involvement in surveillance in a managed way									
To build partnerships and improve communication	Building partnerships between multiple stakeholders									
	Share data									
	Help with decision-making									
	Foster cooperation									
	Build trust and transparency									
	Democratisation of science and policy and land management decision-making									

		Science					Policy	Practice		
	* Engage with external audiences interested in institution									
	* Meet charitable objectives (including education and communication)									
* To gain personal satisfaction	* Enjoy your work									
	* Personal commitment/enthusiasm (e.g. counter to institutional disapproval, religious faith)									
	* Equity and self-determination for participants									
	* Fulfil career objectives, ambitions, building on previous education									
	* Generate impact for people's lives									
	* Work with unpaid experts and harness their enthusiasm for science									

Table 33 Stakeholder motivations

We outline below the additional stakeholder motivations identified for each motivation category:

To contribute to science
As well as the motivations identified from the literature, scientists in university, monitoring, policy and education fields using citizen data (as well as some policy/evidence and practice stakeholders) detailed two new motivations: (1) the need to be able to access data that was currently inaccessible to them – as one scientist explained *"Sometimes I've asked for data from the organisation that I've contributed towards, and it's been declined"* (S*cientist, university*). This prompted them to collect their own data via citizen science; and (2) citizen science offered access to a new funding landscape in the UK for academia that was less restrictive: *"So when those research projects ended we were still getting people approaching us and saying, we'd like to do such and such, and we just saw that as an opportunity to not be quite so restricted by a funding, a research funding programme where you've obviously got deliverables, you need to make sure you tick off all the tick boxes but would enable us to be a bit more flexible in the way in which we worked with people based on their interests and needs. So that's kind of how it came about"* (*Practitioner, community*).

To inform policy
Policy/evidence stakeholders, as well as some scientists (particularly those involved in monitoring and policy), held similar motivations for being involved in citizen science. However, two further motivations emerged from our interviews: (1) citizen science offers a sustainable solution for monitoring activity that is a policy priority – as one respondent explained: *"Well, it offers a sustainable solution for monitoring. I'm not sure that we've ever described it as something that we rely on. It's part of our programme of monitoring. So I think that it's quite hard to categorise our strategy on monitoring but it's probably a combination of utilising best available new technology whilst also using partnerships. So very often we've got citizen science doing this kind of stuff that you just can't do through satellites or remote sensing. So I think that's, so if I had to characterise it, it's adding value to our on going professional funded survey" (Scientist, policy);* and (2) citizen science allows stakeholders the opportunity to fulfil specific evidence needs, although as indicated in Chapter 8 (Barriers and challenges for professional participation), it is clear that this is also a challenge as some data needs can be too specialist/niche for citizen science approaches.

To educate
Education has always been an important motivation for citizen science. Interestingly our survey revealed a new motivation orientated less towards a 'public understanding of science' model of education (whereby the public simply need to be supplied with the 'correct' information), and more towards the connection of people with nature: *"we're connecting people with nature. But we do that through, engag[ing people] with our surveys rather than trying to do it as a standalone thing and also there's the fact that the more we engage with people and the more they learn, the more, obviously the more benefit they get out of it, but also the more benefit we get out of it. So … it's a win, win situation for us to invest that time in training and in developing people's interest and moving them on from maybe quite a simple survey to a more complex one as they grow in confidence and as they learn more about … identification or whatever it might happen to be"* (*Practice, engagement, science*). Scientists who have traditionally been linked to a preoccupation with 'data' also acknowledged the importance of citizen science to education, as well as harnessing people's love of nature

To improve buy in
In the academic literature, the stakeholder motivation of 'buy in' related to the acceptance of policy decisions by the public. Our survey identified an additional motivation to increase public involvement in surveillance and its associated science and policy activities. This motivation links to the mention of civil society as a key stakeholder group for the

implementation of surveillance and monitoring: *"it's about helping support people to provide information and to help undertake surveillance activities in the right way."* (*Policy, evidence*). Importantly, one practitioner indicated the changing role of citizen scientists as a result of emerging pest and disease threats: *"the benefits are definitely to have eyes and ears on the ground in a way that isn't possible in any other affordable way for us" (Practitioner, science, engagement).*

To build partnerships and improve communication
A new sub-category of motivation emerged around institutional publicity as a result of interviews with practitioner stakeholders who are often heavily involved in the communication of the project and the recruitment of volunteers. Two motivations were identified: (1) citizen science as a means of engaging with external audiences who might be interested in the institution/organisation; and (2) meeting the charitable objectives of the organisation, linked, for example, with education, engagement and communication. As one practitioner recounted: *"Obviously below that there are a huge number of other benefits and reasons for engaging with people, … one of our charitable objectives is all about education and improving people's experiences with wildlife and with nature and, because we're connecting people with nature"* (*Practice, engagement, science*). Interestingly, one of the scientists who is not currently using citizen science, but is considering how to adopt the approach in their research, indicated that citizen science has the potential to raise the profile of the institution and research group.

From the new motivations identified here, it is possible to discern a shift in the motivations being identified. As citizen science has become more mainstream, although by no means universally accepted, the motivational range has expanded to incorporate additional ways in which participants and stakeholders might benefit from citizen science which are not purely attributed to data collection. Indeed, they incorporate intrinsic motivations similar to those identified in Chapter 4. As a result of the growth of the sector, and to a certain extent our decision to make sense of both institutional and personal stakeholder motivations, a new category has emerged, namely 'To gain personal satisfaction'. In the next section, we cover this category in more detail.

6.2.1 To gain personal satisfaction
The literature search revealed only one motivation on the theme of personal gain which related to helping scientists fulfil funder obligations. Our interviews asked stakeholders to consider what motivated both their institutional and personal involvement in citizen science. It was important to consider personal motivations as progress may be impeded within an organisation because of the motivation of a staff member. As a result we were able to discern six new motivations that we outline below in more detail:

(1) Enjoy your work
A key motivator for scientists and practitioners was the way in which citizen science enabled them to enjoy their work. As one scientist explained when talking about their involvement in citizen science as a career: *"There's always a degree of serendipity as to what roles are available to you … in my young and idealistic days … I was motivated as an ecologist who wanted to be working in nature conservation. I wanted to understand how things worked or why they didn't work, how we could make it better. And I still have that, but … in terms of choosing a career path, it's what's available to you as much as how you create that career path. I've been exceedingly lucky in that I have remained in the field that I trained for and been able to have some small influence on the way that it works within my organisation. So it's very rewarding in that sense, being able to work, as I say, in something that you were motivated to do when you were young and ideal"* (*Scientist, monitoring, policy*). Another said: *"… for me, it's stuff that I do as a hobby and it's a way of melding my work, which I'm not sure whether is a good or a bad thing, but I think that's a lot of my motivation for it" (Scientist, monitoring, policy)*. One of our science respondents who is not yet using citizen

science suggested that *"The things I really like about my job are where I have an enabling, personal and career development role with my colleagues. I can imagine that involvement with participants might be like that. Citizen science could be part of general enjoyment and benefit from life" (Scientist, not using).*

(2) Personal commitment/enthusiasm

Scientists can be motivated by a range of personal interests, from an enthusiasm and care for science and data to religious beliefs and strong commitment to justice, often drawing on their own experiences as citizen scientists and volunteers. The following interview extracts reveal these significant and varying commitments:

- *"So, if you like there is a religious motivation to do it and that's just partially driven by the fact that I fundamentally believe in universal education, and I don't believe that it's just a preserve of the privileged"* (*Scientist, university*).

- "*I think there is a real disconnect between science and how the world is run really. And I think that for a lot of academics they don't really feel that they need to explain what they are doing, despite the fact that what they're doing is essentially paid for by member[s] of the public in the first place"* (*Scientist, university*).

- *"Well I've had a chequered past. In my first life I was [a management job], which looking at my bank account now maybe I can regret it from a financial point of view that I'm not still doing that, but I think for me, having spent years where you, it's about making rich people richer, I really wanted to have a job and do something which actually had a positive impact on people and the environment, and making our world sustainable in some degree of sense, whether that be from an environmental point of view, a social justice point of view. So that's kind of been my drive … irrespective of the fact that sometimes, yeah, all of the unsociable hours and the fact that Saturdays are not really the weekend depending on what you're working on. I think that what enables you to continue to do it is the fact that actually it's doing some good somewhere along the line, and it's for the betterment, and I think that that for me is key"* (*Practitioner, community*).

- *"Oh, I guess on the personal side it was just being involved … I'm particularly interested in [insects], and so the [national society], which I became a member of and contributed to some of their recording. At that stage, it was in the old days with bits of paper and producing atlases and the like. So I've been involved at that personal level. And then through my work, over many years I've worked alongside some of the smaller schemes and societies in previous roles. [In my first job], I was working alongside other, often citizen scientists. And many of the citizen scientists I was working with at that stage, and still am, to be honest, were, are experts in their field, and the only reason that they're not called professionals is they're not paid for it. So it's been a very long relationship, and a very fruitful one, I find"* (*Scientist, policy*).

- *"I was aware that as a keen volunteer, I was providing data that was going to end up on a national database. And I think for me there was very much that feeling that I was just contributing to something that was going to better help us understand the [species] population, but there was no specific goal"* (*Scientist, university).*

(3) Equity and self-determination for participation

Linked to the motivations surrounding 'To raise awareness and engage people' identified in the literature, for some scientists and practitioners a key motivation is being able to facilitate the participation of civil society in science and decision-making. As one scientist explained, it is about empowerment and actually giving people the tools to engage with. Another

mentioned: *"for me I think the key is to get the kids involved. I quite enjoy that aspect of it because it gets them a chance to think about it and to improve their own environment and that, to me, is the driver for me" (Science, education).* Another talked about a personal commitment to scientific literacy: *"I feel really strongly about the scientific literacy agenda. I think if members of the public understand science … and the process of research, they're more likely to be, think it's something that's important even if they don't want to do it themselves and I think make decisions that are based on research if they're able to understand the whole context. … The more we can talk about it the more we can just interest people and let them know that their opinion is valid. I think that's always going to be a good thing" (Practitioner, science, engagement)*

(4) Fulfil career objectives, ambitions, building on previous education

Surprisingly the existing literature has not identified 'career' as a motivator, however, with the rise of citizen science and the value now placed on involving the public in science, it has become a key motivator. Several respondents indicated how their involvement in citizen science had helped them to secure new appointments, and fulfil their career ambitions of combining educational qualification in natural science disciplines with considerable experience of working with volunteers.

(5) Generate impact for people's lives

It is widely acknowledged that citizen science empowers individuals and communities (Davies et al. 2011). This is a key motivator for scientists and practitioners, particularly for continued involvement and examples include:

- impact on quality of life: *"since we are an … organisation that's funded by public money our work ought to have implications as well as impact on improving the life of, the quality of life for the general public. So in the end of the day generating impact in a positive sense and improving public health or contributing data and information for people to better understand what's happening in the environment and how it affects their life and their wellbeing it's, for me is a central part of the kind of work that we do"* (*Scientist, university*).

- changing people's lives through participation: *"I think when you look back and you see that it could be the smallest of things where, I remember one lady who got involved with [our projects] in a really run down estate …, and she had a number of health issues. But after participating in both of those programmes she said that the whole process has made her realise that she can do things and she knows more than she thought she knew, and now she's going to go and do a course, I think it was a management course … but she hadn't done anything other than basic tertiary education and had been out of education for like 25 or something years. So for her, just that being involved in what she felt was a kind of scientific process empowered her to feel that she had the ability to go on and further her education or attainment. So that's kind of one degree" (Practitioner, community).*

(6) Work with unpaid experts and harness their enthusiasm for science

This motivation has been located here within the category of personal satisfaction. However, it could, we suggest, also form a motivation under 'science'. Citizen science is changing scientific practice for those involved, both professionals and volunteers. Working with and acknowledging the considerable expertise of unpaid experts is a motivation for scientists and policy/evidence stakeholders, who are keen to harness this enthusiasm. As one scientist explained, in their organisation, they are: *"going to those who are already interested, by their own, they're self starters, they are naturalists, you can find a lot out"* (*Scientist, monitoring, policy*). Followed by a stakeholder who explained: *"And also there was a need to, we know that people are passionate about [species], they want to, would they want to help too?"* (*Policy, evidence*).

6.3 Relative importance of motivations by stakeholder type

Whilst there is significant overlap in a number of areas regarding stakeholder motivations, it is possible to identify the following preoccupations (see Table 34).

- Practitioners are motivated by all aspects/benefits of citizen science, often undertaking roles ranging from recruiting volunteers, survey design and data analysis to advocacy, communication and meeting institutional objectives.
- Policy/evidence stakeholders are interested in robust evidence to inform policy and decision-making. For this group, personal satisfaction relates to harnessing enthusiasm for science, engaging with unpaid experts and fulfilling career interests in environment, conservation and policy.
- Scientists only using citizen collected data are motivated by its potential to inform their science and allow them to fulfil a specific evidence need. For this group, personal satisfaction relates to using citizen data in decision-making.
- Scientists are motivated by all sub-groups.

	Practice	Policy/ Evidence	Science /not using/data only	Science
To contribute to science	■	■	■	■
To inform policy	■	■	■	■
To inform conservation and land management	■			■
To educate	■	■		■
To raise awareness and engage people	■	■		■
To improve buy in	■	■		■
To building partnerships and improve communication	■	■		■
To gain personal satisfaction	■	■	■	■

Table 34 Importance of motivations by stakeholder type

6.4 How stakeholder motivations have changed over time

It is also important to consider how stakeholder motivations have altered over time, focussing on institutional motivations in particular. Whilst few were able to articulate this directly, it was possible from the material to draw out how their citizen science projects or institutional engagement with citizen science had changed over time (see Table 35).

Driver of change	**Result**	**Stakeholder Type**
Institutional commitment: institutions of all kinds are recognising the value of citizen science to not only scientific endeavour but also their public profile: *"Initially there was a lot of discussion about whether we should communicate with the general public at all, … there's been a big sea change in that through our organisation, and I think people are also recognising that there's a benefit from a reputational point of view" (Scientist, monitoring, policy)*. Furthermore many organisations have a long term relationship with volunteers (50 years or more in some cases)	Increased buy-in from high-level institutional strategy	Scientist/university; Scientist/monitoring/ policy; Practitioner/science/e ngagement
Technological innovation: Use of computers, websites, apps, regular technological updates; move	Improved engagement and data	Practitioner; Policy/Evidence;

from data submission on paper to online. Technology has improved data flow, better feedback to volunteers, e.g. *"In particular things in the same period the quality and the availability of low cost sensors has become more viable because it's not that long ago when measuring air quality required something above tens of thousands of pounds at least to get anything reliable out" (Science, university)*		Scientist
Bottom up rather than top down: People are more aware of citizen science initiatives, projects being approached by citizens for assistance	Citizen science is becoming collaborative and co-designed	Practitioner/community
Data issues giving way to awareness and behavioural change: Whilst projects remain committed to collecting more data of better quality, participant engagement has become increasingly important	Move towards awareness raising and behavioural change	Scientist/education; Scientist/policy
Saturation point: concerns are emerging surround recruiting enough participants and the idea that there is a limited pool to recruit from when projects demand a quality assured dataset	Suspicion around next generation of participants and skill levels	Policy/evidence
Media interest and public profile: citizen science has become a popular media item and is being used by organisations to increase the number of participants	Use of media to encourage participation in citizen science	Practitioner; Science/engagement
Increased sophistication: citizen science has evolved to allow for: increased numbers of taxa and species: *"[We started with…] where do you find all your interesting dragonflies or where's the nice place for water beetles, things like that, that very basic level of trying to understand where things are before we could even begin to think about how you might conserve them or the relation to what academic researchers needed" (Science, monitoring, policy);* and more challenging research questions: *"they have become more specific and in some cases looked at trends that have been noticed by participants" (Science, hypothesis-led)*	Asking more challenging questions	Scientist/university; Scientist/monitoring; Scientist/policy
From mass participation to targeted surveillance: citizen science is now being viewed as an approach to surveillance and citizens as early-warning systems. Whilst this approach is still in its infancy, there is increased attention on a move away from simple engagement/mass participation.	Training citizen scientists as early-warning systems	Policy/evidence; Practitioner, science, engagement

Table 35 Changes in stakeholder motivations over time

It is possible to suggest that: once institutions started using citizen science they largely remained involved; technological advances have enhanced data collection and the experience for the participant; there is a slow move from largely contributory projects towards those involving co-design, with linked changes relating to a shift away from purely data collection to engaging people and improved communication and media interest; there remains a common misconception that projects will run out of participants, however the growth of

citizen science indicates this is not the case, and that projects are diversifying in order to attract new audiences; and finally, citizen science has evolved in relation to the sophistication of questions asked by projects and the increasing specialisation of participation, for example citizens acting as early-warning systems.

Chapter 7: Matching participant and stakeholder motivations

Chapter highlights
* Recognition of the motivations of participants by stakeholders and incorporating this into the design of projects can increase participation
* In some instances partial fulfilment of motivations may be enough to ensure a contributory project satisfies both participants and stakeholders
* In a more co-designed approach to citizen science requires stakeholders to take a particular interest in the impact of the project on the participants themselves

We are unaware of any studies that look explicitly at whether volunteer motivations match stakeholder expectations or motivations. Only a few studies have explicitly stated the motivations of the project initiator or gathered information about the motivations of participants, and so any attempt to match motivations is difficult to test from the existing literature. However, recognition of the motivations of participants by stakeholders and incorporating this into the design of projects can increase participation e.g. eBird (Sullivan et al. 2009). In this chapter, we consider the challenge of matching motivations and offer some scenarios.

7.1 Variations in citizen scientist motivation by project type

Table 36 (below) displays the primary motivations of citizen science survey respondents by citizen science-type. Whilst the sample size is small, this breakdown reveals that participants in different types of project report different motivations. 'Recording' refers to traditional biological recording type activity'; 'Science-led' to hypothesis driven research; 'Surveillance' to early warning and detection; and other to other types of activity such as citizen panels on local environmental issues. 'To help wildlife in general' remains the most important motivation for the first three types, with 'To contribute to scientific knowledge' second most important to the first three types. The 'Other' category, while having smaller number of respondents, gives contributing to scientific knowledge greater importance. Participants in surveillance projects are more likely to be motivated by helping a specific site than participants in other types of projects.

Primary motivation	**Number of citizen science respondents (% of those who responded)**			
	Recording	Science-led	Surveillance	Other
To help wildlife in general	51 (55%)	9 (64%)	3 (50%)	3 (21%)
To help a specific site	6 (6%)	0	1 (17%)	0
To contribute to scientific knowledge	24 (26%)	3 (21%)	2 (33%)	8 (57%)
To meet people/for fun	0	0	0	0
To learn something new	3 (3%)	1 (7%)	0	0
To spend more time outdoors	3 (3%)	0	0	0
To get some exercise	1 (1%)	0	0	0
To share my knowledge and experience	0	1 (7%)	0	1 (7%)
Someone wanted me to do it (e.g. family, teacher)	3 (3%)	0	0	1 (7%)
To develop new skills	0	0	0	0
To help my future career	0	0	0	1 (7%)
Other	2 (2%)	0	0	0

Table 36 Primary motivations for citizen science by respondent type

Equally, motivations for stakeholders involved in different types of activity also varied (see Table 33). Just taking the scientists, the purpose of their involvement reveals that motivations vary in focus, but also in range.

7.2 Recognition of motivations

In some types of project the motivations of the stakeholders involved and the motivations of participants are aligned in a way that makes it easier to create a project that is able to meet its objectives, for example co-designed citizen science. Of course, the motivations of stakeholders and participants do not need to be completely aligned, and it is possible that meeting some of the participants' key motivations may be enough to result in an effective project. It is also possible that the participant's and stakeholder's motivations do not 'match' but that the motivations that are held result serendipitously in the data that is needed being collected. Drawing on the data from this study, it is worth considering some scenarios of projects with different objectives to understand which motivations might be important and how other motivations might be taken into account.

The first scenario (Figure 4 left) shows a typical contributory/recording type project with the primary motivations of scientists involved in monitoring (in blue) and the primary motivations of participants involved in recording (in orange), the size of the bubble represents the importance of the motivation. In this scenario, the most important motivations for both the stakeholders and participants are met. There are some lesser motivations which were not matched, which would need to be sufficiently recognised and satisfied in the design and conduct of the project to make it appealing to the participant and to meet the stakeholder's needs. This scenario underlines the importance of feedback to participants to show how their contribution is helping wildlife and aiding scientific understanding.

Figure 4 (right) shows a scenario of a project where the participant has an immediate interest in and use for the data, involving varying levels of collaboration and co-design. Motivations for scientists involved in education are shown in blue, and participants with an interest either a particular site, or in impact on well-being in orange. Again, the major motivations of both stakeholders and participants are met, but this relies on the stakeholders having a particular interest in the impact of the project on the participants themselves.

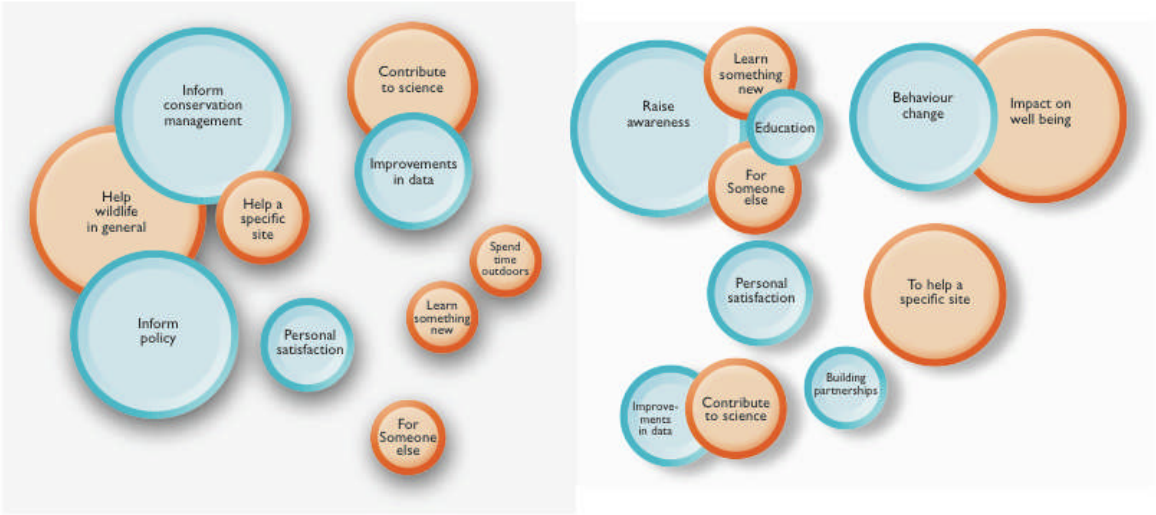

Figure 4 Recognition of motivations scenarios

Involving participants at an early stage in project development will help to develop a shared understanding of both the participants and stakeholders motivations and to recognise where these motivations can and cannot be met within a project.

Chapter 8: Barriers and challenges for stakeholder involvement in citizen science

Chapter highlights
* Existing literature on stakeholder barriers and challenges is confined to scientific and land manager communities, and identifying: data quality and biases; peer review and mistrust of citizen generated data; the need for specialist equipment or knowledge; time and resourcing issues; and lack of skills for working with the public; and the potential for political ramifications
* Interviews revealed 'mobilising and maintaining citizen science projects' (related to funding and time) as a common barrier across stakeholder groups
* Interviews revealed a distinction between science and policy/evidence stakeholder barriers around data quality and biases and practitioner barriers relating to survey design and over reliance on technology
* Citizen science must be promoted at a high level within institutions to maintain profile and resourcing

In this chapter, we present the findings of our literature search relating to the barriers preventing the participation of organisations, professionals and practitioners in citizen science. Whilst it was possible to identify a number of barriers relating predominantly to scientists, our interview responses have enabled us to carry out a more thorough assessment of the barriers of other stakeholder groupings, including scientists, policy/evidence specialists and practitioners.

8.1 Existing work on barriers for stakeholder participation

The existing literature on barriers for stakeholder participation is largely confined to scientific and land management communities, however, it is possible to discern the following barriers:

(1) Data quality and biases

Data quality and biases in data are the most frequently cited reservation about the citizen science approach (e.g. Riesch & Potter 2014) and a large body of literature has built up around these issues and how to overcome them, particularly in relation to observational data (e.g. Tulloch et al. 2013, Isaac et al. 2014). In some cases this may also relate to the equipment used in citizen science projects; for example, the quality of data collected by low-cost sensors can be low (Sirbu et al. 2015). These issues mean that scientists, policy-makers and land managers can be mistrustful of data collected by non-professionals (Gollan et al. 2012, Kaartinen et al. 2013, Bird et al. 2014, Lucky et al. 2014, Fuccillo et al. 2015, Hyder 2015), and particularly by non-naturalist volunteers (Couvet & Prevot 2014). In a land-management context, for example, inaccurate data on habitat quality could result in further funding being spent unnecessarily, or habitat restoration being declared a success in error (Gollan et al. 2012). It should be noted that there is often a failure to recognise errors, biases and uncertainty in data collected by professional scientists (Bird et al. 2014).

Furthermore, concerns have been raised about the motivations of citizens and their potential biases which might influence their activity in citizen science projects (Nature 2015), without recognising that professional scientists also hold their own motivations and biases (Haklay 2015b).

(2) Peer review/mistrust

Mistrust of citizen science data also extends to peer-reviewers (Bahls 2015) which may in part explain why there are more citizen science projects than publications about citizen science (Gardiner et al. 2012) or why scientists may not advertise the origins of the data

included in publications (Theobald et al. 2015). Some scientists may, therefore, be reluctant to get involved in citizen science because they are unsure if their results will get published (Riesch & Potter 2014). Related to this is the concern that engaging with the public will detract from spending time on writing papers and acquiring grant income, i.e. the metrics by which academics are often judged (McKinley et al. 2013).

(3) Requirement of specialist equipment/knowledge

In some cases, the reason for not using a citizen science approach is that some scientific questions need to be answered using specialist equipment or analytical or data collection skills which require extensive training (Arvanitidis et al. 2011, McKinley et al. 2013, Danielsen et al. 2014, Hyder 2015), although some authors note that volunteers could still be involved, for example, in collecting samples (Mackechnie et al. 2011). For tasks that require regular and frequent input from participants, difficulties with recruitment and commitment of volunteers may be a barrier to achieving the initial scientific aims (Riesch & Potter 2014). Furthermore, inaccessibility of areas may be a barrier, for example, most people do not live near the coast which is problematic for engaging people in marine citizen science (Hyder 2015). In some cases, the scale of citizen science projects may be a barrier to using its data. For example, in the context of marine conservation, there are a lot of local projects which are not particularly useful for policy-making (Hyder 2015).

(4) Time consuming and resourcing issues

There may also be issues related to resourcing: efforts to mobilise and maintain large citizen science or community-based initiatives can be costly and time-consuming (Danielsen et al. 2014). In addition, there may also be concern about volunteers doing the jobs of professionals and the consequences of this for job opportunities or security of professionals (Ferster et al. 2013, Riesch & Potter 2014).

(5) Politics

Land managers have raised concerns that distributing data without professional interpretation of results may lead to unrealistic or poorly-informed demands by the public for particular actions (Ferster et al. 2013). Concerns have also been raised about liability; for example, in the context of wildfire management, could project organisers be held liable if volunteered assessments of wildfire risk led to the decision not to treat an area where a wildfire then occurred (Ferster et al. 2013)?

(6) Uncomfortable/unprepared to work with the public

Finally, it should be noted that some scientists may feel uncomfortable or unprepared for engaging with the public (McKinley et al. 2013, Varner 2014).

8.2 Barriers and challenges by stakeholder type

In what follows, we extend the barriers summarised above to incorporate additional barriers and/or challenges identified by other stakeholder groups (see Table 37 – containing examples and stakeholder quotes). We asked our interviewees to identify the challenges they faced in relation to participation in citizen science. Unsurprisingly new barriers emerged as a result of talking to policy and practice communities.

Table 37: Barriers and challenges to stakeholder participation in citizen science

Over-arching theme (* indicates newly identified)	**Barriers or challenges** (* indicates newly identified)	**Examples from stakeholder interviews**	Scientist/university	Scientist/monitoring	Scientist/policy	Scientist/education	Scientist/not using/data only	Policy/evidence	Practitioner/science/engagement	Practitioner/community	Practitioner/education
			Science					**Policy**	**Practice**		
Data quality and biases	Inadequate equipment (e.g. low quality sensors)										
	Mistrust data from non-professionals			■	■		■		■		
	Biases influencing decision to participate						■				
	* Scalability of data	Quality of data is not at a level for use on a wide scale				■					
	* Partnerships with local authorities	Local authorities can lack manpower to assist	■								
	* Patchiness of data	Statistical techniques available to even out patchiness	■				■				
	* Specific evidence need beyond the scope of citizen science	*"it wasn't our direct need, and with only, with low resources that wasn't our priority" (Scientist, monitoring, policy)*		■	■						

Peer review/mistrust	Peer reviewer reservations during publication process											
	* Citizen science frowned upon by colleagues	Scientist (university) told: *"should be doing proper science"*. Another explained: *"We as scientists are often a bit snobbish about our ability in comparison to other people's ability, and you see that in the response to citizen science from a lot of the policymaking community. Citizen science equals poor data, that's their starting point" (Scientist, monitoring, policy).*										
	*Institutional reservations about citizen science	Need to get board members on side										
Requirement of specialist equipment/knowledge	Training required	Scientist indicates specialist training is required due to challenges of identification: *"Gone are the days where you used to have a huge visible injury on vegetation has gone, because there's been acute exposure to everything." (Scientist, policy, monitoring)*										
	Difficulties of recruitment and commitment of volunteers	*"And then continued engagement, the enthusiasm barrier, because you get a drop off, an exponential drop off of participation as time goes on. So how do you keep the exponential drop off … as low as possible?" (Practitioner, science, engagement)*										
	Inaccessible sites	Linked to patchiness of data, *"It's difficult to tell people to go to a site that they think will be rubbish as well, I think if you want to see lots of dragonflies you go to a good dragonfly site rather than just anywhere" (Scientist, policy, monitoring)*										
	* Unable to keep up with technological developments	Once technology is in place, it must be maintained and updated										

	* Getting people to use technology	*"a survey that started off on paper, it's actually very hard to move people over" (Practitioner, science, engagement)*											
	* Crowded marketplace for citizen science projects in certain areas	Technology and online data options are flooding the market with similar citizen science projects											
Time consuming Resourcing issues	* Promoting citizen science	Launching apps requires time and resources for promotion and maintenance											
	* Communication	No time to explain key scientific ideas (e.g. recording absence is as important as presence)											
	* Slow process	Policy want answers yesterday											
	* Individual interactions	Individual requests for support are time-consuming											
	Mobilising and maintaining citizen science project	Time spent validating, verifying, selecting appropriate technology, calibrating sensors; lack of funding, short-termism of funding, unable to prove concept, no funding for essential technical development											
	Volunteers threaten job opportunities/security of professionals												
	Lack of interpretation may lead to poorly-informed public demands												
Politics	Liability of organisers if don't act on citizen data												
	* Unaware using citizen science data	Scientists often use published data sets unaware that they are citizen science data											
	* Nobody championing citizen science on high level	Projects should identify someone high level to champion their project institutionally											
	* Differing science and engagement objectives	*"you have to decide where you sit along the spectrum for the mass engagement versus data quality question" (Practitioner, science, engagement)*											

	* Activities require legislatory approval	Challenges when species become scientific instruments. Legislated by Home Office										
	Lack of interest in engaging the public through citizen science											
Uncomfortable/unprepared to work with the public	* Lack of attention to needs and expectations of the citizen science audience	Must understand demands on participant's time and project's requirements may differ										
* Unaware of audience	* Little acknowledge of different types of volunteer	Differing volunteer types, e.g. paper-based volunteer, don't want to lose them due to quality										
	* Need more volunteers	There aren't enough volunteers participating										
	* Survey design by committee, by professionals only	Too much discussion of small issues, but decision has to eventually be taken										
* Survey design and implementation issues	* Lack of clear research question	Avoid "*reverse engineering to a question"*, instead *"[be] led by a question" (Practitioner, science, engagement)*										
	* Survey is inaccessible	Participants must be able to understand questions										
	* Language barrier (scientific and linguistic)	Avoid over-complication										
	* Assumption that people have access to the internet and to a mobile phone	Not everyone has a mobile phone on a data plan, nor access to the internet										
	* Assumption that people are comfortable with technology	Technological literacy should never be assumed										
	* Over-reliance on web-based solutions	Web-based solutions can be exclusionary										
	* Designed a 'boring', yet scientifically important, survey	*"Well, it could be that it's a really … important square, and when you go there and count your … your butterflies, you might only, you might see none, you might see one. And that's a really boring day out" (Scientist, policy, monitoring)*										

Table 37 Barriers and challenges to stakeholder participation in citizen science

Table 37 highlights some interesting findings.

- Data quality and biases

Whilst the majority of our scientist respondents were already using citizen science, those who were not or were only using citizen data remained interested in questions of data quality. However, questions from users have progressed to consider how citizen data might be up-scaled and used in other ways. Scientists indicated some of the challenges of collaborating with local authorities on scientific endeavours and the challenges of lack of resource. In addition, a key barrier for those scientists working in government agencies is the need for data to answer very specific evidence needs, which fall beyond the scope of a citizen science approach. This barrier is also linked to requirement for specialist equipment and knowledge

- Peer review/mistrust

As indicated above, the issues identified by this study do not relate to data quality per se, and instead highlight how citizen science is perceived by colleagues and institutions. For example, citizen science has yet to be fully accepted as a scientific approach and it is often difficult to get senior management in institutions to buy into citizen science.

- Requirement of specialist equipment/knowledge

Training remains a concern for scientists, particularly as the issues being examined through citizen science increase in complexity. Scientists also appreciate the challenge of asking someone to visit a site only to identify that a species is absent. This category has, as a result of our study also been extended to include challenges relating to technology and keeping up to date, as well as encouraging participants to use online submission forms. Furthermore, as practitioners and scientists indicated, technology has enabled the increase in citizen science projects and there is now increasing amounts of competition in the marketplace for citizen science collected data.

- Time consuming

Citizen science is not free science (Pocock et al. 2014). It is time consuming and requires resourcing (discussed further below in point (5)). Scientists and policy respondents indicated the time demands when initiating and maintaining a project, the need for promotion of activities and communication of key scientific ideas, as well as the often slow process of data collection and analysis (a particular concern for policy/evidence respondents). Further calls on time stem from individual participants requesting one-to-one support from a scientist. Resourcing was identified by ALL respondents as a key barrier to mobilising and maintaining a citizen science project. Scientists were concerned about a lack of time and funding, particularly for maintaining the longevity of the project. Policy colleagues indicated the challenges around increased partnership working associated with reduced funding. Practitioners were particularly concerned with issues of funding for specific technical roles (e.g. website development), the need to prove the value of citizen science, and, in common with other respondents, the funding short-termism related to citizen science, and science projects in general.

- Politics

Interestingly, none of our stakeholders referred to ‘Lack of interpretation may lead to poorly-informed public demands’ or ‘Liability of organisers if don't act on citizen data’. However, in other sections of this report, it is acknowledged that these are important concerns to consider when a key benefit and motivation for citizen science is to increase public involvement with decision-making (see Chapter 6). Furthermore, this study has broadened the ‘politics’ discussed in relation to citizen science barriers. One scientist respondent working with citizen data, but not involved in citizen science per se, indicated that one challenge is that scientists often don’t realise that they are working with citizen science data, and suggested that more work could be done to raise the profile of such data. Furthermore, one practitioner indicated

that without buy in from senior colleagues, projects may not secure the funding they require, and another noted that projects must be clear on their aims and objectives: to collect data for science and/or to engage the public. Related to politics is the need in some instances for legislator approval from the Home Office to license the use of animals as scientific subjects in a citizen science project.

- Uncomfortable/unprepared to work with the public

None of our respondents have mentioned this as an issue, although several did indicate that currently their roles were not public-facing, and recognised there was more work to be done in this area.

- Unaware of audience

It was suggested by policy/evidence stakeholders and practitioners that there was often a lack of awareness of the audience for the citizen science project, i.e. stakeholders lacked information about the target audiences, including their motivations.

- Survey design and implementation issues

Practitioners we interviewed were very concerned about barriers and challenges surrounding survey design and implementation. Whilst partnership working and survey design by groups of stakeholders are increasingly common in citizen science, particularly as this lends strength to the end product, there can be much debate on what to include that can lead to delays in survey design. A number of respondents indicated the importance of a strong idea of what 'science' question the citizen science project was contributing to from the outset.

8.3 Change in barriers over time

As indicated in Chapter 3, we interviewed stakeholders who had been involved in citizen science for a range of time periods. Those more experienced stakeholders offered the following advice in response to some of the barriers/challenges identified in the literature, and how, what might have been barriers in the past, are not necessarily challenges now.

Data quality and data biases
Rather than relying upon known analytical approaches, stakeholders should consider alternative ways to use the data; if the way that the data has been collected is not ideal, there may be other ways to use it:

> *"Even if you could communicate that zeros are important, it still doesn't take away that fact that it's not very interesting for the volunteer. … there are statistical techniques that you can use to even out patchiness of recording" (Scientist, university, data only)*

Peer review/mistrust and politics
Issues relating to buy in from colleagues and respect for citizen science activities often involve being able to influence colleagues and institutional objectives. One practitioner who has been involved in a long-term citizen science initiative indicated:

> *"OK. I think it's really important that your project has a high profile internally and I think you have to keep plugging away at that. So whether there are key individuals that you realise you need to get on board, you need to invite them to a volunteer day, you need sit down with them and share some results, or if you've had a brilliant press moment, share that. So you can be strategic, you can pick off the few people that you feel really need to get it and invest time in them.*
>
> *There's also the broader brush approach, most organisations have internal communications, whether that's a staff email or a noticeboard or whatever, but just*

to keep plugging away. Every time you have a success or you find something interesting, make sure you share it. And, obviously, being a strong personal ambassador for that project in whatever way. So I think it's a drip feeding approach, just keep showing value. And, also, to use the language that that particular person will recognise is very, very important. So if you, if they are particularly inspired by resilience or, I don't know, media opportunities to see or email sign ups, whatever it is that inspires them, that's the language you need to talk in, I think. I've found that over the years." (Practitioner, science, engagement)

A scientist stakeholder indicated that universities were now very keen on citizen science as a result of the metrics used to measure research quality:

"For [our citizen science project], what really helped us was that it was held up … as an exemplar of research impact … if research impact is going to define 40% of your funding as a university and citizen science projects have got four star rankings then any university worth their salt I think will sit up and take note." (Scientist, university)

In one instance, a UK university has committed core funding to citizen science:

"Some of it of course does, we, we've been quite fortunate with [our university] in that they have, with the roles that started out as just funded, externally funded, the [university] has taken on all the core roles, and they've been incorporated into the different faculties and units where they're sitting, because … the projects are not just one faculty or one unit.[...]. So for example, a few years ago my role was made permanent and more centred.[...]our previous vice chancellor was very keen on [our activities], and I remember having to send updates to his office every month or every couple of months because he loved to pull this thing out … and when you have leaders at certain levels who take this on board, that helps, that will help." (Practitioner, education)

Chapter 9: Technology in citizen science

Chapter highlights
* Technology has transformed the potential of citizen science, making it possible to collect and analyse large quantities of data, and share that data
* Citizen science participants continue to use a range of online and traditional paper-based technologies
* Long-term participants can be slow to convert to online recording and data submission and stakeholders need to approach this with sensitivity, particularly as data quality is usually very high
* Stakeholders must not assume that all citizen scientists have access to technology or are familiar with how to use particular technologies
* Technology has the potential to increase the number of stakeholders involved in citizen science

9.1 The current place of technology

Over the last 20 years or more, technology has transformed the ways in which: (1) research, monitoring and surveillance has been conducted; (2) data are analysed; and most importantly, (3) data can be shared (Haklay 2015a). As one stakeholder noted: *"[our project] wouldn't have worked in 1980, it only works in 2016" (Practitioner, science, engagement).* This has had a profound effect on the rise of citizen science and partnership working between individuals, communities, agencies and other organisations, and the ability to work with members of the public in professional science projects, long-term monitoring and community-led science (Roy et al. 2012). There are many 'digital natives' who now live their lives via their devices, drawn to things that allow them to use their smartphone. People are receiving information about their geographic location and now want more information, and even want to contribute more. Digitization is not just an easier method to collect data, but also a significant motivator for encouraging people to engage (see also section 4.2 on motivations in online citizen science).

As a result, technological innovations have meant that citizen science and the associated activity of biological recording have moved away from the use of:

> *"a piece of paper on which you had a tiny column to fit something in, or going back to your computer and putting things into a relational database. No, it becomes a lot more user friendly, so [technology] makes a difference and it takes away the onerous part of getting data moving. … because we've got tech and because we've got cunning ways of analysing things, we can get more information than we ever thought we could from a wider group of people but also from a wider set of ways of gathering information" (Scientist, monitoring, policy).*

Furthermore there is an expectation by some members of the public, and stakeholder institutions, that technology will be integral to any citizen science project:

> *"I think that is the expectation that people have is that how they record is going to be … a lot more digital than it used to be. … I don't think interest in wildlife in, and nature in general is a barrier that we've really come up against, I think there's a huge amount of interest and people who like watching, even just the birds in their garden, the wildlife that they see around them. … I really don't think we've exploited everyone for data that we could do, … I don't think it's like, oh no … there's, no one else is interested in nature. I think there's a huge amount of people who are*

interested in nature and it's just finding ways of convincing those people that telling somebody about it, what they see and making it easy for them, is the challenge for us" (Practitioner, science, engagement).

Yet, it is important to remember that some of those long-term, expert volunteers are still only using traditional methods for data collection and submission, and it is important not to alienate them:

"There are still some people who have to use bits of paper because they just can't get on with technology, and we have to have support alongside to make sure that those key individuals, or motivated individuals, are still able to feedback without tech" (Scientist, monitoring, policy).

This has led many stakeholders to spend considerable time encouraging a digital switchover:

"*… you get people who are obviously completely computer literate, but because they'd started off recording on paper forms, it's all about habit forming isn't it? What people are used to doing they'll carry on doing, and a survey that starts off online is one thing, but then a survey that started off on paper, it's actually very hard to move people over. … so I did a lot of prodding people and saying, you're doing the [survey] online, why are you still doing [the survey] on paper, very nicely obviously, and it's very important that people don't get the impression that you're marginalising them or excluding them, because of the way they prefer to record. So it's very important for us on a lot of these surveys that we try and accommodate how people like to record, because if people think that you're not valuing them, or you're not valuing their data, then they get quite annoyed about it and could quite easily stop doing it, so it's, we find that taking a bit of a hard line on this tends to not work very well" (Practitioner, science, engagement).*

In what follows we outline some of the barriers and challenges surrounding technology.

9.2 Challenges surrounding technology

Whilst technology has been described as an important factor in the democratisation of knowledge and involvement of increasing numbers of people in science, stakeholders must proceed with caution: *"I don't think we'd be able to do half the stuff we're interested in doing without the internet or mobile phones and stuff like that, so I think it's really vital. We understand that this does exclude a proportion of the population from doing it but it's a very easy way of being able to engage with large numbers of people. So it's like a … bit of a balancing act between the two really isn't it?" (Scientist, monitoring, policy)*. Projects need to be clear on the appropriate technologies to use, their participant's ability to access those technologies and the associated technological abilities required to achieve a successful outcome (Roy et al. 2012). As one stakeholder respondent suggested: "*different people are comfortable less or more with different technologies in play*" (*Practitioner, community*). As a result, project leaders must not assume that all of their participants have access to technology or are comfortable with using it. One of our stakeholders gave this example of technologies in action:

"… we use the tools which are appropriate for the people that we're working with and the overarching objective of what people are trying to achieve here. So just using air quality as an example, the tools to be able to collect data and the methodology, we have it on pen and paper, people can write it down, they've got a survey sheet, but we've also built a mobile application so that people can do it digitally and it streamlines the process a little bit more if they have that technology and they're comfortable with using it. The data, in terms of mapping it, we've got an

online interactive mapping system whereby communities can put their results on the map, but in the same token we will also use a more traditional GIS and we will map the data on behalf of communities if, again, they don't feel that they have the capacity or ability to do that themselves. So it's really thinking about, OK, what is suitable for a specific community in a specific context, what, do we need the pen and paper, do, are we, is it OK to just use mobile application devices? What, yeah, what works in a, in one case will not necessarily work in another, and in some cases you may use a whole arsenal, a whole suite of different technologies to be able to deliver something meaningful" (Practitioner, community).

This respondent works with many communities in the UK and beyond, and raised several issues that were *not* considered by any of our other stakeholder participants. Importantly, stakeholders should not assume that their participants:

(1) have access to the internet;
(2) have time (e.g. working full-time, single parent);
(3) are able to follow strict data collection protocols;
(4) have access to a mobile phone data plan; and
(5) will be comfortable with web-based solutions.

The following excerpt from our interview brings these points home:

"Well I mean there are always going to be barriers, and it depends on what tools you're using as part of the process, but if we're sending call outs via Twitter and email and our website, you're already assuming that somebody has access to the internet, that they're digitally literate, and so forth. So you've already lost a segment of the population just in the nature of which, and then you also take things into consideration like time. Certain demographics have more time than others. I'm a mother of two but if I'm a mother of three and I have two jobs and what have you, I really don't have the time, or maybe even the inclination to get involved in these kind of things because I'm far too busy chasing my tail and just trying to survive. And that's where I think some of the citizen science, bigger citizen science programmes are really exclusive because the level of, so time, when I say time it's, some of the protocols, data collection protocols are really quite rigorous, and I think a project that I was involved in when we were trying to collect noise readings and really get space time coverage would require people to go out and commit how much time to actually following this rigorous protocol to make sure that there's measurements taken in every grid at these different times of the day. So you're assuming already that people have time. Then you're assuming that people have a mobile phone data plan whereby they've got unlimited data so they can upload and download, and all of these types of things. Then you start to lose people. If … I've got a Pay As You Go then I'm not going to be using my Pay As You Go credit to be taking readings and things like that using my mobile phone. So I think, yes, there are barriers. We try, we're not perfect but we tried to keep things as simple as possible so that they can be inclusive, and we don't require, we don't rely solely on web based solutions so that there is still the face to face, paper, pen, pencil ways in which people can get involved" (Practitioner, community).

9.3 Technologies currently used by stakeholders

In addition to the technologies involved in communication and feedback, such as websites and email, the following technologies were identified in our stakeholder interviews:

Method		Benefits and challenges
Traditional	Pen and Paper (e.g. printed booklets, laminated sheets)	Low barrier to entry
		Free post cost
Technological	GIS Mapping	Geographical precision
	Data Analysis Programmes (data sharing too)	Sophisticated analysis and tailored feedback
	Apps	Identification guide, GPS device, description, photos
		Development time can be expensive
		Speed of data submission
		Easier data collection (e.g. broad scale data across UK, particularly from rural areas often unmonitored)
		Photographs to allow for improved verification
	Online data submission	Quick, interactive, participants own their data, understand it more, why you are asking particular questions
	Sensors	Facilitates wider public involvement regardless of specialist expertise (see air quality case study below

Table 38 Technologies, benefits and challenges for stakeholders

9.4 The rise of sensors: an air quality case study

Our stakeholder interviews with those representing science, policy and practice relating to air quality identified the availability of low cost sensors as an important area in which the potential of technology was growing. One practitioner commented:

> *"the technology is advancing with regards to sensor networks, wireless networks and low cost sensors and devices to enable more people to participate in these kind of monitoring exercises, but there is still limitations with regards to the accuracy of some of these devices" (Practitioner, community).*

Whilst some projects have adopted sensor networks, these are still in the minority and the cost of sensors remains prohibitive for many citizen science initiatives. However, one scientist working in air quality monitoring and policy explained, the benefits go beyond data quality:

> *"there's a lot more low cost sensors, or the technology for low cost sensors is improving. So I think there's a huge potential, that there's this public awareness and concern about air quality, and the technology is such that there could be more monitoring and other opportunities for citizen science in the field of air quality. Not just, you could just think we'll be much more au fait with this, but there's the benefits that could bring by getting people involved and more aware. The crossover to ecosystems and, and maybe it's a slightly different story in terms of biodiversity impacts and human health impacts, you've got slightly different exposure routes, etc, but nevertheless if they give us a general awareness of pollution, it will drive policy in the right directions for both human health and biodiversity" (Scientist, data only).*

Furthermore, the same participant, who uses citizen collected data, but is not involved in citizen science projects, suggested technology might be one way in which stakeholders may become more involved:

> *"I think it's actually in terms of kind of technology increasing, and low cost sensors and things and getting better, well as they develop there's an opportunity for a better understanding of the spatial patterns of pollution exposure. And that's always useful because we rely on currently quite expensive monitoring done on just a few, relatively few sites across the UK, and haven't got anything in between, so anything that can help with that would be good. ... Yeah, so that's kind of the exposure side of it, and then we're interested in the impacts. The trouble we face is that you can use indicators such as lichens, and hence the example we've already discussed, but the impacts are fairly, they're chronic and they're not terribly easy to spot. Gone are the days where you used to have a huge visible injury on vegetation has gone, because there's been acute exposure to everything. So there's quite a subtle shift, which was really hard for even experts to go out and say yeah, that's nitrogen causing that change on that site. So that limits what we can do with citizen science, or even sort of staff within the agencies in terms of interpreting changes and what's driving them, that's down to big physical exercises. Which then you go back to looking at vegetation data more broadly, not necessarily gathered for nitrogen deposition impact assessment, but can be useful, and that goes back to what we were just talking about before where we used their surveillance data" (Scientist, data only).*

For a detailed review of technology available for citizen science, please read this section in conjunction with Roy et al.'s 2012 report, where they highlight methods for data collection, visualisation, data management, crowd-sourcing, and virtual communities.

Chapter 10: Evaluation of citizen science

Chapter highlights
Monitoring and evaluation are vital parts of project management as they help to ensure the project is meeting its goals, the needs of participants and the funder's requirements
Stakeholders recognise that evaluation is necessary and useful to improve the project and understand its impact
Evaluation can relate to data and scientific outcomes, data collection processes, and successful citizen scientist participation
Barriers to evaluation relate to resourcing, with evaluation and monitoring becoming desirable rather than essential aspects of any citizen science project
Some stakeholders felt evaluation might bombard participants
Common methods include: surveys; training activities; project team meetings
There is a focus on 'outputs' and 'reaction' based evaluation and less on 'outcomes and impact' or 'learning, behaviour and results'

In this chapter, we discuss the purpose and value of evaluation and monitoring to the management of successful citizen science projects. As suggested in our desk-based study and our online survey with citizen scientists and environmental volunteers, feedback and communication are regarded as integral to the success of any project, particularly in terms of encouraging continued participation and a good volunteer experience (Chapter 5). Furthermore, our review of the literature surrounding stakeholder motivations indicated that we need greater understanding of how scientists think the aims, motivations and benefits of their projects can be achieved and evaluated.

Based upon our literature review and stakeholder interviews, successes in terms of data quality appear to be tested much more frequently than aims related to participants. While many projects claim they have aims beyond science, such as education, increasing scientific literacy and encouraging behaviour change, they do not appear to be doing anything active within the project to meet these objectives or test whether these aims have been met. As highlighted by Shirk et al. (2012), this needs to be an active not passive process for which a deliberative design and intentional opportunities to learn and reflect are needed. A common evaluation framework for citizen science projects could assist with encouraging people to think about this when designing projects.

In what follows, we first discuss some of the key principles of evaluation. In order to highlight the varying and inconsistent uptake of evaluation, we move to the findings of our stakeholder interviews relating to the question: "How do you evaluate the impact of your projects?" We conclude with resources for stakeholders to access around evaluation good practice and our model derived from the evidence in this report for the stage-by-stage inclusion of motivations and evaluation

10.1 Existing work on evaluation and monitoring

Monitoring and evaluation are vital parts of project management as they help to ensure the project is meeting its goals, the needs of participants and the funder's requirements. *Evaluation* offers a way of assessing the value of activities in terms of their outcomes or impacts. It involves collecting information about the activities, characteristics and outcomes of a project in order to judge its worth, improve its effectiveness and/or inform decisions about the future (Patton 2002). There are other definitions of evaluation, but they all tend to emphasise that the primary purpose of evaluation is to improve and inform practice (Clarke

1999). Allied to evaluation is *monitoring*, which involves collecting numerical data about, for example, the numbers, ages and genders of people taking part in activities (RCUK 2005). Much of this data tends to be collected as part of daily administration (Easton 1996), and can include records of numbers of people attending events, downloading materials, and so on. These numbers are sometimes divided into active beneficiaries (e.g. those who request information, attend events or participate in the project), and passive beneficiaries (e.g. those who attend an event and pick up a leaflet which describes the project, or who listen to a radio programme, or visit a website).

There are two main types of evaluation – formative and summative. Formative evaluation is that which is carried out during the lifetime of the project in order to provide information about how to improve it (Patton 2002), whilst summative evaluation is conducted at the end of the project to help assess whether the project has been successful or not (National STEM Centre 2009).

Projects can be evaluated in many different ways, but outcome-based approaches are particularly popular, and funders often encourage recipients to use an outcome-based approach to evaluation (Ellis and Gregory 2008). Outcomes can be defined as changes that occur as a result of the project, and it can be helpful to use a 'logic model' to think about what these changes might be. This is where the evaluator defines the inputs (resources), activities, outputs and outcomes of programmes, and then quantifies these different elements (Easton 1996).

An example of a completed logic model is shown in Figure 5 (see also Shirk et al. 2012 for logic models within citizen science). Outputs are the immediate results, such as numbers attending. Outcomes are the short to medium term changes that occur as a result of the programme, whilst impact can be defined as the vision: the hoped for change that takes place over a longer term (Patton 2002). Thinking about project outcomes is a vital first step for any project evaluation, and can also be used when designing projects (Shirk et al. 2012).

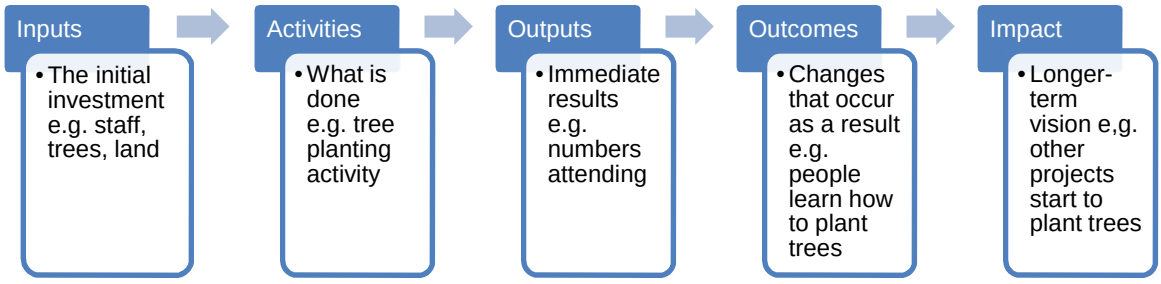

Figure 5 Logic model of evaluation, using example of tree planting (from West 2014)

The programme's success can be measured through one or more of the Outputs, Outcomes and Impact components. Once project staff have decided what outcomes they expect to achieve through their project, then methods can be designed to measure them. Outcomes occur over different timescales, and evaluating these requires different approaches. The Kirkpatrick evaluation model, which is commonly used in business and industry training settings, categorises evaluation into one of four levels; Reaction, Learning, Behaviour and Results evaluation, with each level giving increasingly detailed data about the impact of programmes on participants that is more time consuming to collect (see Figure 6). *Reaction* evaluation looks at participants' initial responses to participation, *Learning* evaluation looks at changes in understanding or awareness, *Behaviour* evaluation considers whether people modify what they do after participation, and *Results* evaluation tracks long-term impacts on measurable outcomes (Kirkpatrick 1996, RCUK 2005). All projects should conduct Reaction

evaluation (to find out whether the participants enjoyed themselves and how the experience could have been improved), and ideally some Learning evaluation (to find out what participants have learnt), but Behaviour and Results evaluation are often too time consuming for small projects to conduct and can require external expertise (RCUK 2005).

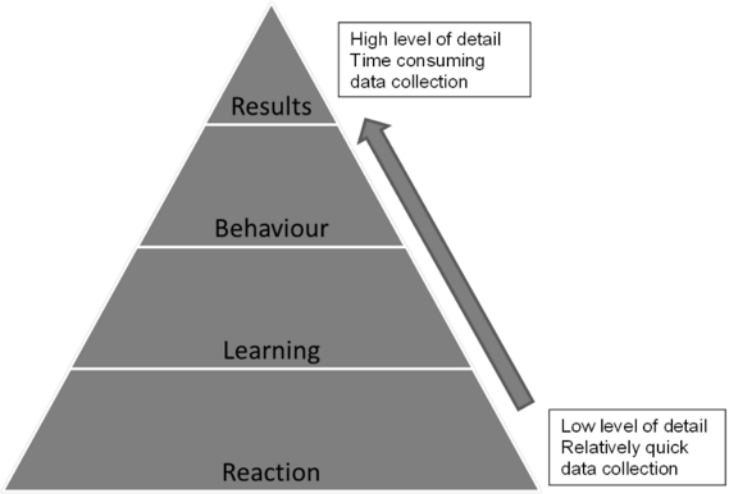

Figure 6 Kirkpatrick model of evaluation (from West 2014)

Practitioners and participants in projects may have different interpretations of the outcomes that occur from projects (West 2015). This is important because mismatches between the expectations of the participants and the objectives of project staff or the reality of the role can contribute to high turnovers of volunteers (Measham and Barnett 2007). This highlights the importance of discussing expectations and goals with participants where possible.

10.2 Current status of stakeholder evaluation activities

We asked all stakeholder interviewees involved in citizen science projects, whether they evaluate their activities. This evaluation related to:

- data and scientific outcomes: *"the formal means of assessing a citizen science project is whether you can accept or reject your null hypothesis" (Scientist policy, monitoring);*
- data collection process: "*start with a user group … and then focus groups in the definition of the approach and the project objectives and as well during the project to see if we are … on target and after the project to actually do the wash up and lessons learned of what has worked, what hasn't worked as well in looking at … what future projects would [do]" (Scientist, university);*
- citizen participation: *"feedback from the volunteers" (Policy, evidence), "Motivation and how it is for the individuals" (Science, policy), "what they like, did they enjoy participating, was it easy, did they enjoy the feedback" (Practitioner, science, engagement)*

Returning to the evaluation models identified in our literature review in section 10.1, the stakeholders we interviewed described a focus on evaluating outputs over outcomes and impact, and on reaction rather than learning, behaviour or results. The stakeholders were more familiar with evaluating the scientific outcomes of the citizen science project than the experience of their participants, with the following methods being identified:

Surveys: online, paper questionnaires, ad hoc and formal	*"We do send out surveys from time to time. We've done one quite recently on the paper newsletter, what we send people, is it what you want? Are you telling us, are we telling you what you're interested in? We also ask questions like, what motivated you to start? What motivates you to continue? Those kind of questions."* (*Practitioner, science, engagement*)
Training activities: through training or in their words 'checking' the science	*"So are people identifying their species correctly? Are they doing the protocol in the way that they have been asked to, and continue development of that? … There's also checking that people are going where they're saying they're going at the time that they're going. And you can only do that by asking and you can only do that by, another way would be to look for anomalies, so when you analyse the data, if something's an outlier, you want to know why. So our partners will then often phone people up and say, or communicate with them in some way and just say, well, could you just talk me through what you were doing there? You don't say, you've got it wrong, but just try to understand why somebody's different from the majority of other people around them. There are various ways of just checking up on the quality of what's coming through."* (*Scientist, policy, monitoring*)
Other Evaluation and monitoring	online surveys (ad hoc and regularly); feedback forms; behavioural change based upon project-specific questionnaires; training activities; twitter statistics; talking to colleagues and reminding each other of the aims and objectives, refining our priorities, sharing what's successful; learning evaluation and legacies of participation

Table 39 Current modes of citizen scientist evaluation used by projects

Yet, our interviews revealed that whilst evaluation is regarded as important to the success of citizen science projects, it is rarely undertaken with participants:

- *"We don't do any formal evaluation … to be honest it tends to be in my head" (Practitioner, science, engagement);*
- *"[I] have done evaluation on a couple of projects that we've undertaken but I am really bad at doing evaluation, and it's something that I need to do more" (Practitioner, community);*
- *"This is something that we're trying to sort of improve the process of because I think a lot of public engagement is done on quantitative metrics. So bums on seats as it were. How many people have been processed?" (Practitioner, science, engagement);*
- *"But as an organisation whose primary aim is to provide evidence to support policy and management what we've judged our projects on is whether they've actually delivered datasets that can be of use" (Scientist, policy, monitoring);* and
- *"I would say it's probably the weakest bit of what we've done so far" (Scientist, monitoring, policy).*

Several challenges relating to resourcing, time, and inclination were identified, as well as a focus on what Kirkpatrick describes as 'reaction' evaluation:

1. *More confident dealing with data than people*: several respondents suggested that they felt more comfortable evaluating the success of the science element of citizen science *("obviously we evaluate data that comes in" (Practitioner, science, engagement)*) rather than evaluating the volunteer experience. As a result, the evaluation may lie with other project partners and/or non-scientists. One scientist/policymaker respondent talked about a project they were partnered on: "*For them it was difficult, as it is for us, because we're not social scientists, so we have to think of how the best way is to ask that. So my only way I was able to help them at that stage was to say, go and ask [our organisation] because they're big and they know what they're doing, and they've done it before. So I know that [our*

organisation] have done it several times. … So it's something that we're aware of but also aware that we're not the experts" (*Scientist, policy, monitoring*).

2. *Responsibility for evaluation:* not all respondents were sure whether evaluation had taken place on their projects, indicating that this may be a role assigned to a particular individual and that not all team members are involved in or privy to evaluation information. Another respondent highlighted how they knew they needed to do evaluation, but it wasn't always at the top of their priority list (see also quotes above).

3. *Timing of the evaluation:* several respondents indicated that evaluation had taken place but only at the end of the trial phase, with no further formal evaluation of the project. One policy respondent indicated evaluation is critical at the pilot phase, for example *"do you have a sufficient number of volunteers to give you a sample size that gives you a robust trend at whatever level you want to do?"* (*Scientist, policy*), but evaluation is often overlooked due to funding/resource constraints once the project is live.

4. *Funding availability:* The above example was also linked to the funding availability as once a project is operational it has to be '*self-sufficient*' (*Scientist, policy*). A practitioner about to launch a citizen science project highlighted how at the current stage *"the survey evaluation is not actually something that we've given much thought to at this stage"* (*Practitioner, science, engagement*), yet as the literature in the next section reveals, evaluation must be considered at all stages of the project. Time and money are key barriers to evaluation: *"… evaluation takes time and money, if you're going to do it properly, and if you're doing a research project you design evaluation, in your funding application you have a whole work package on evaluation, and you'll have people that are contributing to that work package and you've got a sum of money or resources designated for that. We are very much a small organisation, almost running hand to mouth in a sense, so we don't always have the luxury of having, well we never have the luxury of having the finances or the resources to really undertake evaluation seriously. So I have done it where we've been commissioned for a couple of bits of work, I have, and not in any depth but started with an opening questionnaire with the participants and then one at the end just to look at the distance travelled and see what's changed through their involvement. But yeah, we're really bad at not really doing it, and it's just, yeah."* (*Practitioner, community*)

5. *Information overload for participants:* As mentioned in the section of communication and feedback, it was suggested by the stakeholders we interviewed that evaluation might overload the participants. Some stakeholders make the conscious decision not to bombard participants, particularly when other aspects such as training often have to take a higher priority in the volunteers' time: *"when people signed up we said that we would only send them a maximum number of emails because of, we were just aware that we didn't want to continually bombard people. But partly just through some anecdotal evidence that people just feel, like in the same way that when we were doing our engagement work in the shopping centres, people just thought we were chuggers, they thought we were trying to sell them something, and I think that that's, there's almost a scepticism when you get an email from us in your inbox, so what do they want now? (Scientist, education)*

10.3 Support for evaluation

There are several guides available to help with project evaluation.

- *Guide to Citizen Science: developing, implementing and evaluating citizen science to study biodiversity and the environment in the UK* – research leading the new and existing practitioner through the project development and delivery by Tweddle et al. (2012). A copy of the guide is available from www.ukeof.org.uk.
- *User's Guide for Evaluating Learning Outcomes from Citizen Science* – Cornell Lab of Ornithology have created a guide specifically for citizen science projects. Phillips et al.'s guide (2014) is useful for designing and conducting evaluations, with examples of best practice.
- Guides that have been produced for public engagement more widely may also be helpful for those wanting to evaluate citizen science projects: RCUK (2005): "*Evaluation: practical guidelines*", produced by the Research Councils UK was designed for researchers wanting to evaluate public engagement, but gives helpful insight into some of the key terminology around evaluation and gives practical tips for evaluation.
- The National Co-ordinating Centre for Public Engagement also has some useful web pages designed to help researchers evaluate their public engagement activities, with a brief introduction to developing an evaluation plan http://www.publicengagement.ac.uk/plan-it/evaluating-public-engagement

10.4 Our design for evaluation

Based upon the literature and our stakeholder interview findings, we have designed the following stage-by-stage guide for the inclusion of evaluation in any citizen science project. Evaluation begins pre-project and informs all stages of the process through feedback, improvements and formative and summative evaluation.

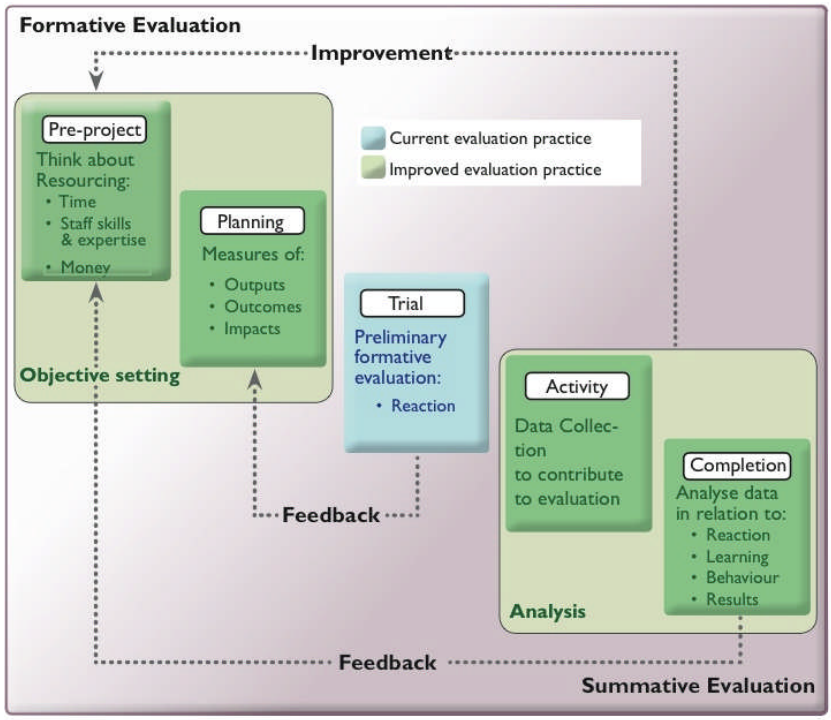

Figure 7 Stage-by-stage inclusion of evaluation

Chapter 11: Conclusion

Citizen science plays an important role in delivering environmental data at local and national scales, and can form the basis of scientific research, as well as evidence for policy and management. Citizen science is also an important way of connecting people with nature, and has been used to help organisations communicate the importance of their work in the area of nature conservation. This study was designed to explore the motivations of environmental-based citizen science participants and stakeholders from 'science', 'policy' and 'practice' communities. We have outlined here the motivations, benefits and barriers surrounding citizen science for these groups, as well as discussed the evolving nature of the term citizen science and the increasing role of technology in data collection, analysis and communication. Our research also revealed the centrality of feedback and communication to successful citizen science, particularly as a key motivator for citizen scientists and environmental volunteers, and the associated importance of evaluation and monitoring. In this chapter we draw out the key findings of our study, and offer our recommendations and proposals for further work in this area.

11.1 Key findings

Our research reveals:

1. Citizen science does not have 'one' definition for all stakeholders, as a result the term has been used by stakeholders in a range of different ways to meet the different needs of many different projects. For example the term citizen science may be used by organisations externally to brand their recording activities, but the activities themselves remain firmly within the category of traditional biological recording with the involvement of 'amateurs'.

2. Citizen science and biological recording are intimately linked through the activities participants are asked to undertake and the subtle shifts in how projects are branded (as suggested above). As a result participants do not always associate their involvement to a particular subject area, instead being drawn to a particular species or set of activities. Stakeholders are aware of this difficulty, but acknowledge this allows them to access a range of audiences.

3. Policy priority areas, such as pollination, air quality, weather & climate change and tree health, were not as visible to citizen science participants as initially predicted. Citizen scientists preferred to identify with particular species, for example butterflies, moths and birds.

4. Motivations must be understood in order to successfully recruit volunteers and maintain the projects in question. Altruistic motivations were dominant in our survey of both citizen science and environmental volunteering participants, specifically 'to help wildlife in general' and 'to contribute to scientific knowledge'.

5. 'Sharing enthusiasm' and 'enjoyment' were identified as additional motivations in the 'other' category by citizen science and environmental volunteering respondents. The open-ended answers provided by survey respondents revealed the importance of emotion and emotional attachments as intrinsic motivations towards initial and continued participation.

6. Environmental volunteers shared the same primary motivations as citizen science participants suggesting that citizen science projects may appeal to many environmental volunteers. Although it must be acknowledged that our study revealed considerable overlap between the projects represented in our survey by those who self-identified as

doing citizen science and those doing environmental volunteering. Thereby reinforcing the difficulties surrounding the use of the term.

7. Only 1 in 4 of our citizen science respondents felt their motivations had changed over time, with the figure being 1 in 5 for environmental volunteering respondents. However, of those that did feel their motivations had changed they revealed that knowing they were making a contribution to scientific knowledge, sharing their knowledge and a stronger concern for conservation were important. This finding was linked to a movement from passive to more active roles, including leading projects and testing protocols.

8. Dispositional and organisational variables remain integral to the continued participation of volunteers in citizen science. Of those who answered the question regarding motivations and satisfaction, only two volunteers were dissatisfied, however this did not dissuade their continued participation, in fact they remained encouraged to do more. People hold competing and contradictory views, highlighting the complexity of the social world and people's involvement in citizen science.

9. Feedback and communication are vital to both citizen science and environmental volunteering respondents. Feedback was the single-most cited reason for remaining involved in a citizen science project, followed by the linked reason of knowing their participation had made an impact or contribution.

10. Environmental volunteers want to do more volunteering. However, our survey identified a number of barriers to participation, namely: over-committed already; lack of time; advancing age; bureaucracy; family; knowledge; inclination; health; job; and the weather.

11. Stakeholders readily acknowledged the importance of feedback and communication to continued participation. The majority of our interviewees did offer feedback. However, some stakeholders identified the associated time commitment and resourcing issues as potential barriers to successful, reliable, and regular communication.

12. Experienced practitioners in citizen science suggested that feedback and communication must be immediate, specific to the locale or individual, interpretable, and offer online and offline options.

13. Stakeholders wear a number of different hats, ranging from institutional roles involving funding, using, running, facilitating, and advocating citizen science, to personal commitments to individual projects and volunteering in their spare time. Stakeholders represent a diversity of policy priorities, engagement activities, managerial responsibilities and personal passions for the inclusion of civil society in science and decision-making.

14. Personal experiences of citizen science, biological recording and environmental volunteering influence stakeholder involvement in citizen science. Stakeholders from science, policy and practice communities are also citizens and many are citizen scientists – volunteering, recording, and contributing data in their spare time. Their participation in such activities gives some of them a purpose in their professional lives and a commitment to valuing the activities of the citizen scientist and amateur naturalist.

15. Stakeholder motivations matched those identified in the existing literature on scientist motivations for citizen science involvement. However, our research revealed a shift in the stakeholder motivations being identified as citizen science has become more widely-accepted. The motivational range has expanded to incorporate those ways in which participants might benefit from citizen science, and not just about collecting data. As a result, a new motivational area has emerged, namely the category of personal satisfaction.

16. Stakeholders identified changes in their institutional and personal motivations for citizen science over time, involving increases in: institutional commitment to citizen science; technology; bottom up approaches; public engagement; media reports; and sophistication of activities.

17. Our research revealed that recognition by stakeholders of the motivations of participants and incorporating this into the design of projects can increase participation. However, different motivations needed to be met depending on whether the citizen science project was contributory, collaborative or co-designed.

18. Existing literature largely focuses on the barriers affecting scientists and their involvement in citizen science. Our research incorporated barriers and challenges affecting those in science, policy and practice.

19. Interviews revealed 'mobilising and maintaining citizen science projects' (related to funding and time) as a common barrier across stakeholder groups. However, distinctions can be drawn between science and policy/evidence stakeholder barriers around data quality and biases and practitioner barriers relating to survey design and over reliance on technology. Whilst many barriers and challenges were identified, so were solutions.

20. Technology has transformed the potential of citizen science. Whilst increasing numbers of current and potential citizen science participants are driven by technology, stakeholders need to acknowledge that not all participants will have the same level of access to technology or knowledge about how to use it.

21. Technology has the potential to increase the numbers of stakeholders involved in citizen science.

22. Evaluation and monitoring were identified in the literature and in our stakeholder interviews as integral to the success of any citizen science initiative, whether the focus is on data quality, data collection or participant motivations. However, stakeholders in all groups identified resourcing issues as a barrier to evaluation, making it desirable rather than essential to their project.

23. Stakeholders described a focus on evaluating outputs over outcomes and impact, and on reaction rather than learning, behaviour or results. Stakeholders were more familiar with evaluating the scientific outcomes of the citizen science project than the experience of their participants.

11.2 Recommendations

Based upon our study, we recommend:

- Stakeholders maintain their links with, learn from, and share their good practice with other national, European and global citizen science networks;
- Stakeholders should raise the profile of traditional recording/amateur naturalist communities in their citizen science initiatives, and where necessary celebrate the distinction between biological recorders and citizen scientists;
- Stakeholders need to consider how their citizen science projects can move from contributory to collaborative and co-designed projects, to enhance the participant experience;
- Stakeholders without access to academic journals need to keep up to date with the academic literature. In particular, we are thinking about the work of social scientists and the principles they apply to understanding the world. Other resources of this

nature include conference programmes and websites containing research links. Umbrella organisations might be able to collate this data.

- Project websites are not using citizen science language. Organisations need to reflect on whether they are branding their citizen science projects as citizen science internally and/or externally, and whether some potential participants hold negative connotations around the term and would prefer biological recorders. Stakeholders need to be clear on the language they are using, specifically when and where.
- Stakeholders should approach existing environmental volunteering projects that may have links with a particular location, species or activity to help widen the audience for citizen science participation.
- Feedback and communication are vital to successful citizen science. Stakeholders should refer to our quick-list (Table 32) on what encourages and discourages participation in citizen science.
- Projects should involve an element of critical self-reflection to understand the competing stakeholder motivations around personal satisfaction and the project aims and objectives. Stakeholders exhibited varying levels of: enjoying their work; personal commitment/enthusiasm; equity and self-determination for participation; fulfilling career objectives, ambitions, building on previous education; generating impact for people's lives; working with unpaid experts and harnessing their enthusiasm for science.
- Stakeholders must consider the motivations of their participants, and the motivations of other stakeholders engaged in the project.
- More work is required to develop a hub for resources on what works and what does not in citizen science. The UKEOF's *Understanding Citizen Science and Environmental Monitoring* should be recommended for troubleshooting problems in the first instance (Tweddle et al. 2012, Roy et al. 2012).
- Social science research and evaluation is vital to the development of successful citizen science initiatives. However, some stakeholders and citizen science participants feel bombarded with surveys and interviews. Stakeholders interested in using these methodologies need to carefully plan and structure their activities to avoid overwhelming respondents.

11.3 Proposed further work

(1) Evaluation

Our research revealed the need for further work to support projects to implement evaluation, particularly beyond a focus on outputs. We recommend a series of one-day training workshops to draw on existing activities and the experience of practitioners from other fields, such as public engagement.

(2) Longitudinal study of citizen science participants

The open-ended answers to our online survey revealed the commitment many citizen science participants have to their activities, however, it missed out the details of what it is really like to participate in a citizen science project (whether contributory, collaborative or co-designed). Our telephone interviews with stakeholders revealed the richness of an ethnographic approach. As we have learnt volunteer motivations change over time and that people hold different motivations – therefore the need for longitudinal studies and extensive evaluation (see chapter 10) is vital. It is not our suggestion that UKEOF seek to fund this, but that stakeholders collaborate with social scientists to seek funding for this activity. This is particularly important for impact, practice, science and policy, as well as identifying future generations of potential citizen science and biological recording communities.

(3) Contributory, collaborative or co-designed

The respondents to the online study had largely taken part in contributory citizen science projects. As citizen science takes an increasingly participatory turn, it is important to focus to

a greater extent on the motivations of participants in projects that have been co-designed and co-evolved with their participants.

(4) Global environmental challenges and data needs

Whilst it was not a key aim of our research, the literature revealed a need to understand how motivations differ in/between developed and developing nations. The potential for using citizen science in developing countries has received little attention. However, understanding and overcoming the challenges of doing citizen science in these different cultural contexts is important because these countries tend to be characterised by high biodiversity which is likely to be threatened by economic transition or environmental change and where financial resources are lacking to conduct large-scale monitoring (Loos et al. 2015).

Bibliography

Agyeman, J. and P. Spooner. 1997. Ethnicity and the rural environment. In: Cloke, P. and Little, J. Contested Countryside Cultures. London, UK: Routledge. pp. 197-217.

Anderson, J. A., and A. B. Alford. 2014. Ghost fishing activity in derelict blue crab traps in Louisiana. Marine Pollution Bulletin 79:261-267.

Arvanitidis, C., S. Faulwetter, G. Chatzigeorgiou, L. Penev, O. Banki, T. Dailianis, E. Pafilis, M. Kouratoras, E. Chatzinikolaou, L. Fanini, A. Vasileiadou, C. Pavloudi, P. Vavilis, P. Koulouri, and C. Dounas. 2011. Engaging the broader community in biodiversity research: the concept of the COMBER pilot project for divers in ViBRANT. Zookeys:211-229.

Asah, S. T., M. M. Lenentine, and D. J. Blahna. 2014. Benefits of urban landscape eco-volunteerism: Mixed methods segmentation analysis and implications for volunteer retention. Landscape and Urban Planning 123:108–113.

Azavea, and SciStarter. 2014. Citizen Science Data Factory. A distributed data collection platform for citizen science. Part 1: Data Collection Platform Evaluation. Azavea and SciStarter. Retrieved from www.azavea.com/index.php/download_file/view/1368/

Bahls, L. L. 2015. The role of amateurs in modern diatom research. Diatom Research 30:209-210.

Bell, S., M. Marzano, J. Cent, H. Kobierska, D. Podjed, D. Vandzinskaite, H. Reinert, A. Armaitiene, M. Grodzińska-Jurczak, and R. Muršič. 2008. What Counts? Volunteers and their organisations in the recording and monitoring of biodiversity. Biodiversity and Conservation 17:3443–3454.

Bird, T. J., A. E. Bates, J. S. Lefcheck, N. A. Hill, R. J. Thomson, G. J. Edgar, R. D. Stuart-Smith, S. Wotherspoon, M. Krkosek, J. F. Stuart-Smith, G. T. Pecl, N. Barrett, and S. Frusher. 2014. Statistical solutions for error and bias in global citizen science datasets. Biological Conservation 173:144-154.

Bone, J., M. Archer, D. Barraclough, P. Eggleton, D. Flight, M. Head, D. T. Jones, C. Scheib, and N. Voulvoulis. 2012. Public Participation in Soil Surveys: Lessons from a Pilot Study in England. Environmental Science & Technology 46:3687-3696.

Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J. and C.C. Wilderman. 2009. Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education. A CAISE Inquiry Group Report. Online Submission.

Bonney, R., C. B. Cooper, J. Dickinson, S. Kelling, T. Phillips, K. V. Rosenberg, and J. Shirk. 2009. Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy. Bioscience 59:977-984.

Bonney, R., T. B. Phillips, H. L. Ballard, and J.W. Enck. 2015. Can citizen science enhance public understanding of science? Public Understanding of Science.

Braschler, B. 2009. Successfully Implementing a Citizen-Scientist Approach to Insect Monitoring in a Resource-poor Country. Bioscience 59:103-104.

Brossard, D., Lewenstein, B. and R. Bonney 2005. Scientific knowledge and attitude change: The impact of a citizen science project. International Journal of Science Education, 27:1099-1121.

Bruyere, B. and S. Rappe. 2007. Identifying the motivations of environmental volunteers. Journal of Environmental Planning and Management 50:503-516.

Casanovas, P., H. J. Lynch, and W. F. Fagan. 2014. Using citizen science to estimate lichen diversity. Biological Conservation 171:1-8.

Clarke, A. 1999. Evaluation Research: An Introduction to Principles, Methods and Practice. London: Sage.

Clary, E. G., and M. Snyder. 1999. The motivations to volunteer: Theoretical and practical considerations. Current Directions in Psychological Science 8:156-159.

Cooper, C. B., and J. A. Smith. 2010. Gender Patterns in Bird-related Recreation in the USA and UK. Ecology and Society 15:13.

Couvet, D, and A. Prevot 2014. Citizen-science programs: Towards transformative biodiversity governance. Environmental Development 13:39-45.

Craggs, R., H. Geoghegan and H. Neate. 2013. Architectural enthusiasm: visiting buildings with the Twentieth Century Society. Environment and Planning D: Society and Space 31:879-896.
Crall, A. W., R. Jordan, K. Holfelder, G. J. Newman, J. Graham, and D. M. Waller. 2013. The impacts of an invasive species citizen science training program on participant attitudes, behavior, and science literacy. Public Understanding of Science 22:745-764.
Curtis, V. 2015. Online citizen science projects: an exploration of motivation, contribution and participation. PhD thesis The Open University.
Danielsen, F., K. Pirhofer-Walzl, T. P. Adrian, D. R. Kapijimpanga, N. D. Burgess, P. M. Jensen, R. Bonney, M. Funder, A. Landa, N. Levermann, and J. Madsen. 2014. Linking Public Participation in Scientific Research to the Indicators and Needs of International Environmental Agreements. Conservation Letters 7:12-24.
Danielsen, F., N. D. Burgess, and A. Balmford. 2005. Monitoring matters: examining the potential of locally-based approaches. Biodiversity and Conservation 14:2507-2542.
Davies, L., J.N.B. Bell, J. Bone, M. Head, L. Hill, C. Howard, S.J. Hobbs, D.T. Jones, S.A. Power, N. Rose and C. Ryder. 2011. Open Air Laboratories (OPAL): A community-driven research programme. Environmental Pollution 159:2203-2210.
Della Porta, D. and M. Keating. eds. 2008. Approaches and methodologies in the social sciences: A pluralist perspective. Cambridge University Press.
Devictor, V., R. J. Whittaker, and C. Beltrame. 2010. Beyond scarcity: citizen science programmes as useful tools for conservation biogeography. Diversity and Distributions 16:354-362.
Dickinson, J. L., B. Zuckerberg, and D. N. Bonter. 2010. Citizen Science as an Ecological Research Tool: Challenges and Benefits. Annual Review of Ecology, Evolution, and Systematics, 41:149-172.
Duputie, A., N. E. Zimmermann, and I. Chuine. 2014. Where are the wild things? Why we need better data on species distribution. Global Ecology and Biogeography 23:457-467.
Easton, P. A. 1996. Sharpening our tools. Improving evaluation in adult and nonformal education. UNESCO Institute for Education and German Foundation for International Development. Available at http://unesdoc.unesco.org/images/0010/001099/109960eo.pdf [Last accessed 21st August 2015].
Ellis, J. and T. Gregory 2008. Accountability and learning. Developing monitoring and evaluation in the third sector. London: Charities Evaluation Service.
ESRC 2016 ESRC, What is social science? Part 1: https://www.youtube.com/watch?v=kUApnFN2vGk Part 2: https://www.youtube.com/watch?v=1DTRjAqC61s [Last accessed 21st August 2015].
Everett, G. and H. Geoghegan. In press. Initiating and continuing participation in citizen science for natural history. BMC Ecology.
Fairclough, D. V., J. I. Brown, B. J. Carlish, B. M. Crisafulli, and I. S. Keay. 2014. Breathing life into fisheries stock assessments with citizen science. Scientific Reports 4.
Ferster, C. J., N. C. Coops, H. W. Harshaw, R. A. Kozak, and M. J. Meitner. 2013. An Exploratory Assessment of a Smartphone Application for Public Participation in Forest Fuels Measurement in the Wildland-Urban Interface. Forests 4:1199-1219.
Finkelstien, M. A. 2009. Intrinsic vs. extrinsic motivational orientations and the volunteer process. Personality and Individual Differences 46:653-658.
Fradera, R., D. Slawson, L. Gosling, P. Lakeman-Fraser, K. Makuch, Z. Makuch, K. Madani, K. Martin, R. Slade, H. Geoghegan, A. Moffat, and M. Haklay. 2015. Exploring the nexus through citizen science. Nexus Network think piece Series, Paper 010.
Fuccillo, K. K., T. M. Crimmins, C. E. de Rivera, and T. S. Elder. 2015. Assessing accuracy in citizen science-based plant phenology monitoring. International Journal of Biometeorology 59:917-926.
Galesic, M. and M. Bosnjak. 2009. Effects of questionnaire length on participation and indicators of response quality in a web survey. Public opinion quarterly 73:349-360.

Gardiner, M. M., L. L. Allee, P. M. J. Brown, J. E. Losey, H. E. Roy, and R. R. Smyth. 2012. Lessons from lady beetles: accuracy of monitoring data from US and UK citizen-science programs. Frontiers in Ecology and the Environment 10:471-476.

Garner, J. T., and L. T. Garner. 2011. Volunteering an opinion: Organizational voice and volunteer retention in nonprofit organizations. Nonprofit and Voluntary Sector Quarterly 40:813–28.

Geoghegan, H. 2013. Emotional geographies of enthusiasm: belonging to the Telecommunications Heritage Group. Area 45:40-46.

Gollan, J., L. L. de Bruyn, N. Reid, and L. Wilkie. 2012. Can Volunteers Collect Data that are Comparable to Professional Scientists? A Study of Variables Used in Monitoring the Outcomes of Ecosystem Rehabilitation. Environmental Management 50:969-978.

Grand, A., C. Wilkinson, K. Bultitude, and A. F. T. Winfield. 2012. Open Science: A New "Trust Technology"? Science Communication 34:679-689.

Grese, R. E., R. Kaplan, R. L. Ryan, and J. Buxton. 2000. Psychological benefits of volunteering in stewardship programs. Restoring nature: Perspectives from the social sciences and humanities:265-280.

Groffman, P. M., C. Stylinski, M. C. Nisbet, C. M. Duarte, R. Jordan, A. Burgin, M. A. Previtali, and J. Coloso. 2010. Restarting the conversation: challenges at the interface between ecology and society. Frontiers in Ecology and the Environment 8:284-291.

Guillemin, M. and L. Gillam. 2004. Ethics, Reflexivity, and “Ethically Important Moments” in Research, Qualitative Inquiry 10:261-280.

Haklay, M. 2015a. Citizen Science and Policy: A European Perspective. Washington, DC: Woodrow Wilson International Center for Scholars.

Haklay, M. 2015b. ‘Nature’ editorial on citizen science. Article published on the European Citizen Science Association website. Retrieved from http://ecsa.citizen-science.net/node/139 [Last accessed 21st August 2015].

Hardisty, A., D. Roberts, and Biodiversity Informatics Community. 2013. A decadal view of biodiversity informatics: challenges and priorities. BMC Ecology 13.

Haywood, B. K., and J. C. Besley. 2014. Education, outreach, and inclusive engagement: Towards integrated indicators of successful program outcomes in participatory science. Public Understanding of Science 23:92-106.

Hobbs, S. J., and P. C. L. White. 2012. Motivations and barriers in relation to community participation in biodiversity recording. Journal of Nature Conservation 20:364-373.

Hochachka, W. M., D. Fink, R. A. Hutchinson, D. Sheldon, W. K. Wong, and S. Kelling. 2012. Data-intensive science applied to broad-scale citizen science. Trends in Ecology & Evolution 27:130-137.

Hollow, B., P. E. J. Roetman, M. Walter, and C. B. Daniels. 2015. Citizen science for policy development: The case of koala management in South Australia. Environmental Science & Policy 47:126-136.

Hyder, K., B. Townhill, L. G. Anderson, J. Delany, and J. K. Pinnegar. 2015. Can citizen science contribute to the evidence-base that underpins marine policy? Marine Policy 59:112-120.

Isaac, N. J. B., A. J. van Strien, T. A. August, M. P. de Zeeuw, and D. B. Roy. 2014. Statistics for citizen science: extracting signals of change from noisy ecological data. Methods in Ecology and Evolution 5:1052-1060.

Israel, M. and Hay, I. 2006. Research Ethics for Social Scientists: Between ethical conduct and regulatory compliance. London: SAGE.

Jackson, C. B., C. Osterlund, G. Mugar, K. D. Hassman, and K. Crowston. 2015. Motivations for sustained participation in crowdsourcing: Case studies of citizen science on the role of talk. In System Sciences (HICSS), 2015 48th Hawaii International Conference on (pp. 1624–1634). IEEE. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=7070006 [Last accessed 21st August 2015].

Jacobsen, S. K., J. S. Carlton, and M. C. Monroe. 2012. Motivation and satisfaction of volunteers at a Florida natural resource agency. Journal of Park and Recreation Administration 30:51–67.

Jansujwicz, J. S., A. J. K. Calhoun, and R. J. Lilieholm. 2013. The Maine Vernal Pool Mapping and Assessment Program: Engaging Municipal Officials and Private Landowners in Community-Based Citizen Science. Environmental Management 52:1369-1385.
Jennett, C., Kloetzer, L., Schneider, D., Iacovides, I., Cox, L.A., Gold, M., Fuchs, B., Eveleigh, A., Mathieu, K., Ajani, Z. and Y. Talsi. 2016. Motivations, learning and creativity in online citizen science. JCom 15 (03) A05.
Johnson, M. F., C. Hannah, L. Acton, R. Popovici, K. K. Karanth, and E. Weinthal. 2014. Network environmentalism: Citizen scientists as agents for environmental advocacy. Global Environmental Change-Human and Policy Dimensions 29:235-245.
Jordan, R. C., S. A. Gray, D. V. Howe, W. R. Brooks, and J. G. Ehrenfeld. 2011. Knowledge Gain and Behavioral Change in Citizen-Science Programs. Conservation Biology 25:1148-1154.
Kaartinen, R., B. Hardwick, and T. Roslin. 2013. Using citizen scientists to measure an ecosystem service nationwide. Ecology 94:2645-2652.
Kampen, H., J. M. Medlock, A. G. C. Vaux, C. J. M. Koenraadt, A. J. H. van Vliet, F. Bartumeus, A. Oltra, C. A. Sousa, S. Chouin, and D. Werner. 2015. Approaches to passive mosquito surveillance in the EU. Parasites & Vectors 8.
Katz, D. 1960. The functional approach to the study of attitudes. Public opinion quarterly, 24:163-204.
Kirkpatrick, D 1996 Great ideas revisited. Training & Development, 50, 54.
Kreuter, F., Presser, S. and R. Tourangeau. 2008. Social desirability bias in CATI, IVR, and Web surveys the effects of mode and question sensitivity. Public Opinion Quarterly 72:847-865.
Lawrence, A. 2009. The first cuckoo in winter: Phenology, recording, credibility and meaning in Britain. Global Environmental Change-Human and Policy Dimensions 19:173-179.
Liu, H.-Y., M. Kobernus, D. Broday, and A. Bartonova. 2014. A conceptual approach to a citizens' observatory - supporting community-based environmental governance. Environmental Health 13.
Locke, M., A. Ellis, and J. Davis Smith. 2003. Hold on to what you've got: The volunteer retention literature. Voluntary Action 5:81–99.
Loos, J., A. I. Horcea-Milcu, P. Kirkland, T. Hartel, M. Osvath-Ferencz, and J. Fischer. 2015. Challenges for biodiversity monitoring using citizen science in transitioning social-ecological systems. Journal for Nature Conservation 26:45-48.
Loss, S. R., S. S. Loss, T. Will, and P. P. Marra. 2015. Linking place-based citizen science with large-scale conservation research: A case study of bird-building collisions and the role of professional scientists. Biological Conservation 184:439-445.
Lottig, N. R., T. Wagner, E. N. Henry, K. S. Cheruvelil, K. E. Webster, J. A. Downing, and C. A. Stow. 2014. Long-Term Citizen-Collected Data Reveal Geographical Patterns and Temporal Trends in Lake Water Clarity. Plos One 9.
Lucky, A., A. M. Savage, L. M. Nichols, C. Castracani, L. Shell, D. A. Grasso, A. Mori, and R. R. Dunn. 2014. Ecologists, educators, and writers collaborate with the public to assess backyard diversity in The School of Ants Project. Ecosphere 5.
Mackechnie, C., L. Maskell, L. Norton, and D. Roy. 2011. The role of 'Big Society' in monitoring the state of the natural environment. Journal of Environmental Monitoring 13:2687-2691.
Market Research Society. (2015). Census Output on Approximated Social Grade. Retrieved from https://www.mrs.org.uk/cgg/social_grade
Massung, E., D. Coyle, K. F. Cater, M. Jay, and C. Preist. 2013. Using crowdsourcing to support pro-environmental community activism. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 371–380). ACM. Retrieved from http://dl.acm.org/citation.cfm?id=2470708 [Last accessed 21st August 2015].
McClintock, B. T., D. P. Onorato, and J. Martin. 2015. Endangered Florida panther population size determined from public reports of motor vehicle collision mortalities. Journal of Applied Ecology 52:893-901.
McDougle, L. M., I. Greenspan, and F. Handy. 2011. Generation green: understanding the motivations and mechanisms influencing young adults' environmental volunteering:

Understanding environmental volunteering. International Journal of Nonprofit and Voluntary Sector Marketing 16:325–341.
McKinley, D. C., R. D. Briggs, and A. M. Bartuska. 2013. When peer-reviewed publications are not enough! Delivering Science for natural resource management (Reprinted from Forest Policy and Economics, vol 21, pg 1). Forest Policy and Economics 37:9-19.
Measham, T. G., and G. B. Barnett. 2007. Environmental volunteering: motivations, modes and outcomes. Australian Geographer 39:537-552.
National STEM Centre. 2009. Does it work? Better evaluation: better STEM. National STEM Centre.
Nature. 2015. Rise of the citizen scientist. Nature 524:265.
Newton, C., K. Becker, and S. Bell. 2014. Learning and development opportunities as a tool for the retention of volunteers: A motivational perspective. Human Resource Management Journal 24:514–30.
Nicholson, H.J., Weiss, F.L. and P.B. Campbell. 1994. Evaluation in informal science education: Community-based programs. Informal science learning. 107-176.
Nov, O., Arazy, O. and D. Anderson. 2011. Dusting for science: motivation and participation of digital citizen science volunteers. In Proceedings of the 2011 iConference (pp. 68-74). ACM.
Ockenden, N. 2007. Volunteering in the natural outdoors in the UK and Ireland: A literature review. London, UK: Institute for Volunteering Research.
OPENspace. 2003. Diversity review: options for implementation, Final Report and Research Note for the Countryside Agency. Available at http://www.openspace.eca.ac.uk/researchprojects_diversityreviewoptions.php [Last accessed 21st August 2015].
Overdevest, C., Orr, C.H. and K. Stepenuck. 2004. Volunteer stream monitoring and local participation in natural resource issues. Human Ecology Review 11:177-185.
Patton, M. Q. 2002. Qualitative research and evaluation methods (3rd ed.). Thousand Oaks, CA: Sage Publications.
Peachey, J. W., A. Lyras, C. Cohen, J. E. Bruening, and G. B. Cunningham. 2014. Exploring the motives and retention factors of sport-for-development volunteers. Nonprofit and Voluntary Sector Quarterly 43:1052-1069.
Penner, L. A. 2002. Dispositional and organizational influences on sustained volunteerism: An interactionist perspective. Journal of Social Issues 58:447–467.
Phillips, T B, Ferguson, M, Minarchek, M, Porticella, N, and R. Bonney. 2014. User's guide for evaluating learning outcomes in citizen science. Ithaca, NY: Cornell Lab of Ornithology. Available at http://www.birds.cornell.edu/citscitoolkit/evaluation/ [Last accessed 21st August 2015].
Pocock, M.J., Roy, H.E., Preston, C.D. and D.B. Roy. 2015. The Biological Records Centre: a pioneer of citizen science. Biological Journal of the Linnean Society 115:475-493.
Pocock, M.J.O., D.S. Chapman, L.J. Sheppard, and H.E. Roy. 2014. Choosing and Using Citizen Science: a guide to when and how to use citizen science to monitor biodiversity and the environment. Centre for Ecology & Hydrology.
POSTnote. 2014. http://researchbriefings.parliament.uk/ResearchBriefing/Summary/POST-PN-476 [Last accessed 21st August 2015].
Raddick, M. J., G. Bracey, P. L. Gay, C. J. Lintott, P. Murray, K. Schawinski, A. S. Szalay, and J. Vandenberg. 2013. Galaxy Zoo: Motivations of citizen scientists. ArXiv E-Prints, http://arxiv.org/abs/1303.6886.
RCUK. 2005. Evaluation: practical guidelines. Research Councils UK. Available at http://www.rcuk.ac.uk/documents/publications/evaluationguide.pdf [Last accessed 21st August 2015].
Riesch, H. and C. Potter. 2014. Citizen science as seen by scientists: Methodological, epistemological and ethical dimensions. Public Understanding of Science 23:107-120.
Ritchie, J. and J. Lewis. 2013. Qualitative Research Practice: A Guide for Social Science Students and Researchers. SAGE London.

Rosevelt, C., M. Los Huertos, C. Garza, and H. M. Nevins. 2013. Marine debris in central California: Quantifying type and abundance of beach litter in Monterey Bay, CA. Marine Pollution Bulletin 71:299-306.
Rotman D., J. Preece, J. Hammock, K. Procita, D. Hansen, C. Parr, D. Lewis, and D. Jacobs. 2012. Dynamic changes in motivation in collaborative citizen-science projects. Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work. Seattle, Washington, USA. (pp. 217-226).
Roy, H.E., Pocock, M.J.O., Preston, C.D., Roy, D.B., Savage, J., Tweddle, J.C. & L.D. Robinson. 2012. Understanding Citizen Science & Environmental Monitoring. Final Report on behalf of UK-EOF. NERC Centre for Ecology & Hydrology and Natural History Museum.
Ryan, R. L., R. Kaplan, and R. E. Grese. 2001. Predicting volunteer commitment in environmental stewardship programmes. Journal of Environmental Planning and Management 44:629–648.
Shirk, J L, Ballard, H L, Wilderman, C C, Phillips, T, Wiggins, A, Jordan, R, McCallie, E et al. 2012 Public participation in scientific research: A framework for deliberate design. Ecology and Society 17(2): 29. doi:10.5751/ES-04705-170229
Shirk, J. L., H. L. Ballard, C. C. Wilderman, T. Phillips, A. Wiggins, R. Jordan, E. McCallie, M. Minarchek, B. V. Lewenstein, M. E. Krasny, and R. Bonney. 2012. Public Participation in Scientific Research: a Framework for Deliberate Design. Ecology and Society 17.
Silvertown, J., 2009. A new dawn for citizen science. Trends in ecology & evolution, 24(9), pp.467-471.
Sirbu, A., M. Becker, S. Caminiti, B. De Baets, B. Elen, L. Francis, P. Gravino, A. Hotho, S. Ingarra, V. Loreto, A. Molino, J. Mueller, J. Peters, F. Ricchiuti, F. Saracino, V. D. P. Servedio, G. Stumme, J. Theunis, F. Tria, and J. Van den Bossche. 2015. Participatory Patterns in an International Air Quality Monitoring Initiative. Plos One 10.
Smith, F.M., Timbrell, H., Woolvin, M., Muirhead, S. and Fyfe, N., 2010. Enlivened geographies of volunteering: situated, embodied and emotional practices of voluntary action. Scottish geographical journal, 126(4), pp.258-274.
Sparks, T.H. and P.D. Carey. 1995. The responses of species to climate over two centuries: an analysis of the Marsham phenological record, 1736-1947. Journal of Ecology 321-329.
Stebbins, R.A., 1992. Amateurs, professionals, and serious leisure. McGill-Queen's Press-MQUP.
Sullivan, B. L., C. L. Wood, M. J. Iliff, R. E. Bonney, D. Fink, and S. Kelling. 2009. eBird: A citizen-based bird observation network in the biological sciences. Biological Conservation 142:2282-2292.
Sullivan, B. L., J. L. Aycrigg, J. H. Barry, R. E. Bonney, N. Bruns, C. B. Cooper, T. Damoulas, A. A. Dhondt, T. Dietterich, A. Farnsworth, D. Fink, J. W. Fitzpatrick, T. Fredericks, J. Gerbracht, C. Gomes, W. M. Hochachka, M. J. Iliff, C. Lagoze, F. A. La Sorte, M. Merrifield, W. Morris, T. B. Phillips, M. Reynolds, A. D. Rodewald, K. V. Rosenberg, N. M. Trautmann, A. Wiggins, D. W. Winkler, W.-K. Wong, C. L. Wood, J. Yu, and S. Kelling. 2014. The eBird enterprise: An integrated approach to development and application of citizen science. Biological Conservation 169:31-40.
Theobald, E. J., A. K. Ettinger, H. K. Burgess, L. B. DeBey, N. R. Schmidt, H. E. Froehlich, C. Wagner, J. HilleRisLambers, J. Tewksbury, M. A. Harsch, and J. K. Parrish. 2015. Global change and local solutions: Tapping the unrealized potential of citizen science for biodiversity research. Biological Conservation 181:236-244.
Trumbull, D. J., R. Bonney, D. Bascom, and A. Cabral. 2000. Thinking scientifically during participation in a citizen-science project. Science Education 84:265-275.
Tulloch, A. I. T., H. P. Possingham, L. N. Joseph, J. Szabo, and T. G. Martin. 2013. Realising the full potential of citizen science monitoring programs. Biological Conservation 165:128-138.
Tweddle, J.C., Robinson, L.D., Pocock, M.J.O. and Roy, H.E., 2012. Guide to citizen science: developing, implementing and evaluating citizen science to study biodiversity and the environment in the UK. NERC/Centre for Ecology & Hydrology.
UKEOF. 2011. Citizen Science Observations and Monitoring: Scoping Requirements, Knowledge

exchange and finding potential synergies. UK Environmental Observation Framework. http://www.ukeof.org.uk/documents/ukeofcitizenscienceworkshopreport.pdf .
Unell, J., and R. Castle. 2012. Developing sustainable volunteering within the Natural Connections Demonstration Project: A review of evidence. Natural England Commissioned Report NECR096, retrieved from publications.naturalengland.org.uk/file/1995537 [Last accessed 21st August 2015].
Van Den Berg, H. A., S. L. Dann, and J. M. Dirkx. 2009. Motivations of adults for non-formal conservation education and volunteerism: Implications for Programming. Applied Environmental Education and Communication 8:6-17.
Van Selm, M. and Jankowski, N.W., 2006. Conducting online surveys. Quality and Quantity 40:435-456.
Varner, J. 2014. Scientific Outreach: Toward Effective Public Engagement with Biological Science. Bioscience 64:333-340.
West, S. E. 2014. Evaluation, or Just Data Collection? An Exploration of the Evaluation Practice of Selected UK Environmental Educators. Journal of Environmental Education 46:41-55.
West, S. E. 2015. Understanding participant and practitioner outcomes of environmental education. Environmental Education Research 21:45-60.
West, S. E., and R. M. Pateman. In press. Recruiting and retaining participants in citizen science: What can be learnt from the volunteering literature? Citizen Science: Theory and Practice.
West, S. E., R. M. Pateman, and A. J. Dyke. 2015. Motivations and data submissions in citizen science. Report to DEFRA.
White, R. L., A. E. Sutton, R. Salguero-Gomez, T. C. Bray, H. Campbell, E. Cieraad, N. Geekiyanage, L. Gherardi, A. C. Hughes, P. S. Jorgensen, T. Poisot, L. DeSoto, and N. Zimmerman. 2015. The next generation of action ecology: novel approaches towards global ecological research. Ecosphere 6.
Wilson, J. 2012. Volunteerism research: A review essay. Nonprofit and Voluntary Sector Quarterly 41:176–212.
Winfield, I. J. 2014. Biological conservation of aquatic inland habitats: these are better days. Journal of Limnology 73:120-131.
Wright, D. R., L. G. Underhill, M. Keene, and A. T. Knight. 2015. Understanding the Motivations and Satisfactions of Volunteers to Improve the Effectiveness of Citizen Science Programs. Society & Natural Resources 28:1013-1029.
Wu, Y., C. Li, and S. Khoo. 2015. Predicting future volunteering intentions through a self-determination theory perspective. VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations.

Appendix 1: Online survey

UKEOF Study of Motivations in Citizen Science

Introduction
The Universities of Reading, York and the West of England (UWE) are conducting research into motivations for participation in Citizen Science in the UK. This research is funded by the UK Environment Observation Framework (UKEOF).

We define environmental 'Citizen Science' as the participation of non-professional volunteers in professional science projects relating to the environment.

What would you like me to do?
We would like you to complete the following survey. Importantly, there are no 'right' or 'wrong' answers – we do not mind what you say, we will just be very interested to hear what you think.

If you have any questions, please get in touch with Glyn Everett (details below). Please remember this is voluntary – if you take part you will help us a lot, but if you do not want to take part then this will be okay and will not affect you in any way.

What will happen to the information I give you?
All information collected will be stored securely. Any data used will be anonymous. Because of this anonymity, we will not be able to remove your data after you submit it. The research findings will be used in a publication for UKEOF and academic articles.

What happens next?
If you are happy to be involved, please complete the survey.

Thank you for reading this information. Please ask any questions if you are not sure about what is written here.

Contact details
Survey developer: Dr Glyn Everett, UWE (Frenchay), Coldharbour Lane, Bristol, BS16 1QY.

Tel: 0117 3283023 Email: glyn.everett@uwe.ac.uk

Ethical Clearance
This investigation was granted ethical approval by the UWE ethics committee. If you have any questions or concerns, please contact: Secretary of the Faculty of Environment and Technology Research Ethics Committee, UWE (Frenchay), Coldharbour Lane, Bristol, BS16 1QY
Tel: 0117 32 81170 Email: researchethics@uwe.ac.uk

Consent

I have read and understood the information above. The aims and methods of the research have been clearly explained to me. I am happy for the information I provide to be used by the project team.

I understand that submitting my data will be considered my consent. I understand that due to the anonymity of the data, I will not be able to ask for my contribution to be removed after I have submitted.

If you have any concerns or questions, please contact Glyn Everett on glyn.everett@uwe.ac.uk.

Yes ■ No ■

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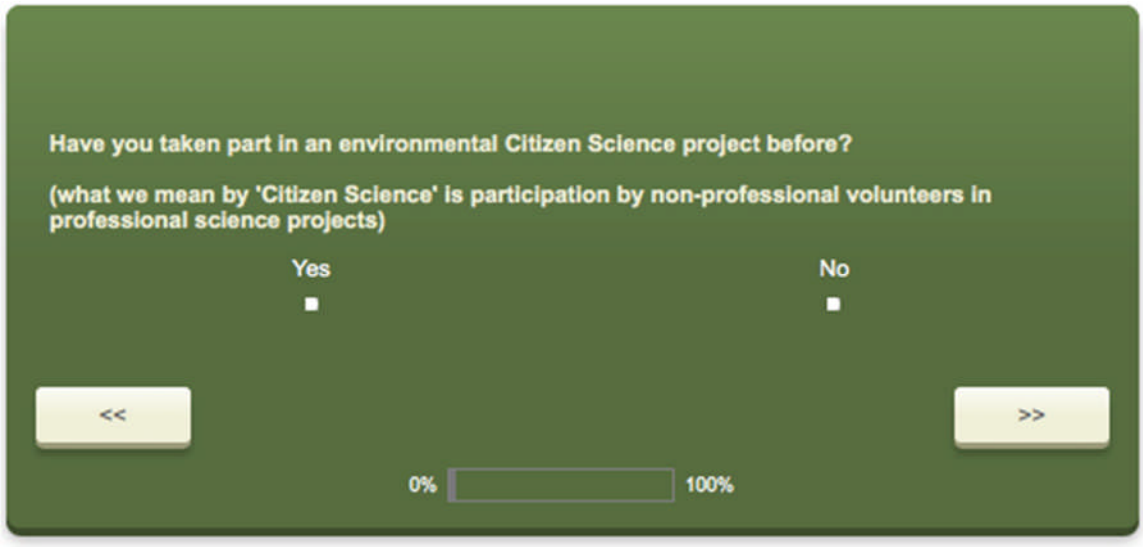
Have you taken part in an environmental Citizen Science project before?
(what we mean by 'Citizen Science' is participation by non-professional volunteers in professional science projects)
Yes
No
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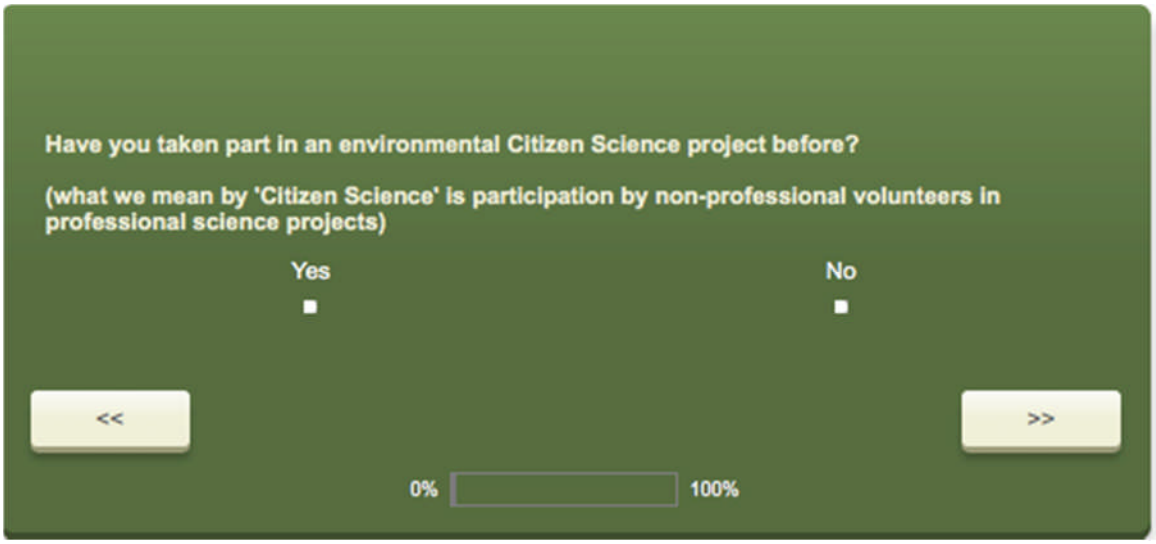
Have you taken part in an environmental Citizen Science project before?
(what we mean by 'Citizen Science' is participation by non-professional volunteers in professional science projects)
Yes
No
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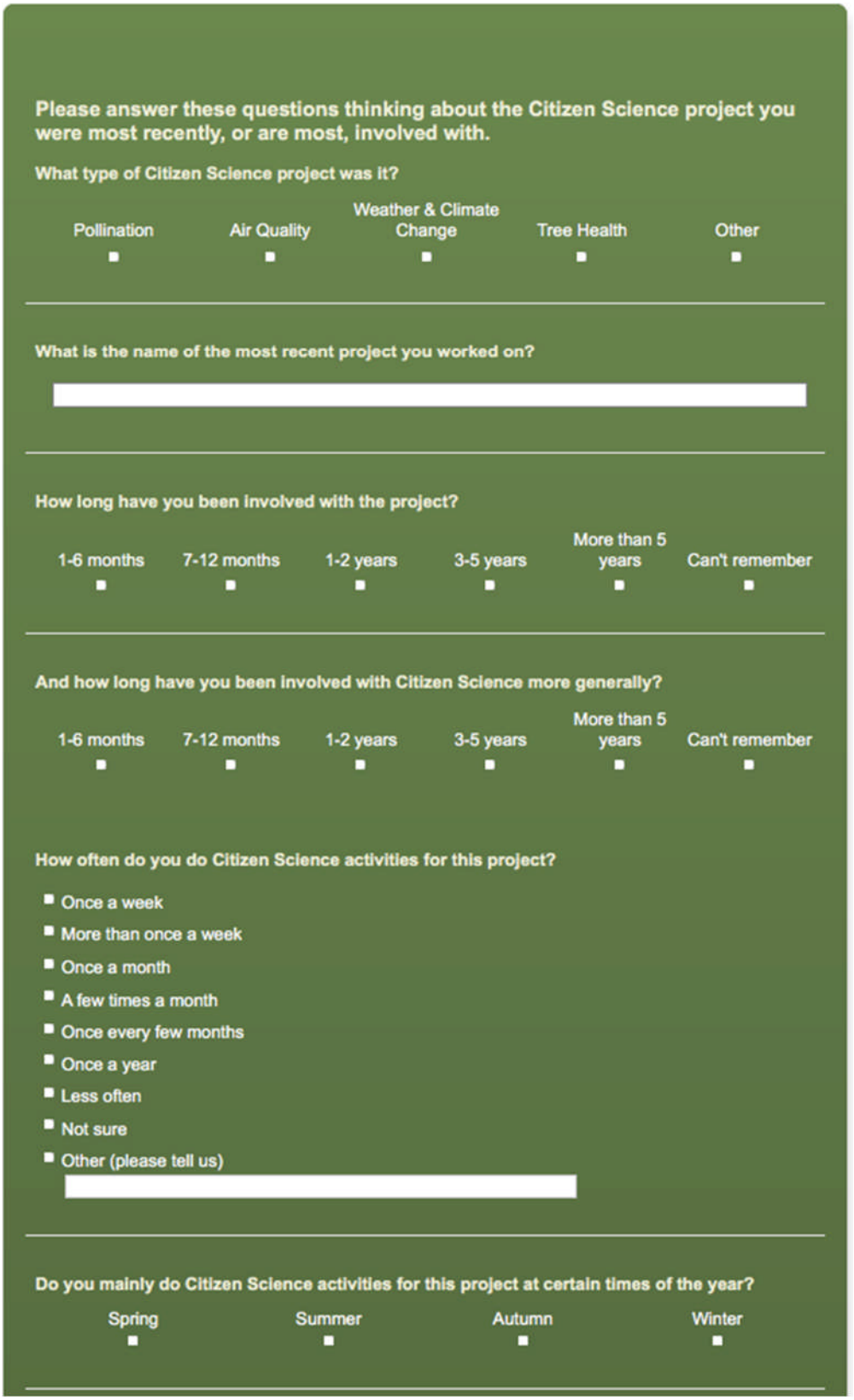
Questions for citizen science respondents



Please answer these questions thinking about the Citizen Science project you were most recently, or are most, involved with.

What type of Citizen Science project was it?

Pollination ■ Air Quality ■ Weather & Climate Change ■ Tree Health ■ Other ■

What is the name of the most recent project you worked on?

How long have you been involved with the project?

1-6 months ■ 7-12 months ■ 1-2 years ■ 3-5 years ■ More than 5 years ■ Can't remember ■

And how long have you been involved with Citizen Science more generally?

1-6 months ■ 7-12 months ■ 1-2 years ■ 3-5 years ■ More than 5 years ■ Can't remember ■

How often do you do Citizen Science activities for this project?

- ■ Once a week
- ■ More than once a week
- ■ Once a month
- ■ A few times a month
- ■ Once every few months
- ■ Once a year
- ■ Less often
- ■ Not sure
- ■ Other (please tell us)

Do you mainly do Citizen Science activities for this project at certain times of the year?

Spring ■ Summer ■ Autumn ■ Winter ■

If yes, why is this?

Are you currently involved with more than one Citizen Science project?

Yes	No
■	■

Please feel free to tell us more about the various projects you are involved with, if more than one.

Thinking about your most recent Citizen Science project, what sorts of activities have you been involved with?

	Never	Once	2-5 times	6+ times	Not sure
Recording species	■	■	■	■	■
Data collection	■	■	■	■	■
Data submission	■	■	■	■	■
Organising activities	■	■	■	■	■
Leading activities	■	■	■	■	■
Developing the survey tools	■	■	■	■	■
Designing the overall research questions	■	■	■	■	■
Moderating forums	■	■	■	■	■
Supporting others' involvement	■	■	■	■	■
Other (please explain)	■	■	■	■	■

Were you alone or part of an organised group?

	Alone	Group	Both
Recording species	■	■	■
Data collection	■	■	■
Data submission	■	■	■
Organising activities	■	■	■
Leading activities	■	■	■
Developing the survey tools	■	■	■
Designing the overall research questions	■	■	■
Moderating forums	■	■	■
Supporting others' involvement	■	■	■
Other (please explain)	■	■	■

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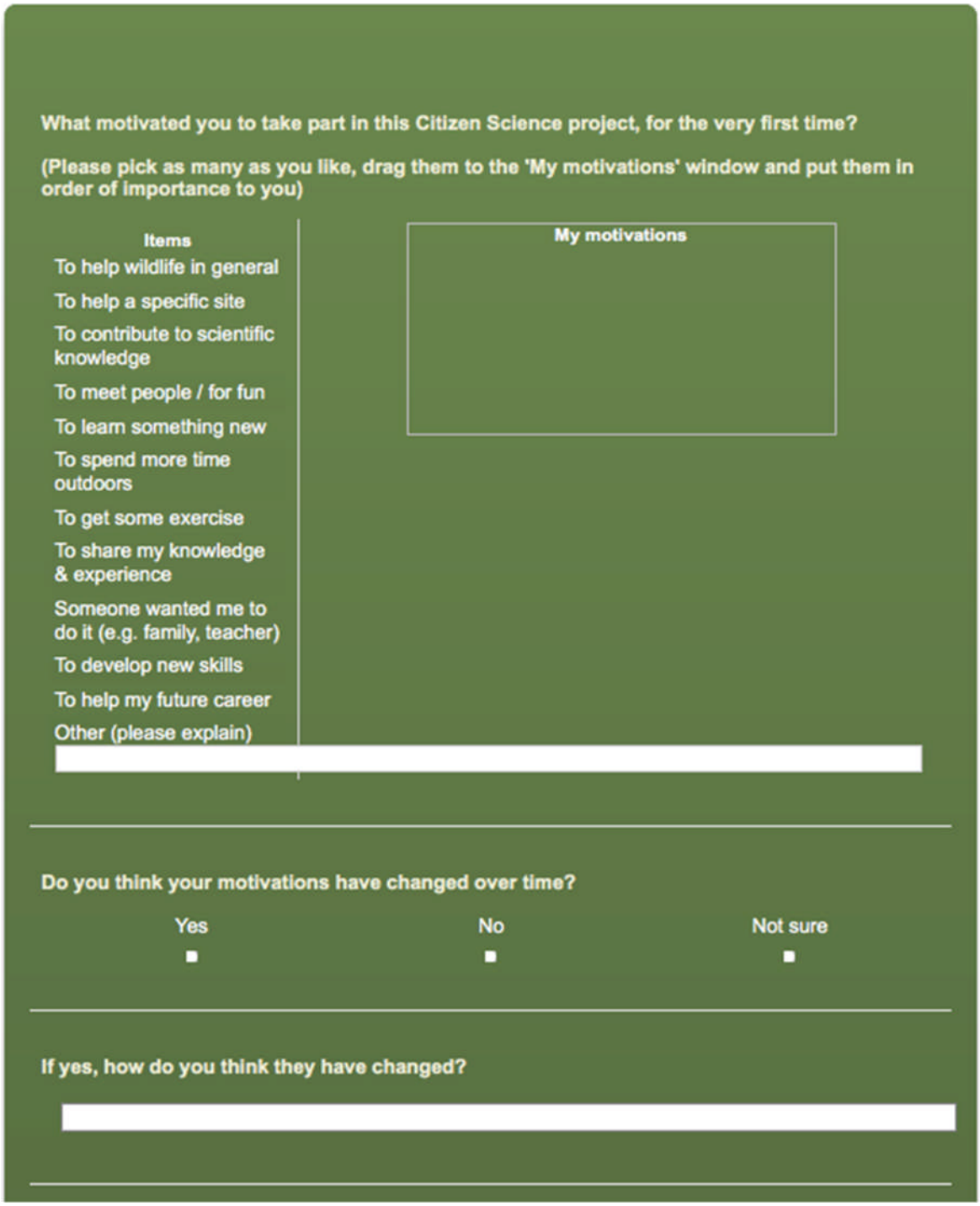

What motivated you to take part in this Citizen Science project, for the very first time?
(Please pick as many as you like, drag them to the 'My motivations' window and put them in order of importance to you)
Items
To help wildlife in general
To help a specific site
To contribute to scientific knowledge
To meet people / for fun
To learn something new
To spend more time outdoors
To get some exercise
To share my knowledge & experience
Someone wanted me to do it (e.g. family, teacher)
To develop new skills
To help my future career
Other (please explain)
My motivations
Do you think your motivations have changed over time?
Yes
No
Not sure
If yes, how do you think they have changed?

Do you feel your motivations have been satisfied, overall?

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied	Not Sure	Too soon to say	N/A
To help wildlife in general	■	■	■	■	■	■	■	■
To help a specific site	■	■	■	■	■	■	■	■
To contribute to scientific knowledge	■	■	■	■	■	■	■	■
To meet people / for fun	■	■	■	■	■	■	■	■
To learn something new	■	■	■	■	■	■	■	■
To spend more time outdoors	■	■	■	■	■	■	■	■
To get some exercise	■	■	■	■	■	■	■	■
To share my knowledge & experience	■	■	■	■	■	■	■	■
Someone wanted me to do it (e.g. family, teacher)	■	■	■	■	■	■	■	■
To develop new skills	■	■	■	■	■	■	■	■
To help my future career	■	■	■	■	■	■	■	■
Other (please explain)	■	■	■	■	■	■	■	■

Did your involvement in the project motivate you to do more Citizen Science?

Strongly discouraged me — Strongly encouraged me

0	1	2	3	4	5	6	7	8	9	10
■	■	■	■	■	■	■	■	■	■	■

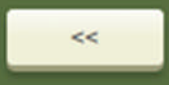
Do you feel your citizen science skills have developed over time?

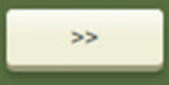
Yes	No	Not sure
■	■	■

Has this encouraged or discouraged your further involvement in Citizen Science?

Strongly Discourage	Discouraged	No difference	Encouraged	Strongly Encouraged
■	■	■	■	■

Why is that, do you think?






Was your data submitted? (by you or somebody else)
Yes
No
Don't Know
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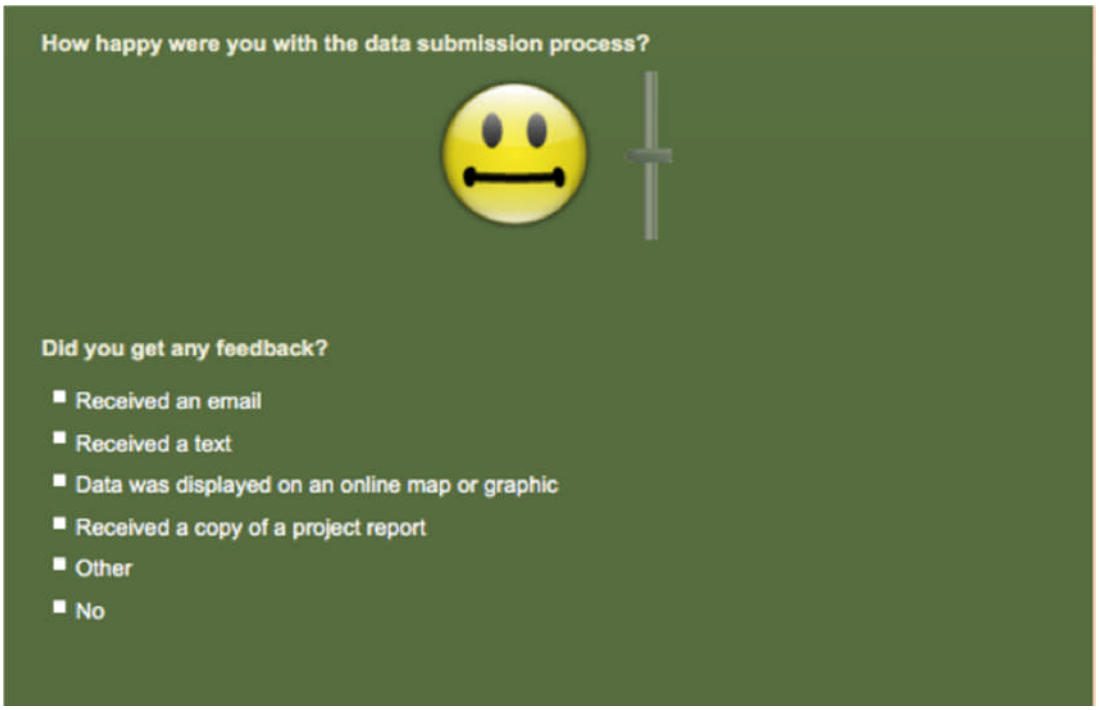
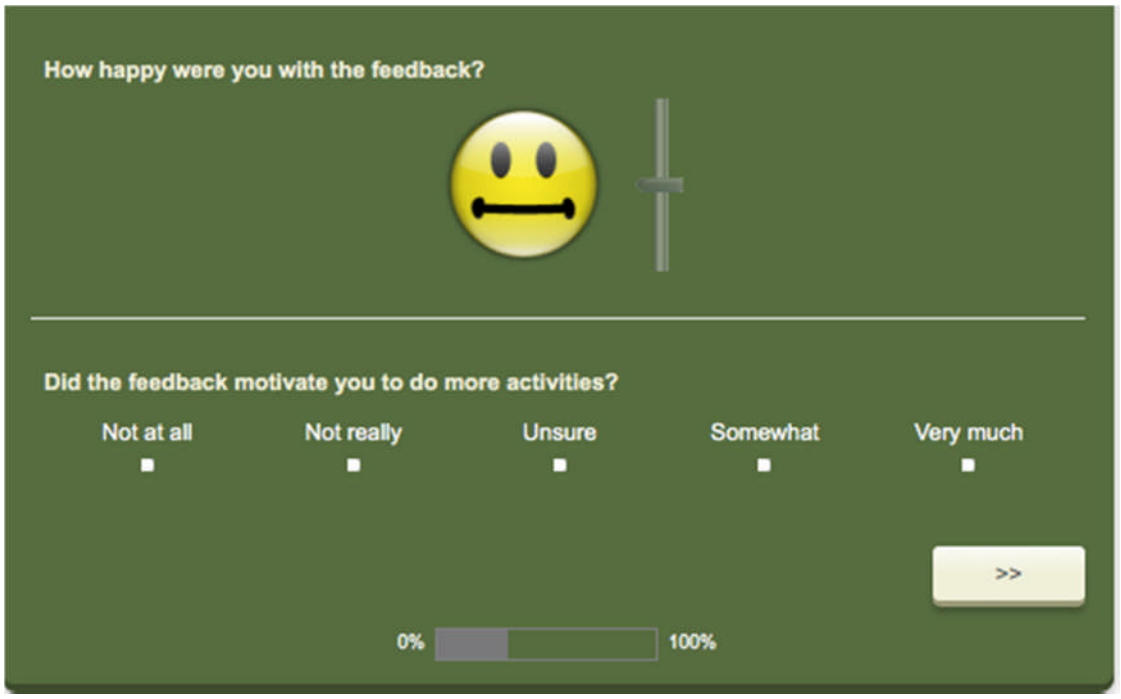
Citizen science data submitted


How happy were you with the data submission process?
Did you get any feedback?
Received an email
Received a text
Data was displayed on an online map or graphic
Received a copy of a project report
Other
No


How happy were you with the feedback?
Did the feedback motivate you to do more activities?
Not at all
Not really
Unsure
Somewhat
Very much
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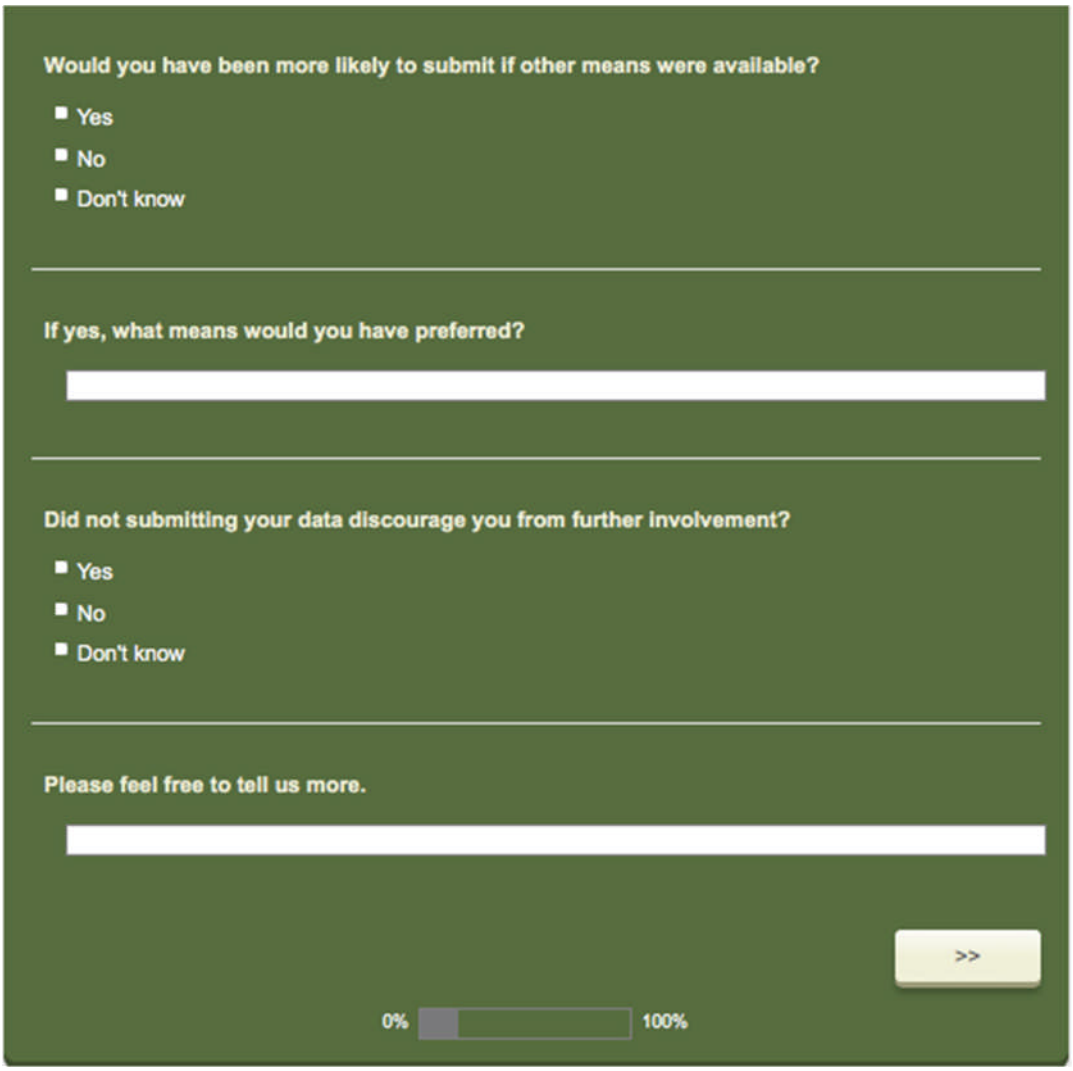
Citizen science data not submitted


Would you have been more likely to submit if other means were available?
Yes
No
Don't know
If yes, what means would you have preferred?
Did not submitting your data discourage you from further involvement?
Yes
No
Don't know
Please feel free to tell us more.
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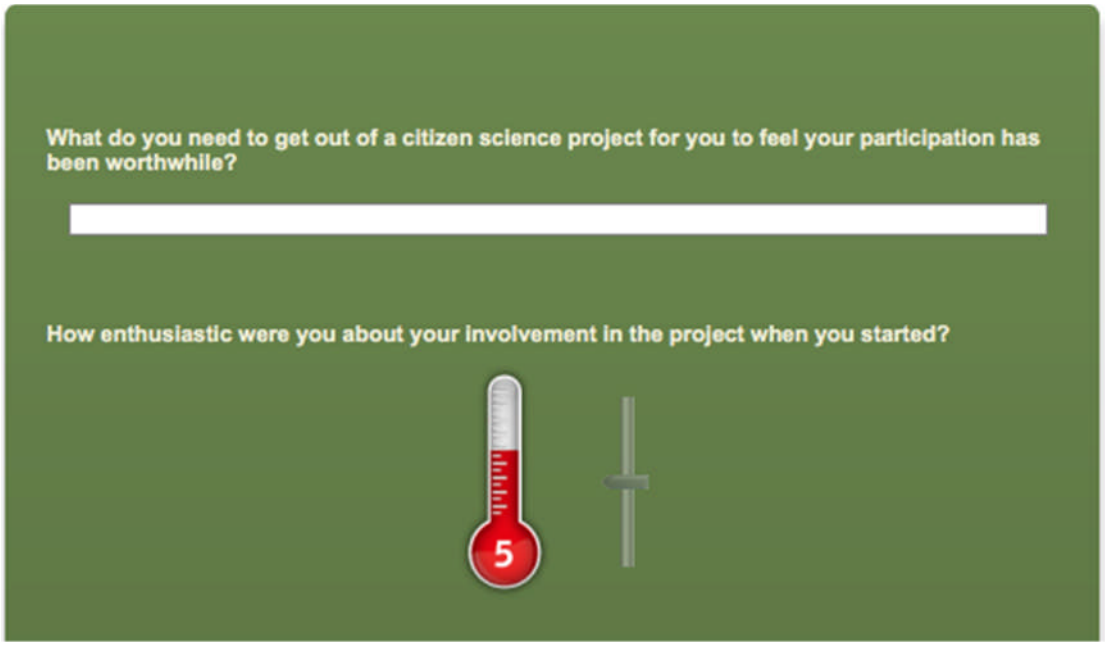
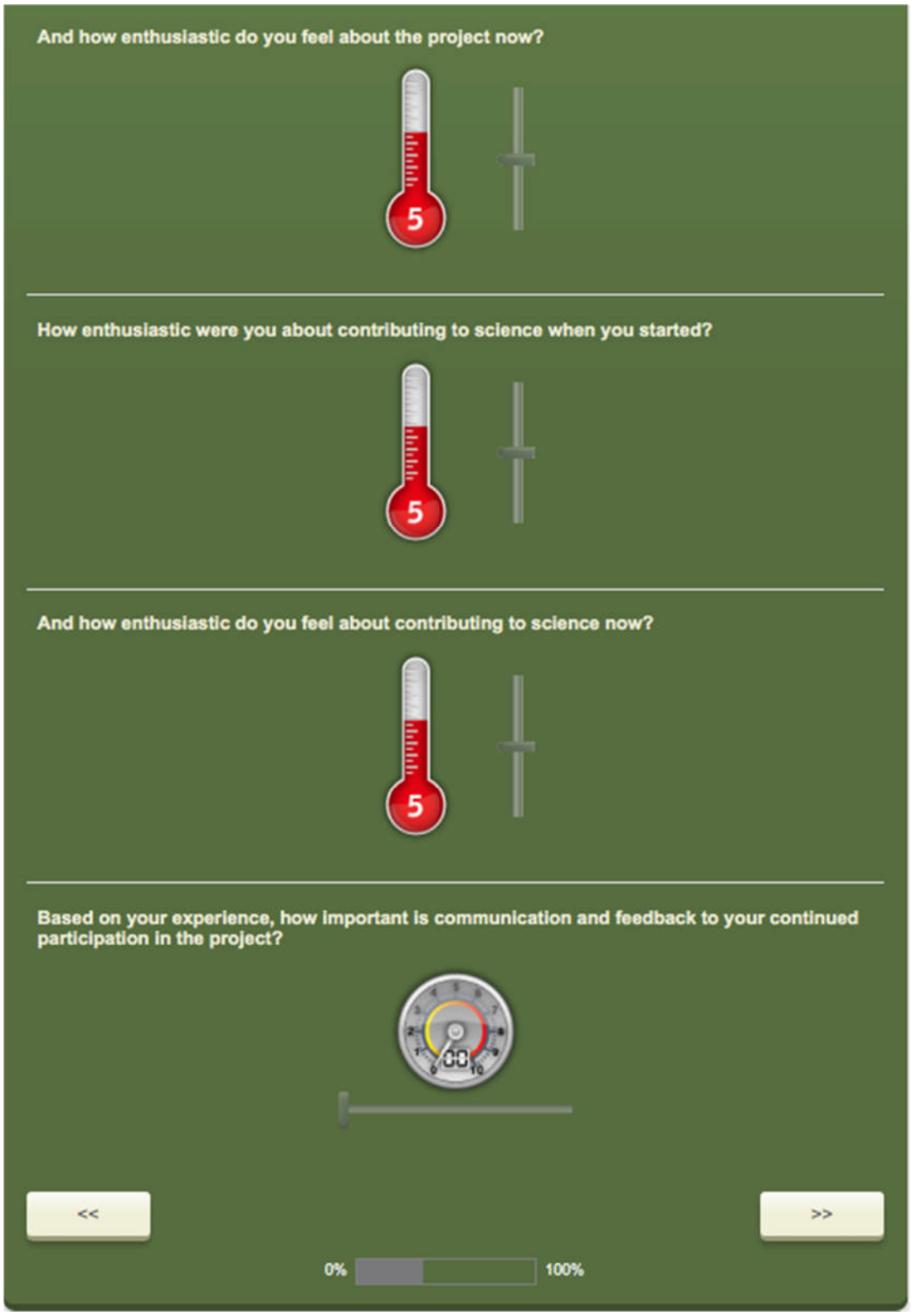
Both – citizen science and environmental volunteering




And how enthusiastic do you feel about the project now?
5
How enthusiastic were you about contributing to science when you started?
5
And how enthusiastic do you feel about contributing to science now?
5
Based on your experience, how important is communication and feedback to your continued participation in the project?
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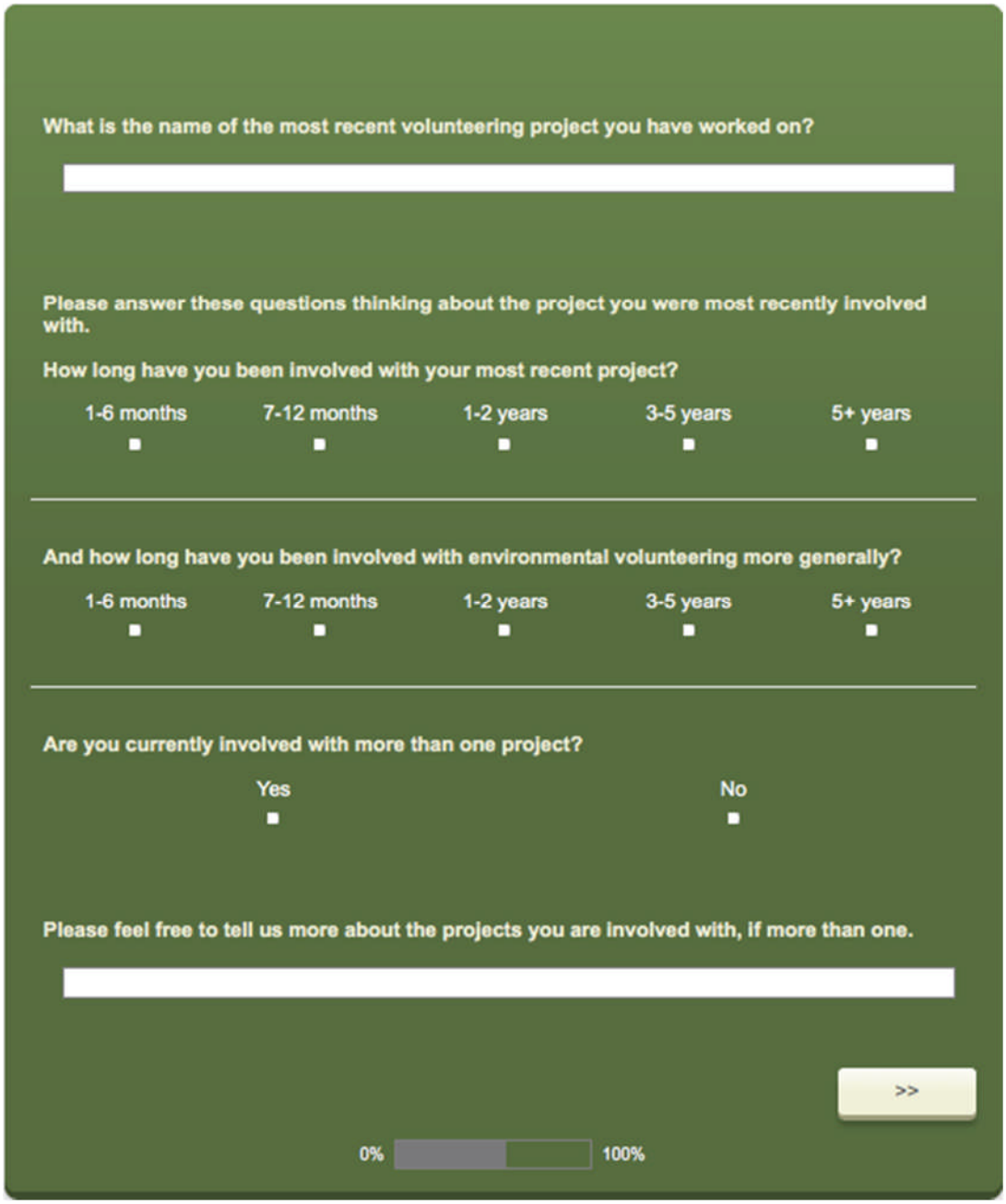
Questions for environmental volunteering respondents



How happy are you with the volunteering you do?

How do you currently benefit from volunteering?

- ■ I feel I am helping the wildlife
- ■ I feel I am helping a specific site
- ■ I meet people & have fun
- ■ I spend more time outdoors
- ■ I get some exercise
- ■ I get to share my knowledge & experience
- ■ I develop new skills
- ■ I am helping my future career
- ■ I feel better about myself
- ■ Other (please tell us)

Would you like to be able to do more?

Not at all										Absolutely!
0	1	2	3	4	5	6	7	8	9	10
■	■	■	■	■	■	■	■	■	■	■

If yes, what is it that prevents you, do you think?

- ■ Lack of time
- ■ Difficulty in getting to activities
- ■ Shortage of other people to do it with
- ■ Lack of money (for travel, materials, food etc.)
- ■ Don't know
- ■ Other (please tell us)

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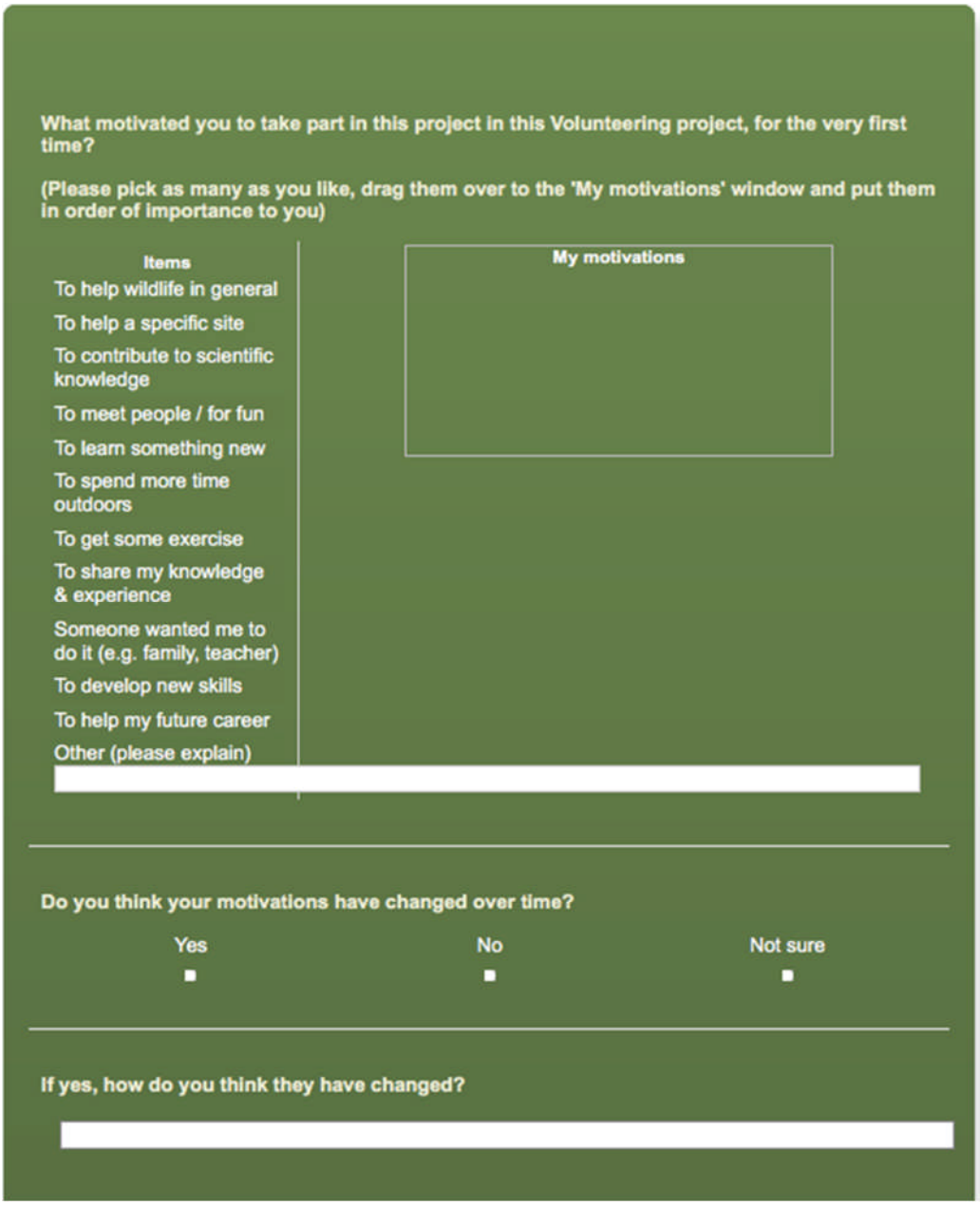
What motivated you to take part in this project in this Volunteering project, for the very first time?
(Please pick as many as you like, drag them over to the 'My motivations' window and put them in order of importance to you)
Items
To help wildlife in general
To help a specific site
To contribute to scientific knowledge
To meet people / for fun
To learn something new
To spend more time outdoors
To get some exercise
To share my knowledge & experience
Someone wanted me to do it (e.g. family, teacher)
To develop new skills
To help my future career
Other (please explain)
My motivations
Do you think your motivations have changed over time?
Yes
No
Not sure
If yes, how do you think they have changed?

Do you feel your motivations have been satisfied, overall?

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied	Not Sure	Too soon to say	N/A
To help wildlife in general	■	■	■	■	■	■	■	■
To help a specific site	■	■	■	■	■	■	■	■
To contribute to scientific knowledge	■	■	■	■	■	■	■	■
To meet people / for fun	■	■	■	■	■	■	■	■
To learn something new	■	■	■	■	■	■	■	■
To spend more time outdoors	■	■	■	■	■	■	■	■
To get some exercise	■	■	■	■	■	■	■	■
To share my knowledge & experience	■	■	■	■	■	■	■	■
Someone wanted me to do it (e.g. family, teacher)	■	■	■	■	■	■	■	■
To develop new skills	■	■	■	■	■	■	■	■
To help my future career	■	■	■	■	■	■	■	■
Other (please explain)	■	■	■	■	■	■	■	■

Did your involvement motivate you to do more volunteering?

Strongly discouraged me — Strongly encouraged me

0	1	2	3	4	5	6	7	8	9	10
■	■	■	■	■	■	■	■	■	■	■

Do you feel your volunteering skills have developed over time?

Yes	No	Not sure
■	■	■

Has this encouraged or discouraged your further involvement with volunteering?

Strongly Discourage	Discouraged	No difference	Encouraged	Strongly Encouraged
■	■	■	■	■

Why is that, do you think?

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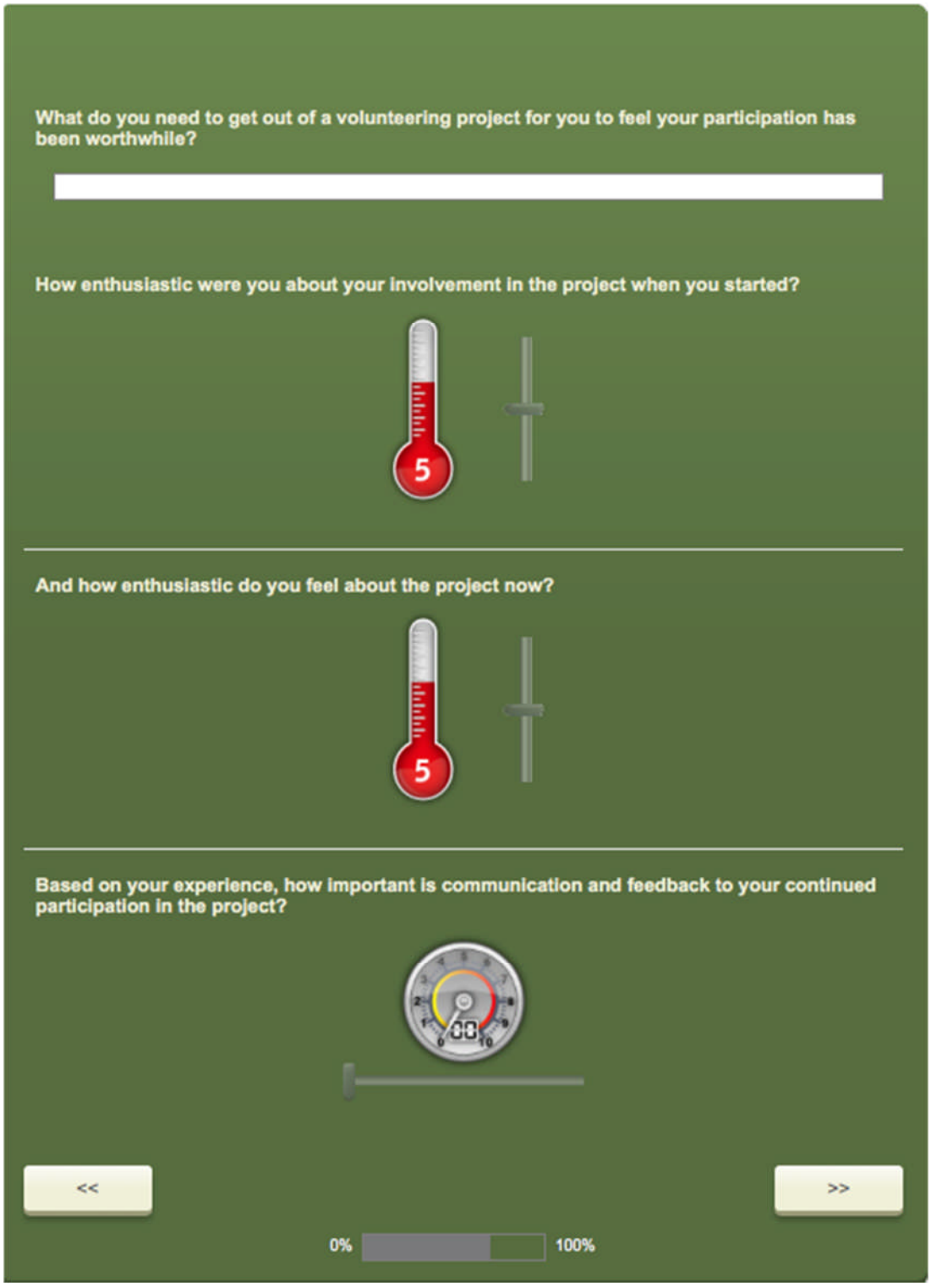
What do you need to get out of a volunteering project for you to feel your participation has been worthwhile?
How enthusiastic were you about your involvement in the project when you started?
5
And how enthusiastic do you feel about the project now?
5
Based on your experience, how important is communication and feedback to your continued participation in the project?
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>>
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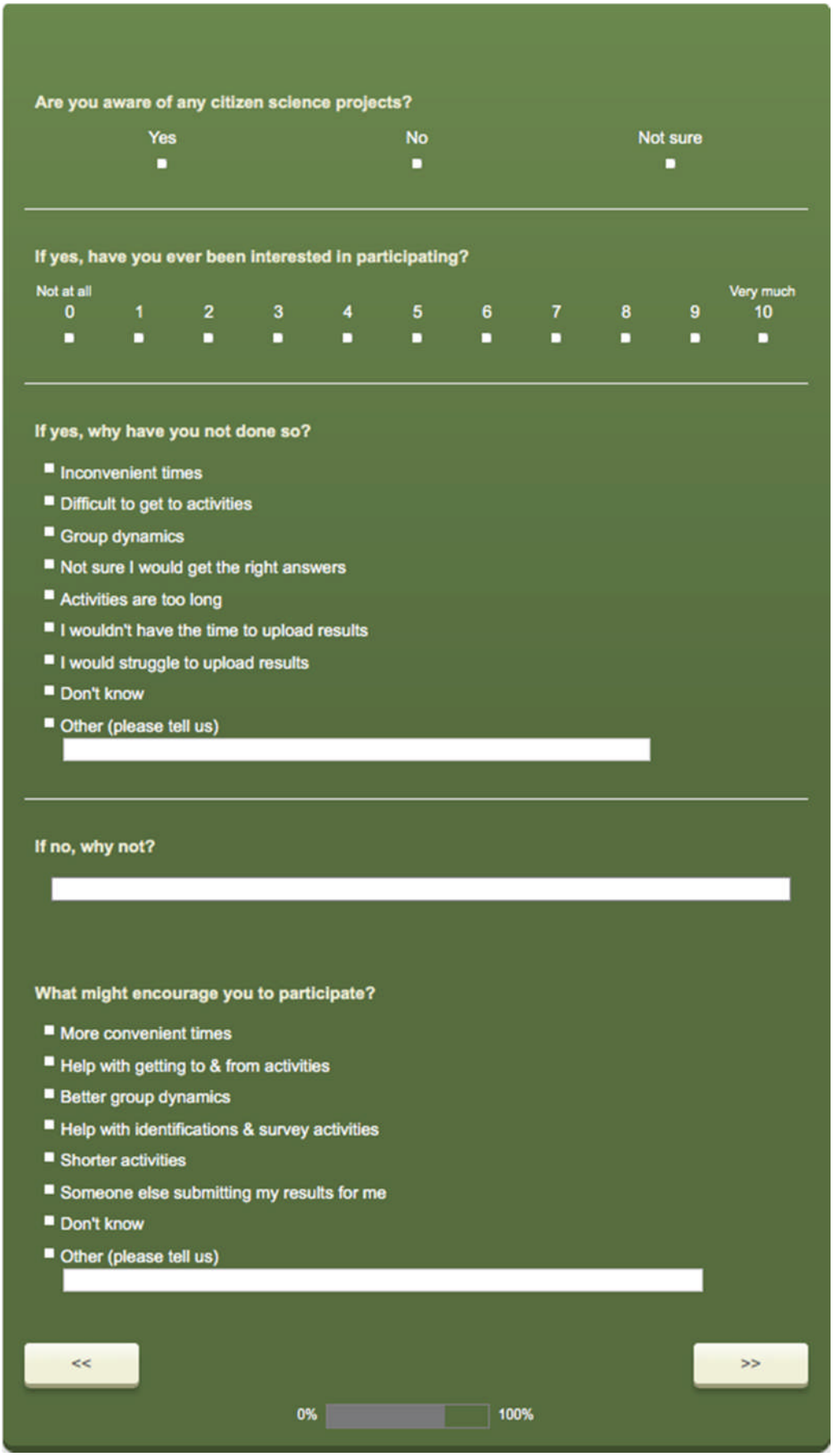
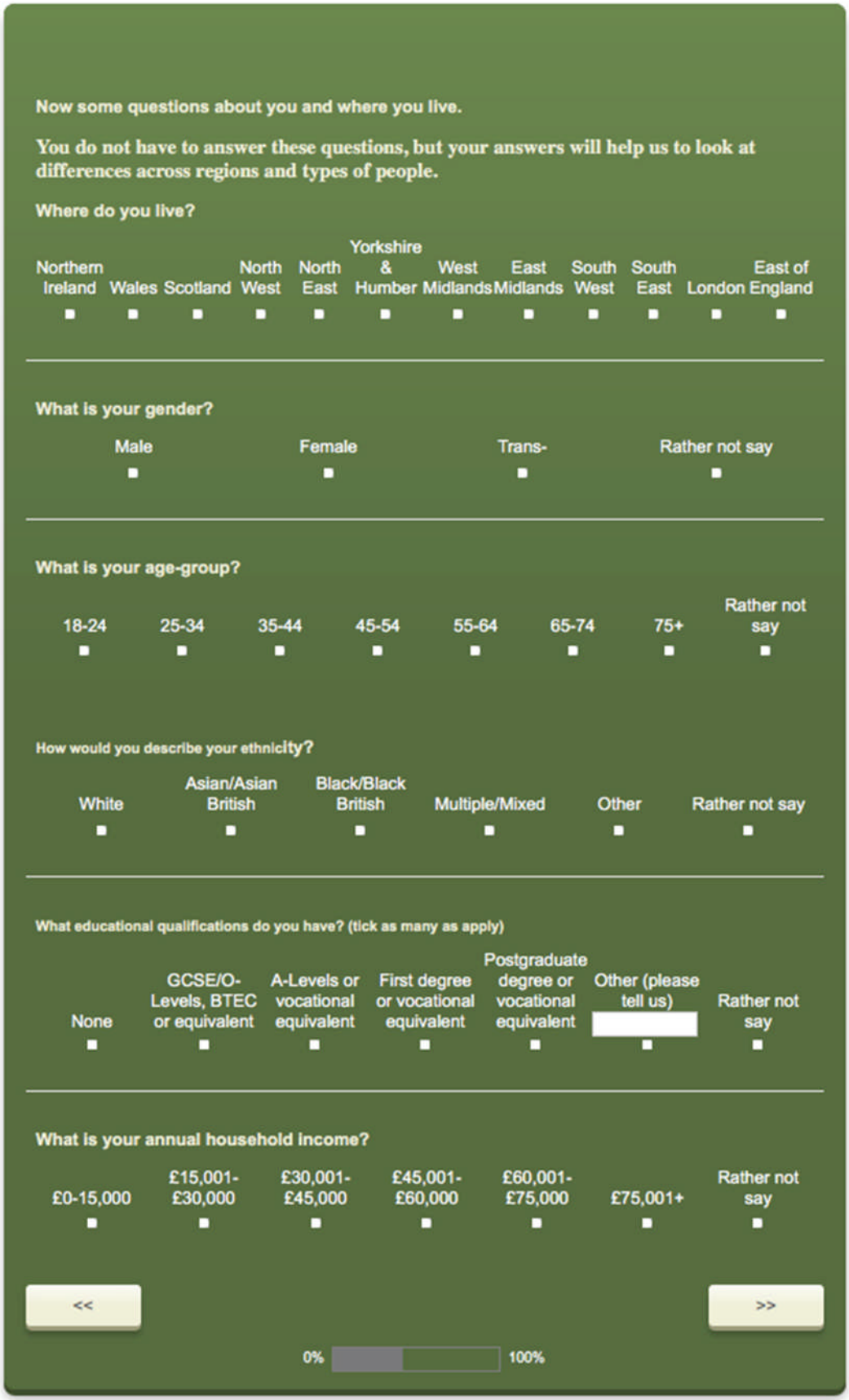
Questions for environmental volunteering respondents



Demographics for ALL respondents



Now some questions about you and where you live.

You do not have to answer these questions, but your answers will help us to look at differences across regions and types of people.

Where do you live?

Northern Ireland ■ | Wales ■ | Scotland ■ | North West ■ | North East ■ | Yorkshire & Humber ■ | West Midlands ■ | East Midlands ■ | South West ■ | South East ■ | London ■ | East of England ■

What is your gender?

Male ■ | Female ■ | Trans- ■ | Rather not say ■

What is your age-group?

18-24 ■ | 25-34 ■ | 35-44 ■ | 45-54 ■ | 55-64 ■ | 65-74 ■ | 75+ ■ | Rather not say ■

How would you describe your ethnicity?

White ■ | Asian/Asian British ■ | Black/Black British ■ | Multiple/Mixed ■ | Other ■ | Rather not say ■

What educational qualifications do you have? (tick as many as apply)

None ■ | GCSE/O-Levels, BTEC or equivalent ■ | A-Levels or vocational equivalent ■ | First degree or vocational equivalent ■ | Postgraduate degree or vocational equivalent ■ | Other (please tell us) [ ] ■ | Rather not say ■

What is your annual household income?

£0-15,000 ■ | £15,001-£30,000 ■ | £30,001-£45,000 ■ | £45,001-£60,000 ■ | £60,001-£75,000 ■ | £75,001+ ■ | Rather not say ■

<< >>

0% 100%


Thank you very much for contributing to our survey.
We greatly appreciate your taking the time to provide us with such useful information. In several months, a report on our findings will be made available on the UKEOF website (www.ukeof.org.uk), so please keep an eye on that if you would like to read more about what we find out.
0%
100%

Appendix 2: Interview sheet

Career
What is your current role?
What does it involve?
What's your main role in relation to citizen science?
Projects and definitions
How long have you been involved in CS
Is there an identifiable theme or topic to the projects?
Have the projects that you've discussed 'evolved'?
How are you defining citizen science?
Motivations
What prompted your involvement in citizen science?
What motivates your continued involvement?
Do you take into account your participant's motivations in cit sci?
Benefits, challenges, overcoming barriers
What are the benefits and opportunities of citizen science
What are the challenges of citizen science
What are the barriers of citizen science and how have you overcome them?
Feedback, communication and technology
How do you communicate with CS participants?
How important is communication?
How do you feed back to your participants?
What makes feedback effective
What role does data technology play in data collection, use and feedback?
Matched expectations, success and evaluation
What does successful citizen science look like?
What does failure look like?
How do you determine the success/failure of your projects?
How do you evaluate the impact of your projects?

Appendix 3: Survey open-ended answers

Responses to: (1) what encourages involvement in citizen science? (2) What makes participation worthwhile?

What encourages involvement?	***In their own words…***
Feedback	Good feedback to make me feel like it was worth my time; future evidence to show my data are being used and was useful; To know how the data is being used; Knowledge that my efforts have been useful to future research/conservation; Some response; academic papers, contributions to scientific knowledge; Some evidence of the data being used to extend scientific knowledge and this informing policy change; See the end result, the report, hear about the findings and whether this has resulted in changes being made; To know that data is of value to organisations and others and that it will be used to aid conservation / further research / education etc.; Valued feedback; Receive some feedback even if it is the first year of the project. Data analysis can wait but a general outline of coverage and initial observation sis very welcome; Feedback; To see results used in papers; To see how it has contributed to scientific knowledge; Positive feedback and seeing the results published; Evidence that the data collected is being used and is achieving something positive for environmental management; To see the results somewhere; Survey results update; Response from the organisers; Feedback relevant to the project, updates on the project etc.; A report of the species monitored/surveyed on yearly basis; Notification that my data has been used in the project; evidence that the data are useful or contributing to a cause (even just a map will do) - and on iSpot – identifications; Would like to receive the full outcomes or reports; some feedback that the data have contributed toward something worthwhile; so I'm not someone needing feedback, although I like to see the results; See how BTO use the final project data to report bird health and population change; Seeing reports published; being able to see my data in the context of the wider findings; need to know that the data has been acted on and feedback given - for JLbees there was alot of very helpful feedback and a feeling of belonging to the web community. A ref was supplied to a published paper; Feedback, a sense of involvement, and that results of project are used to inform policy makers; Feedback of results even if just general; Feeling that the information is of value and is used; feedback of data results; The knowledge that you are helping other people and the environment in general - derived from positive and informative feedback; Feedback; Just a confirmation that my record has been accepted; TO KNOW THAT THE INFORMATION WILL BE USED; feedback on survey at national level, and how my input has contributed; accepted records and requests for future assistance; To know what I've done is of use; To know my data is being used; To feel that my sightings information and site data have been recognised and used; Feedback and reporting; Access to combined results; That the data has been used by the organisation collecting it; data analysed and reported; To be sure that my data is contributing towards the aims of the project; Mapping, Report, Thanks/Acknowledgement for each batch of data submitted; The knowledge the info obtained is being used

	for conservation purposes; Evidence that the data is being used intelligently; Personal feedback; Evidence that the information gathered will have practical conservation outcomes; know data is valued need feedback; Knowledge that what I am doing is worthwhile; FEEDBACK! :-) (but I'm now one of the converted and self motivated anyway); Affirmation from professionals; production of annual reports; Observation of statistical data and how it reinforces decision making and habitat work (when/where/if required), plus recognition helps!; Recognition of being helpful; I enjoy statistics, so at the end of a year or survey period it's always good to see the final results (both my contribution but also overall, as usually a number of people are involved); A copy of the report where I could see the general results and, perhaps, find out how my contribution fitted in; Notification that it has been received and used, followed by maps and information on how it has been disseminated; Knowing that my data has been included in reports, charts and maps and that these are available for me to see
Impact and contribution	Positive action, sharing knowledge to help others see what lives in Orchard Park and care for it; To see the impact that it has had; know and understand how the data is contributing to ecology and conservation and how it will be used for positive change; knowledge that it is making a difference, e.g. evidence of climate change; Make a difference; Robust scientific analysis and reports leading to conservation action where required; positive results; knowing I have helped the gathering of knowledge; That I'm making an important contribution which would not otherwise be made; Useful data provided. Data provided to input on the bigger picture e.g. through NBN; data used; Need to be sure the protocols are robust; Lots of involvement and to see the results; The feeling that I am contributing something worthwhile and doing something I enjoy; not just feedback, but feeling that the general project is doing some good ie at policy making level; Participation in projects that make a difference; It would be nice to feel it had a chance of making an impact; to know that it is is being used to benefit the species involved; Taking part in it; See outcomes that reverse loss of biodiversity or could do so in the future; The knowledge that the data is being disseminated and used to inform policy; the knowledge that my data has been used to help increase understanding of wildlife biology; seeing positive benefits; To see that the whole is greater than the sum of the parts i.e. that by contributing data from a specific area, you are contributing to a national perspective; seeing the project succeed and more people join in; To see people navigating using maps I have contributed to; Completing the data collection and knowing it is useful to monitor change
Enjoyment	Enjoy doing it. My area of interest and knowledge. Confidence I know enough to report accurately; It has to be an enjoyable process; personal enjoyment and knowledge; People to enjoy and readily participate and understand the projects relevance; Happy participants and a completed survey!; It should be fun or interesting, and in the knowledge that the work has been helpful; I think it is the intrinsic enjoyment of identifying wildlife and being outside; Pleasure knowing that I am making a contribution
Good project	A feeling that the project is well organised, with serious scientific intent, and that the results are of regional/national importance

Skill development	Learning; New skills, helping others;
Involvement	Deep involvement in all aspects, not participating as a sensor.
Support	Clear instructions, support if needed, access to a forum to discuss with other citizens.

What makes participation worthwhile?	***In their own words…***
Impact	I want to know that something useful has happened, from which people or wildlife will benefit; Watching/monitoring the areas tackled. Persuading people of the value of what one is doing be it for Sustrans or trying to protect/sustain/improve the wider environment; visible progress; See obvious improvements in species numbers and distribution; The delivery of the original objectives; Some tangible results and feeling the project will have long term benefits; The feeling that I'm doing something worthwhile; To make some improvement over what went before, or to feel I'm adding to the body of knowledge about a particular site; More butterflies; Seeing the sites improve as the seasons progress during the year; To feel I have contributed something useful; To see positive output from the science; increase in public awareness; Partly satisfaction that the project is a good one; to feel that what I have done is important and will make a positive difference; To do something for which I can see/envisage some practical outcome; To see the objectives set out at the start realised or at least starting t be realised; I need to know that the results are being properly co-ordinated and contribute to understanding of wildlife issues; seeing a practical benefit, e.g. more wildlife as a result of our input; That we have done the best we can, that a site is in great condition and the species we have worked for will use it
Publication	An output; A report that says clearly what was achieved; I like to see the outcomes
Networking	Get good connections; social opportunities; I like to share what I see with other like minded people; meeting likeminded people,
Skill development	Learn new skills; Clear understanding of what is required, appropriate tools and training (if necessary), some sense of the outcome
Getting job done	A satisfactory end result. Something has been completed which may be anything from planting a tree to recording moths over the whole year; seeing benefits of work e.g. Coppicing increasing woodland flora and bird habitats; partly the feeling that I am able to make a worthwhile contribution without suffering from the cold and dampness of winter working parties
Data collection	Collecting useful data
Feedback	Feedback; Occasional thanks always welcome; Feedback from the organisation(s) you volunteer with and from people that use your material; Feedback, able to see that I have made a difference; For my own participation, I don't want someone who didn't do anything to be publicly credited while I or others who put in a lot of work are ignored, as has happened many times, but that's less important