

# DESIGNING DIVERSITY INTO CITIZEN SCIENCE



MARCH 15, 2020 - MAY 13, 2020 (D TERM)

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LEIBNIZ-INSTITUTE OF FRESHWATER  
ECOLOGY AND INLAND FISHERIES

An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science



**WPI**

# Abstract

Citizen science is being utilized around the world as a tool to involve non-professionals in the scientific process and advance the open science movement. However, it has been observed that there is a lack of demographic diversity within citizen science programs. Our project was designed to help citizen science programs increase demographic diversity within its participants through the use of guidelines and a video. After collecting data through a literature review, interviews, and a public survey, we determined the most prevalent barriers to diversity in citizen science and established methods to reduce or eliminate these barriers. We found that a lack of resources and time commitment are the largest barriers, and a lack of communication between professionals and non-professionals can exacerbate many other barriers to diversity. In addition, an unexpected barrier we found was that many people do not know what citizen science is in the first place. Our findings then informed the creation of our guidelines and video to help program leaders design diversity and inclusion into their citizen science programs. Through these deliverables, our project will give citizen science programs the tools to encourage diversity and align with the main principle of open science, science for all.

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# Expanding Citizen Science

Open science has recently been gaining momentum as a movement. It describes the process of making every aspect of scientific research available to the public<sup>1</sup>. Since 2005, the number of open science policies around the world has quadrupled. This is due to a rising increase of technology and use of the internet. Individuals can easily connect with each other and engage with information in new and collaborative ways. Not only does this increase the potential for collaboration between professionals, but it gives non-professionals an opportunity to conduct research on topics in which they have a vested interest or stake. An important tool for promoting open science is citizen science as it encourages collaboration between volunteers and organizations. Due to the many benefits of open science, leaders and organizations around the world are utilizing the principles of citizen science for the advancement of scientific research and society.

Germany has a long history of using the principles of open science to advance research. They are at the forefront of this movement around the world. Following the European Union announcement of their vision as “open innovation, open science, open to the world” in 2015, the German government stated their clear commitment to the principles of open science and open access in “Open Access in Germany”. This is seen on their website which proclaims, “The main aim of the platform open-access.net is to provide detailed information about open access for scholars and other stakeholders”<sup>2</sup>. By 2019, there were 96 citizen science projects officially registered with the German Federal Ministry for Education and Research<sup>3</sup>. Additionally, Berlin hosted the first European Citizen Science Association conference where “The Ten Principles of Citizen Science” were developed. These principles serve as a reference to programs around the world as to what makes a well-developed and impactful citizen science project. Therefore, Germany is well established as a leader in utilizing citizen science and open science principles in scientific practices nationwide. Despite these achievements, there are prevalent issues surrounding the

formation and continuation of citizen science projects in Germany and around the world.

Citizen science has many benefits for the future of research and innovation; however, many programs struggle to create a substantial impact. This can be attributed to factors such as a lack of training, inconsistency in data collection, lack of resources, and organizational issues. A glaring issue is that citizen science programs fall short on diversity and inclusion. Integrating diversity and inclusion into citizen science encourages projects that are relevant to society, facilitates discovery, and empowers individuals to aid in decision making processes. Most importantly, it aligns with the main principle of open science, “science for all”. However, there is an observed lack of representation worldwide, and as a result, citizen science programs are not as impactful to society as they should be.

Because of the importance that diversity and inclusion holds for citizen science, we aim to create guidelines for citizen science programs that will support the participation of under-represented individuals. In order to create those guidelines, we will first develop an understanding of the structure of citizen science programs and how diversity is defined within them, as well as the factors that prevent diversity in citizen science. It is important to understand the reasons or theorize what is preventing individuals from partaking in these programs, whether it be lack of interest or lack of knowledge about them. Then, with several preventing factors laid out, we will establish methods to eliminate or diminish these factors. Finally, we will use these methods to create a list of guidelines for budding and even established citizen science programs to use to grow their program. By using the guidelines we develop, citizen science programs worldwide will be able to increase diversity and inclusion in their programs and change the world of science as a whole.



Citizen science participants discuss their project.  
Photo by Alyssa Jones Wood (Provided courtesy of AGU Thriving Earth Exchange)

# Background

Open science is a movement that is changing the way science is studied and understood around the world. Through its main principle, “science for all”, the movement emphasizes making the scientific process more collaborative and transparent. The opportunity for further discovery is not limited to professionals in the field, anyone with an interest can participate regardless of their skillset or professional status. The concept of open science has existed for many years; however, it has recently increased in importance due to the rise in technology. Participants are able to learn about various topics and connect with each other more easily than before, leading to increased collaboration between individuals. Research findings and detailed data can also be stored and shared easily which facilitates further discoveries. This rise in open science can be seen through the increasing number of policies, repositories, and open science initiatives around the world.

From 2005 to 2016, the number of open science policies rose substantially to over 800 policies, many of which were at the research organization level. In 2015, the EU announced its vision for science as “open innovation, open science, open to the world”. In 2019, the United States had 1048 research data repositories available to the public with no restrictions<sup>4</sup>. At the same time, in the Asia and the Pacific Region, UNESCO held a workshop to assess their own open science initiatives and investigate possible barriers and opportunities for advancement<sup>5</sup>.

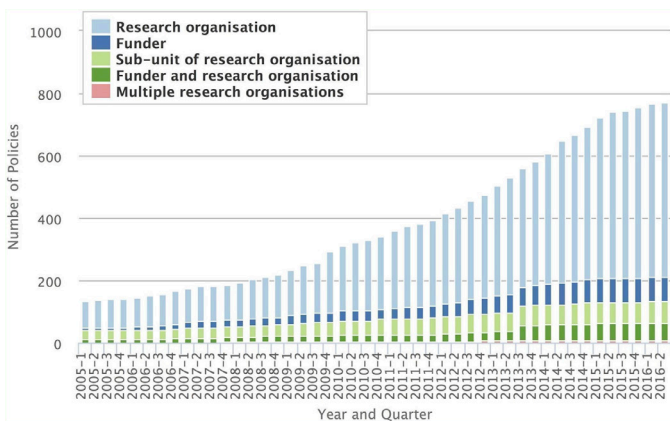


Figure 1: The number of open science related policies worldwide from 2005 to 2016<sup>9</sup>.

Citizen science is gaining importance as a tool to advance the open science movement. As shown in Table 1, the number of fields utilizing citizen science has grown substantially. In addition, the total number of citizen programs has increased from 3 to 333 within a span of less than 20 years. Therefore, along with the rise of the open science movement, citizen science has also experienced a rise worldwide. Citizen science is a collaboration between volunteers and organizations to increase overall scientific knowledge in society. Following the principles of open science, citizen science allows for volunteers to participate in the scientific process regardless of their background. They can become educated in recent discoveries in their field of interest, weigh in on societal decisions, and help accelerate scientific discovery. In addition, citizen science encourages organizations to focus on open sourcing all their research and making it widely available. This helps gain interest in the particular field and also gain a large amount of resources through their volunteers. There are three main aspects to citizen science: open access, data collection, and project formation.

Making scientific information open access facilitates discoveries due to the transparency of the data and methods. Open access is making scientific information, especially a study’s methods and raw data, more available to the public and allowing every individual regardless of their profession to view and learn from the information. There is also more opportunity for people to build upon existing research. This can lead to collaboration among scientists, especially through interdisciplinary research<sup>6</sup>. The co-director of iNaturalist found that about 150 papers had used the open sourced citizen collected data from the iNaturalist project since 2008. The data was able to facilitate discoveries by scientists who were not even a part of the iNaturalist project because the data was open sourced for all to use<sup>7</sup>. In addition, many policies are now being put in place for researchers who receive certain types of funding to publish their research in an open access format. For example, the Robert Wood Johnson Foundation, a major American foundation that supports health-related research, released a statement in 2019 stating that “Research funded by the Robert Wood Johnson Foundation and appearing in peer-reviewed journal publications must be made freely and immediately available for all”<sup>8</sup>.

*Data collection* by citizen scientists leads to less strain on researchers and better analysis. Data collection

Topic	1997–1999	2000–2002	2003–2005	2006–2008	2009–2011	2012–2014	All Years
Astronomy	0	0	0	0	10	34	44
Environment	0	0	1	5	9	37	52
Biology	3	3	11	16	60	234	327
Medical	0	0	0	0	1	8	9
Others	0	0	0	0	4	20	24
<b>Total</b>	<b>3</b>	<b>3</b>	<b>12</b>	<b>21</b>	<b>84</b>	<b>333</b>	<b>456</b>
<b>Break-down of Biology Category</b>							
Avian	3	2	6	8	22	70	111
Marine	0	0	1	1	10	42	54
Terrestrial invertebrates	0	1	3	4	13	56	77
Herpetology	0	0	0	1	2	7	10

Table 1: The distribution of citizen science projects by topic. The data was collected by analyzing citizen science programs through article mentions online<sup>10</sup>.

# Background

is when participants collect relevant data mainly through a mobile application and send it to researchers for analysis. Due to new advances and the increased availability of technology in recent years, volunteers can explore and participate in projects online as well as share relevant data more efficiently. In addition, the tools used in the field have advanced and provide richer data for researchers to use<sup>11</sup>. For researchers that do not have a significant amount of funding, they can gain a large number of volunteers who can easily contribute data, especially through their own mobile devices. A project in Belgium focusing on air quality was able to get about 20,000 people to participate in their project and gain about 17,800 data points. In their analysis they found that certain building arrangements could concentrate traffic exhaust in areas which were a more significant contributor to air pollution than previously thought. Therefore, through the help provided from citizens in the data collection process, scientists were able to collect massive amounts of data at a low cost and better analyze the data set<sup>7</sup>.

Involving citizen scientists through project formation allows for people to create projects based on their interests and prevalent issues in their community. In helping with project formation, participants bring forth an idea or issue and work with an organization to develop methods to study it. This increases interest in science from the community, especially in communities where the majority is not highly educated in scientific fields. An example is the Parks and People Foundation in West Baltimore. The organization worked with community members to determine which projects would be more important to and have more impact on the community. They chose co-leaders from these communities who then helped recruit more participants from their respective areas.

The organization found that participants were more engaged in the projects and dedicated to finding solutions when they had a say in the creation and implementation of the program<sup>12</sup>.

An example of the impact of citizen science can be seen in Linking Landscapes which encouraged collaboration with the community and the formation of policy. Linking Landscapes is a Massachusetts program that focuses on reducing the number of moose and turtle deaths due to road accidents. Through the data collected by volunteers, the MassWildlife organization was able to analyze which areas were hotspots for moose and turtle crossings. They were then able to work with the community to put up warning signs for drivers at these locations. Without the plethora of citizen collected data, the organization may not have been able to accurately locate these hotspots<sup>13</sup>. In addition, the use of citizen science generated enough interest within the town to put up the warning signs. Without this interest, taxpayers and town leaders may not have thought this was an important enough issue.

It has been observed that the benefits of citizen science are further enhanced when programs focus on diversity and inclusion. Since a volunteer's contribution to a project relies on their passion in the topic rather than an extrinsic reward, diversifying project type ensures that everyone can find something that interests them. Having a demographically diverse group of participants brings different ideas and stakeholders and helps to educate various communities that previously may have been overlooked. This also increases the motivation of volunteers since the topic being research has a direct connection to them. The Port Phillips EcoCentre in Australia found that having diverse participants helped their information reach more communities. Volunteers would go back to their community and educate their friends and family in what they learned. Finally, by diversifying the levels of citizen science participation, programs can bring more impact into their project as a whole. As shown in the example with the Parks and People Foundation in Baltimore, Maryland, without the input from members of the community, the organization may not have been able to design projects that have a significant impact. Having the community leaders brought in more participants for data collection which in turn maximized the amount of data collected. However, despite the significant impacts of diversity on citizen science, programs around the world fall short in including underrepresented groups.

The lack of diversity in citizen science programs worldwide shows a disconnect from the main principle of open science, science for all. It is important to note, observation of this claim has been made mainly by project leaders. There are several studies that support this observation, one of which is a recent study performed in Chile. In this study, profiles of divers participating in citizen science as well as their incentives for participating were developed and analyzed by scientists<sup>14</sup>. As shown in Table 2, it was found that there was very little diversity in participants as the majority of divers were middle-age Chilean men, showing very very little diversity in participants. A potential reason for these commonalities is that diving requires a base level education. In order to participate, citizen scientists must complete a course on how to scuba dive. Those who are not willing to complete the course are therefore restricted from participating.



Photo provided by Penguin Watch

# Background

	Artisanal fishermen N = 71	Dive instructors N = 34	Scientific divers N = 58	Recreational divers N = 52	Various N = 14
Nationality (%) Chilean	100%	94%	93%	90%	100%
Gender (%) men	87%	76%	78%	67%	100%
Age (Average ± SD)	48 ± 9	34 ± 11	35 ± 8	34 ± 9	37 ± 13
Education level (%) post-secondary	0%	76%	100%	69%	36%

**Table 2: Measures of diverse categories pertaining to citizen science divers in a study in Chile<sup>17</sup>.**

Most studies tend to be niche and not widely applicable, with supporting evidence for the lack of diversity focused on general observation of citizen science programs. Two barriers preventing organizations from collecting data on diversity in citizen science are laws meant to protect personal data and difficulties producing ways to collect this data. In some countries, privacy laws have been enacted to protect citizens' personal information, making it very difficult for organizations to collect demographic information on participants in their program. For example, in Germany Bundesdatenschutzgesetz (BDSG) is a Federal Data Protection Act in Germany that regulates how public bodies process and distribute personal data<sup>15</sup>. In addition to privacy laws, many citizen science programs also lack the facilities to collect data on their participants. It is common for organizations to collect data from citizen scientists through apps or websites where personal information is not required for submission. As a result of these restrictions, organizations generally rely on observations by project leaders to understand the state of diversity in programs.

Despite the lack of qualitative data, citizen science programs have been actively exploring methods to improve diversity and inclusion in programs around the world. Studies have found citizen science programs that focus on providing diverse learning outcomes and work towards improving the surrounding community tend to gain more support from a wider

variety of participants<sup>16</sup>. For example, the Propage Programme in Grenoble, France works to increase diversity through making projects more accessible and engaging. Designed by the French Natural History Museum, Propage engaged park workers by having them monitor the effect of city management on butterfly populations. Opportunities for training workshops and individual feedback was provided to the workers by project leaders. This gave workers a sense of importance which made them more involved and interested in the program. Both the workshops and feedback expanded citizen science projects in the Propage Programme to include participants in different economic classes and educational levels. This not only benefited the community, but also gave the Propage Programme a larger, more accessible database.

Organizations can also increase diversity within their programs by actively seeking out underrepresented communities and generating interest. The Port Phillip EcoCentre has been working to increase the cultural diversity in both their citizen science participants and their staff. The organization has done this through, first, hiring a diverse staff and, second, through programs designed to encourage participation in diverse communities. When hiring, culturally and linguistically diverse prospects are sought out by EcoCentre in the hopes that they will draw participants in from their communities. Programs such as the multicultural ambassadors work to increase diversity of participants in a similar way. The Multicultural Ambassadors program was designed to provide opportunities for culturally diverse individuals to gain experience in the environmental field. Participants are often at the beginning of their careers and lack experience, this program gives them this experience and exposes their communities to citizen science.

Incorporating diversity and inclusion in citizen science programs helps emphasize the guiding principle of open science, "science for all". Including underrepresented groups in these programs facilitates innovation and new scientific discoveries on a larger scale. The principles of open science can be applied to different fields, data collection and analysis can be conducted on a massive scale, and projects that heavily impact society can be formed. By designing diversity into citizen science, citizen science can maximize its effectiveness as a tool for open science.



**A citizen science participant shows off the samples collected.  
Photo provided by Port Phillip EcoCentre**

# Methods



Figure 2: An overview of our methods.

The goal of our project is to establish means of increasing diversity in citizen science programs. In order to achieve this, we have created five objectives: (1) understand the structure of citizen science programs and how diversity is defined in citizen science, (2) understand the factors that prevent diversity in citizen science, (3) establish methods to eliminate or diminish these factors, (4) create guidelines for organizations to increase diversity, and (5) create a form of media to display the guidelines.

Our sponsor for this project is Leibniz-Institut für Gewässerökologie und Binnenfischerei (IGB) or Leibniz-Institute of Freshwater Ecology and Inland Fisheries. IGB is a research organization dedicated to the understanding of freshwater systems in order to preserve them. Their mission is to generate objective and evidence-based knowledge of freshwater systems, and to make that knowledge available for the public<sup>18</sup>. IGB has several citizen science programs, in which they want to increase the diversity of participants. It is also important to note the involvement of ACTION within these programs. ACTION is an organization whose goal is to “make citizen science more participatory, inclusive and citizen-led, acknowledging the diversity of the citizen science landscape and the different, evolving challenges citizen science teams must meet as their project develops”<sup>19</sup>. ACTION supports many citizen science programs around the world by providing mentorship that ensures projects develop in a positive direction. They sponsor several projects at IGB.

## 1. Understand the structure of citizen science programs and how diversity is defined in citizen science

The first objective of our project was to understand the structure and limitations of citizen science programs. If our overall goal was to establish means of increasing diversity in these programs, we first had to obtain a thorough understanding of how they operate and what limits them. We followed several steps in order to complete this objective, which included: conducting secondary research, identifying major limiting factors in citizen science programs, and interviewing leaders of current programs.

The secondary research we conducted was to inform us on the overall state of current citizen science programs, but also the state of diversity within these programs. We looked for information that described how various programs operate, as well as what demographics make up these programs. It was important that we figure out what specifically makes citizen science a success or a failure. The research was conducted by all members of the team and was compiled. We mainly used scholarly articles and research papers so that our sources remain credible.

The next priority was establishing a definition of diversity within the context of citizen science. This was accomplished through our secondary research and initial interviews with program leaders. The secondary research helped us determine whether programs encourage diversity in their principles and guidelines and whether they attempt to gather data on the state of diversity in their program. The interviews were conducted with citizen science program leaders through Zoom. In the interview, we aimed to learn how different programs view and prioritize diversity and inclusion. We then decided upon a universal, clarifying definition of diversity for our project which helped us with our second and third objectives.

## 2. Understand the factors that prevent diversity in citizen science

Our second objective was to understand the factors that prevent diversity in citizen science. To accomplish this, we started with a literature review by performing secondary research on 28 articles and studies related to diversity in citizen science. We focused on barriers that prevent people from participating in citizen science programs. We recognized that there is not a lot of data and studies performed on this topic, therefore we expanded our research to include participatory science and diversity in programs unrelated to citizen science. This step was conducted in multiple rounds, so that we could develop a thorough source of data. The findings from our literature review were later used to create an interview guide.

We then furthered our understanding through seven interviews conducted with citizen science programs around the world. When choosing programs to interview, we focused



# Methods

on those who emphasized diversity or collected demographic data on the participants. Before the interviews, we had participants sign a consent form specifying whether they approved of us recording video and audio, only video, only audio, or nothing at all. The recordings from the interviews were then transcribed and classified to find important concepts and trends. This helped to further develop our list of factors.

Lastly, we performed a general survey to determine what either motivates or keeps people from participating in citizen science. We also ask for demographic data in the survey in order to see if there is a correlation between those who participate and their demographics. We distributed the survey on social media and through our sponsor, and we received 172 responses total. Through the literature review, interviews, and survey, we were able to create a list of factors that prevent diversity in citizen science.

### 3. Establish methods to eliminate or diminish these factors

Our third objective was to establish methods to eliminate or diminish the factors found in Objectives 1 and 2. In order to do this, we conducted further literature review and interviews with project stakeholders. In our literature review, we developed a list of 22 articles written on studies that analyze projects with success in overcoming factors preventing diversity. From our review, we collected a list of methods that are proven to be effective. This helped to give us concrete and realistic guidelines that are proven to work in real citizen science programs.

In the interviews, we focused on how citizen science organizations have overcome barriers to diversity and potential guidelines for citizen science projects. These interviews were semi-structured, but conversation surrounding the topic of each question was encouraged. This was to allow the interviewee to reflect more on each topic, providing us with more specific data. The data collected from these interviews was coded into similar categories to highlight trends that show which methods of diminishing the factors in objectives 1 and 2 have been most effective. Once this was completed, we derived potential methods that organizations can use.

### 4. Create means to help program leaders achieve diversity in their citizen science programs

Our fourth and final objective was to create a way for citizen science programs to benefit from our findings and improve the diversity of their programs. We decided to create a rubric and guidelines, along with a video. The rubric is for program leaders to analyze the status of their program in terms of inclusion, and the guidelines explain how to improve the areas in which they score low on the rubric. The video is meant for program leaders, and it expresses the message that further action must be taken in order to increase diversity in citizen science, and it then points those leaders to our rubric and guidelines.

Both the rubric and the guidelines were derived from the research and interviews we completed for our previous objectives. For the rubric, we developed various categories for an organization to be scored based on the various barriers for inclusion that we found in our research. We created several

subsections of guidelines, each applying to a different category of our rubric. Our aim was to inform organizations on various approaches they can take for the rubric category in which they need improvement. We also received input from program leaders on our rubric and guidelines as we created them. It was important to ensure that the guidelines we create are applicable to programs, and the rubric is a fair way to analyze them. We achieved this by receiving direct input from program leaders as the guidelines were being created. We reached out to the same people in which we interviewed for our previous methods, and asked them to review and provide feedback on our guidelines. We also reached out to other leaders, experts, and volunteers in citizen science, bringing our total of collaborators to six. By the end of these conversations, we had formed a concrete list of guidelines explaining how to make improvements.

Lastly, a video was created to inform program leaders that action must be taken in order to enhance the inclusion of their program. It was made short and direct, quickly expressing our message and moving the viewer on towards our rubric and guidelines. We started the process by developing a storyboard (see Figure 4). We then developed the actual video using simple animations that were meant to keep viewers engaged in the message.

## OUR DATA COLLECTION PROCESS



**LITERATURE REVIEW**  
total of **28 articles**  
reviewed in two rounds

**INTERVIEWS**  
total of **7 interviews** with  
program leaders in the  
United States, United  
Kingdom, and Australia



**PUBLIC SURVEY**  
total of **172 responses**  
from individuals in the  
United States and Germany

**Figure 3: An overview of our data collection process**

# Data Analysis

The first two objectives of our project required a literature review, as well as interviews. Through these methods, we aimed to develop an understanding of: (a) how citizen science programs are structured, and (b) what factors prevent diversity within citizen science. Our literature review consisted of 28 articles related to the topics of diversity and citizen science. This review was done in two rounds to determine prevalent barriers to diversity in citizen science. In the first round of review, we studied a total of 8 articles to find mentions of factors that lead to a lack of diversity within citizen science. From this, we created a list of 19 barriers that we expanded on in the second round. In the second round, we studied a total of 20 articles to determine the frequency of mention of each code. We also found 9 more barriers that we added to our total list of codes.

Barrier	Code	Frequency	Barrier	Code	Frequency
Stigma against Non-Professionals	1SNP	8	<b>Lack of Resources</b>	<b>15LR</b>	<b>27</b>
Lack of Stakeholder Management and Analysis	2LSM	8	Mode of Advertisement	16MA	10
Knowledge Disconnect	3KD	8	Stigma Against the Subject of the Study/Project	17SSS	2
Discourse on Relevancy	4DR	12	Current Scientific Practices and Expectations	18SPE	6
Level of Participation	5LP	2	Language and Culture	19LC	10
Workshop/Material Effectiveness	6WME	6	Funding Status	20FS	1
<b>Commitment Level/Timeline</b>	<b>7CLT</b>	<b>23</b>	Visual Identity/Branding	21VIB	2
Unclear Definition of Participation	8UDP	4	Minority Groups	22MG	5
Education and Skill Level	9ESL	13	Lack of Diveristy in Study Topic	23UAT	1
Personal Feelings of Incompetence/Confidence Level	10PIC	8	Personal Recognition	24PR	1
Ethics about Data Collection and Privacy Concerns	11EDP	5	Disability/Health	25DH	8
<b>Communication between Professionals and Non-Professionals</b>	<b>12CPN</b>	<b>16</b>	Organizational Issues	26OI	1
Power Imbalances	13PI	8	Mistrust	27MT	5
Motivations (both Organization and Participant)	14MOP	13	Complicated Data Sharing Practices	28CDP	2

**Table 3: Barrier frequency found in literature review**

Informed by our findings, we then interviewed seven citizen science program leaders around the world to understand their perspective on diversity in citizen science. We created an interview guide with questions targeted towards program structure, how the interviewees defined diversity in the context of citizen science, and what the organization does to facilitate diversity in citizen science. We then transcribed the interviews and determined the frequency of each barrier using the same codes from the literature review. This gave us the relative weight and importance of each of these barriers.

Lastly, we designed a general survey using Qualtrics. The survey asked about people's knowledge and involvement in citizen science programs and collected demographic data. We received a total of 172 responses from people in our local communities in New England. Out of the 172 responses, 22 people had been involved in citizen science programs at some point in their life. If people knew what citizen science was and either never participated or stopped, we asked for a text response as to why.

Barrier	Code	Frequency	Barrier	Code	Frequency
Stigma against Non-Professionals	1SNP	0	<b>Lack of Resources</b>	<b>15LR</b>	<b>7</b>
<b>Lack of Stakeholder Management and Analysis</b>	<b>2LSM</b>	<b>4</b>	Mode of Advertisement	16MA	1
Knowledge Disconnect	3KD	1	Stigma Against the Subject of the Study/Project	17SSS	0
<b>Discourse on Relevancy</b>	<b>4DR</b>	<b>7</b>	Current Scientific Practices and Expectations	18SPE	1
Level of Participation	5LP	2	Language and Culture	19LC	2
Workshop/Material Effectiveness	6WME	3	Funding Status	20FS	1
Commitment Level/Timeline	7CLT	3	Visual Identity/Branding	21VIB	0
Unclear Definition of Participation	8UDP	0	Minority Groups	22MG	1
Education and Skill Level	9ESL	0	Lack of Diveristy in Study Topic	23UAT	1
Personal Feelings of Incompetence/Confidence Level	10PIC	0	Personal Recognition	24PR	0
Ethics about Data Collection and Privacy Concerns	11EDP	2	Disability/Health	25DH	1
Communication between Professionals and Non-Professionals	12CPN	3	Organizational Issues	26OI	0
Power Imbalances	13PI	0	Mistrust	27MT	0
Motivations (both Organization and Participant)	14MOP	3	Complicated Data Sharing Practices	28CDP	0

**Table 4: Barrier frequency found in interviews**

# Results

Our objectives were achieved through the collection of data through a literature review, interviews, and a public survey. Our findings were then used to inform the production of our video and guidelines.

## The Structure of Citizen Science Programs

First, international citizen science programs vary in structure. Due to the fluidity of the definition of citizen science, it makes an excellent tool for a wide array of goals. Many programs have adapted citizen science to best fit their needs and study questions. For the purposes of our study, we have defined citizen science as a collaboration between volunteers and organizations to increase overall scientific knowledge in society. In our interviews, program leaders expressed a multitude of different ways they define citizen science. For example, the Thriving Earth Exchange uses the term community science rather than citizen science. The Thriving Earth Exchange feels community science expresses their goals and program structure better than citizen science, which typically does not have the in-depth collaboration between volunteers and professionals that the Thriving Earth Exchange's programs do. Terminology is only a small portion of how citizen science has been adapted.

One of the largest disparities in citizen science program structure we found was online data collection and in person community-oriented programs. Many of the online data collection programs found on websites such as Zooniverse or SciStarter focus on providing volunteers an interesting, fun experience. For example, Penguin Watch works through a simple platform that allows participants to view penguins in time lapse and motion sensor imagery. Program leaders have found this attracts many participants through the subject matter and activity. In contrast, programs that work more directly with specific communities tend to consider community values more heavily and implement them into their programs. The Baltimore Mosquito Study utilized a citizen science program that worked very closely with community members to build an understanding of their values and what they wanted from the project. While the main goal of the study was to collect mosquito data, the program also helped the community take action against pests by providing them data to bring local government leaders and identifying illegal trash dumping sites. Thus, programs all use citizen science as a tool for collecting data, but the ways in which they accomplish this are varied.

## The Definition of Diversity in Citizen Science

Citizen science programs generally define diversity with respect to demographics, rather than project type or participation level, but their prioritization of which demographics fluctuates across programs. Throughout our interviews, program leaders stated they defined diversity through factors such as location, education level, gender, and ethnicity. Only one of our interviewees, a program leader from the Baltimore Mosquito Study, explicitly used the word demographics, as she defined diversity as socio-demographic. In both of our interviews with program leaders from the Port Phillip EcoCentre, diversity was defined through having people from many different locations, educations, professional backgrounds and interests. As one program leader stated, interests. As one program leader

stated,

“Well, in the context of citizen science diversity would be people from all kinds of different backgrounds. It could be people who have an affinity with science because they are scientists themselves or could be retired scientists who still want to do some science. But it could also be people who live near a local beach and have nothing to do with science but are sick with seeing the litter and want to do something about it. Those people could be graphic designers, or lawyers, or stay at home dads, could be anyone.”

Similarly, a program leader from the Thriving Earth Exchange defined diversity not only through gender, geographic location, and education but also through having participants with different perspectives and life experiences.

Diversity is considered by many programs, but their implementation of concrete steps toward making those programs more inclusive is inconsistent. Many programs, especially those that collect data through online platforms such as apps or websites, understand the importance of and value diversity but do not take further steps to address the diversity within their programs. In our interview with a program leader from Penguin Watch, we discussed how large-scale, online programs commonly assume that having their project on an online platform makes it extremely accessible and removes many barriers to participation. Programs also may recognize the importance of diversity but not take steps towards understanding diversity within their program because they do not want to collect information on participants. We found in an interview with a program leader from Linking Landscapes that they do not ask participants for personal information because they do not want to track them. Instead Linking Landscapes focuses on making their program accessible by providing multiple ways of sending in data, holding workshops in person and online, reducing the commitment level.

## The Biggest Barriers to Diversity in Citizen Science

Through our literature review, interviews, and survey, we identified lack of resources and time commitment as the biggest barriers to diversity. In order to participate in citizen science programs, volunteers may require resources ranging from field kits to internet connection. Therefore, if they do not have the resources required, they are unable to participate in the program. This is an issue especially prevalent in many low-income groups and for citizen science programs who may not have the resources themselves to provide for all of their volunteers. To overcome this barrier, we found that programs can partner with other local organizations to provide resources that volunteers may need to participate. For example, a program that asks its volunteers to grow various plants can partner with a local community garden to provide the materials needed to do so.

In addition to a lack of resources, potential participants may not have enough time to dedicate to citizen science projects. This is especially a problem for more community-oriented citizen science programs where heavier participation is needed. On the other hand, even many online data collection programs have sporadic contributions, with some volunteers only showing up once. These programs are mostly low commitment and easy to participate, but individuals may forget about it or lose motivation after their initial data offering. For

# Results

For leaders, clarifying the time commitment involved might be a potential solution by helping participants feel less intimidated by the time requirement and understanding exactly what is required of them before beginning. In addition, programs can work to provide several tiers of contribution, starting with very minimal data collection and ending with involvement in project formulation and management. This gives volunteers a choice as to how much time they would like to commit in addition to removing reservations about participating in citizen science projects.

## The Importance of Communication in Citizen Science

A lack of effective communication between professionals and non-professionals can exacerbate other barriers to diversity and lead to less participation. For example, when non-professionals are not given feedback or provided with opportunities to contribute to project management, they could feel less involved or appreciated in the project itself. Similarly, if professionals do not focus on communication during the project formation and clarification of roles and responsibilities, the project could lose impact on the community or result in volunteers who are not clear on what is expected of them. Therefore, effective communication between professionals and non-professionals needs to be a two-way street.

Beyond communication, co-designing was another key aspect that we found essential to creating more community buy-in, pride, and investment in citizen science projects. For projects that are more community focused, encouraging community voice at every phase of the project can lead to impactful project outcomes and an increased sense of involvement. For example, by involving the community in data analysis, an organization can put the data in perspective and co-design potential solutions. One project leader stated,

“So sometimes we would do data analysis of the data that the citizen scientists had collected and talk about that in relation to landscape variables or “what does that mean for your specific neighborhood” or talk about “how can we translate this data for advocacy?” or “what does this mean in relation to other problems that you are facing?” ... I think it was helpful and fulfilling and I think it fulfilled a really important need for some individuals, that they’re not faceless individuals that are collecting data and sending data but that there’s opportunities with the scientists themselves or with us as the scientists and the project leaders.”

As a result of using co-design principles in the project, both the organization and the volunteers were able to benefit in multiple ways. The organization was able to gain multiple perspectives during data analysis, and volunteers gained a sense of importance in the project. This in turn helped retain community participants and encouraged others to join the project.

In the literature review, we found that simply encouraging project leaders to reach out to the community may not be enough. A contributing factor to the lack of communication is that there may be a significant power imbalance between the organization and its volunteers. For example, workshops can be directed towards solely teaching volunteers skills rather than also educating professionals on the issues of the community. Something such as giving disproportionate speaking times to organizers and volunteers further reinforces the sense

of the organization being more important than the volunteers. Therefore, it is imperative that organizations focus on opening communication channels both ways. This may involve designing workshops that encourage organizations and volunteers to co-manage projects, training program leaders on effective communication strategies, and providing open lines of communication through phone, email, or online chat services.

However, projects that are already existing or that involve data collection or analysis on a massive scale would not be able to involve volunteers in every stage in the project. In addition to providing open lines of communication through email, online forums, or online chat services, we found that providing feedback could encourage volunteers to continue participating. For smaller projects, this feedback could be given in-person or online on an individual basis and push the volunteer to improve their participation. For larger projects, individual feedback may not be as possible due to the lack of resources needed to do so. A solution then would be to provide automated feedback or gamify the project. For example, iNaturalist, a large-scale online citizen science project, uses a leaderboard system in order to encourage participants to submit their data. The leaderboard is an effective yet simple tool for large scale organizations to increase a volunteer’s sense of importance within the project without diverting much needed resources. A leaderboard, like the one shown in Figure X, keeps track of points earned by participants, which in turn motivates them to compete with each other and participate more. In the end, by working to improve communication between an organization and its volunteers, programs can encourage participation, especially of underrepresented groups.

## The Public’s Response to Citizen Science

In our survey of the public in both New England and Germany, we found that many people do not know what citizen science is. Only 51 of 172 (~30%) respondents replied “yes” to “Do you know what citizen science is?” A majority of these respondents were middle-age white females with a high education level. This indicates that many groups may be

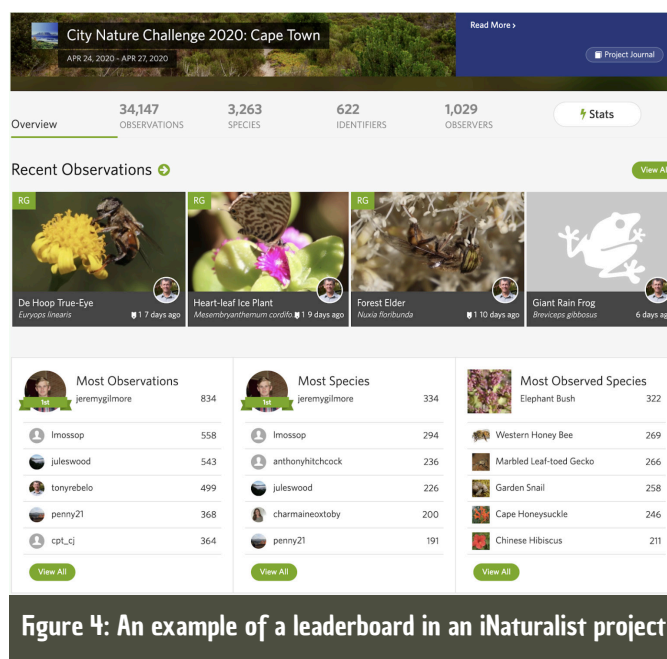


Figure 4: An example of a leaderboard in an iNaturalist project

# Results

underrepresented simply because they do not know about citizen science or how they can be involved. This may be due to the fact that citizen science as we know it today is still an evolving tool. As we found in objective one, many organizations have adapted citizen science to fit their specific needs, and the definition of citizen science itself is still extremely fluid. Potential solutions mainly involve transforming marketing strategies of citizen science programs. In addition to making the program available online, local organizations can advertise at community events and actively seek out underrepresented groups. By educating underrepresented groups about citizen science and engaging in direct outreach, programs can increase participation as a result.

## Creating Guidelines and a Video to Aid Citizen Science Programs

Based on our research, an organization that is successful in improving the state of diversity is one that implements diversity and inclusion into every aspect of its design and results in both the recruitment and retention of underrepresented groups such as minority or low-income groups. In order to help them do so, we created tools for organizations to both recognize the issue of diversity in citizen science and steps that can be taken to improve the state of diversity in their programs. Our first tool is a set of guidelines from which any program can understand what makes a program successful in overcoming barriers to diversity and what steps can be taken to be successful. Our second tool is a video that introduces our guidelines to program leaders and highlights their purpose.

Our guidelines were developed for program leaders to use, and they are meant to explain the various approaches a program could take to increase diversity. We developed these guidelines with convenience in mind, aiming to make it as easy as possible for any program to benefit from our work. For that reason, we categorized five broad areas in which programs could have potential diversity barriers: structure, recruitment, volunteer resources, communication, and relevancy. Each section of the guidelines includes a list of assertions as to what makes a program successful in overcoming specific barriers to diversity. For example, an assertion under “Structure” is “The program analyzes and manages stakeholders to ensure that every stakeholder benefits in some way from the project”. In our research, we found that performing a stakeholder analysis helps programs determine the specific needs of the different groups either involved in or affected by the project. This in turn helps programs reach out to a diverse set of groups in a more effective way. Under each assertion, we provide recommendations as to how the program can improve in that area. These recommendations are built off of our research as to what programs are already doing to improve on the state of diversity. However, we did not limit ourselves to citizen science programs and also included what organizations in general do to increase diversity in the workplace. In the stakeholder assertion, one of the recommendations is to “conduct an effective stakeholder analysis” which is commonly performed in a workplace setting. In addition to the recommendations, we provide references to serve as a starting point for organizations to implement diversity into their design. These references are sources we found online that help educate program leaders on the concept, such as how to perform a stakeholder analysis, or provide examples of

successful initiatives.

Our priority in creating these guidelines was that any program could benefit from them. In order to ensure that our guidelines were sensible, and could be applied to any program, we sought direct feedback from program leaders, participants, and our advisors while developing them. By collaborating in the creation of these guidelines, we have ensured that any program could benefit from our recommendations.

Our next deliverable was the video which aimed to inform program leaders that action must be taken to improve the state of diversity of citizen science. In order to send our message across, we include a clip from Chris Demetry, who is the Director of the Morgan Teaching and Learning Center at WPI and focuses on diversity and inclusion on campus. In the clip, she highlights the importance of diversity to any organization which helps drive in the message that diversity is needed in citizen science. Next, we define diversity in the context of citizen science. This is to clear any misconceptions that program leaders may have and also clarify the specific purpose of our guidelines. We also highlight the benefits of having diversity in citizen science programs to further convince program leaders to take steps to foster diversity in their programs. In our research, we noticed that many program leaders felt that open sourcing their project was enough to eliminate barriers to diversity. To counter this assumption, our video emphasizes that specific action must be taken to foster diversity in citizen science programs and introduces our guidelines as a method to do so. In the video, we use an animated example, “Herman’s Dilemma”, to show a scenario in which open-sourcing is not enough. In the animation, the organization then uses a specific recommendation from our guidelines to effectively eliminate the barrier to diversity, therefore showing the effectiveness and simplicity of our guidelines. The animation itself was created using Adobe Illustrator and Adobe Character Animator and was meant to have clean, captivating artwork to further engage our audience. At the end of the video, we reiterate our message that action needs to be taken by program leaders to improve the state of diversity in citizen science to leave our audience with a call to action. We also provide a link to the guidelines to make sure program leaders have the ability to take the first step.

# Results: Guidelines

Note: This is an abridged version of our guidelines. The full length version can be found on page 15, which includes specific steps to take to achieve each listed example, as well as sources for further research.

## Structure

The structure of a citizen science program and/or project must be considered when attempting to foster diversity in citizen science. A program structure that emphasizes effective management of stakeholders and provides participants with options for involvement encourages different demographics to participate in citizen science.

1. The program analyzes and manages stakeholders to ensure that every stakeholder benefits in some way from the project.
2. The program offers various options for participation in order to accommodate for the different levels of commitment participants will have.
3. The program accommodates for the various languages/cultures of the community to ensure the project is accessible to all.

## Recruitment

Keeping the diversity of the community in mind when recruiting participants helps citizen science programs design their efforts towards including everyone or targeting specific, underrepresented communities.

1. The program both educates and advertises what citizen science is to potential volunteers.
2. The program recognizes the assets and needs of the community to determine the most effective recruitment strategies.
3. The program uses multiple forms of advertisement for its citizen science programs to target a variety of potential participants
4. For sensitive projects, programs work to educate their community and reduce stigma in order to attract participants who may have had previous misconceptions.
5. The program considers its public image and works to highlight itself as an all-inclusive organization.

## Volunteer Resources

When programs work to identify the resources that volunteers may need to participate in their projects, potential participants gain more opportunities to be involved in citizen science.

1. The organization provides clear instructions and guidelines on data sharing practices. The organization also informs participants about how their data will be used in the project. In doing so, the organization makes the data collection process simple and intuitive to all participants and reduces reservations about sharing data.
2. The organization works to accommodate for its participants various disabilities/health related issues.
3. The program provides workshops/training for participants to learn the skills needed.

## Communication

Encouraging effective and meaningful communication amongst participants and program leaders leads to citizen science projects with a larger impact on the target communities.

1. The program educates its program leaders about the benefits of citizen science and includes volunteers at various levels to reduce stigma against involving non-professionals in scientific research.
2. The program clearly defines what participation in the program/project means for the volunteer and communicates this from the beginning to clear any misconceptions or reservations potential participants may have.
3. The program provides open communication strategies between professionals and non-professionals.
4. The program recognizes its volunteers in both its publications and media and continuously gives its participants feedback to give volunteers a sense of appreciation.

## Relevancy

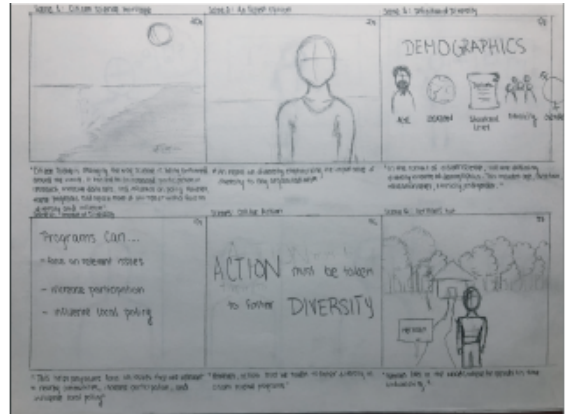
By keeping projects relevant to prevalent issues in the target communities, programs can generate interest from previously underrepresented groups and encourage them to participate in citizen science.

1. The organization actively works with the community to make the programs relevant to community values and interests.

# Results: Video Production Process

## STEP 1: STORYBOARD

- HAND-DRAWN TO LAY OUT SCENES
- HELPED DETERMINE WHAT MEDIA WE WILL NEED FOR THE VIDEO
- CAREFULLY REVIEWED WITH OUR SPONSOR AND ADVISORS TO ENSURE WE WERE GETTING OUR MESSAGE ACROSS

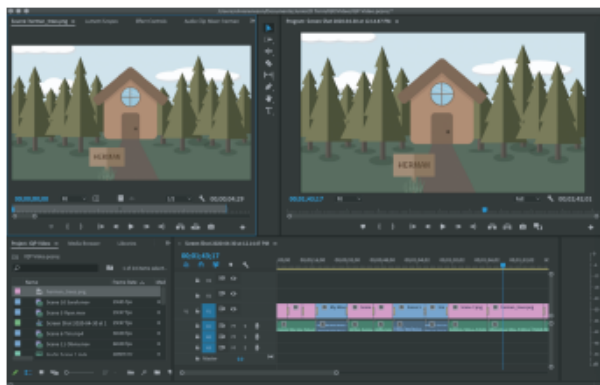


## STEP 2: GATHER MEDIA

- INCLUDED A CLIP FROM AN EXPERT ON DIVERSITY
- GATHERED IMAGES FROM CITIZEN SCIENCE PROGRAMS WE INTERVIEWED
- RECORDED VOICEOVERS

## STEP 3: ANIMATION

- ARTWORK CREATED IN ADOBE ILLUSTRATOR
- ANIMATED USING STOP-MOTION TECHNIQUE IN ADOBE CHARACTER ANIMATOR
- DESIGNED TO BE SIMPLE YET ENGAGING



## STEP 4: PRODUCTION

- MEDIA CLIPS AND AUDIO PUT TOGETHER USING ADOBE PREMIERE PRO
- DESIGNED TO BE SHORT YET IMPACTFUL

# Conclusion

While our study included many important results, the most influential are the structure of citizen science programs and definition of diversity within citizen science, the barriers to participation in citizen science, and many people do not know what citizen science is. In our research, we found that both the structure of citizen science programs and definition of diversity have no central definition. This has led to fluid program structures, which allow flexibility for programs to adjust it to their needs. Since there was no central definition for diversity in citizen science, we chose a more demographic focus for the purpose of our guidelines. Our barriers to participation in citizen science greatly influenced the direction in which we took our guidelines. Lack of resources and time commitment were cited the most, so we made them a central focus through the structure and volunteer resources sections. In our survey, it was uncovered that many people do not know what citizen science is. This was a significant barrier to participation that we had not previously seen in our research.

Our final deliverables, a video and our guidelines, were created to be tools for program leaders to implement diversity into the programs. The video was made to emphasize the importance of diversity within citizen science programs and then point program leaders towards our guidelines. The guidelines were then meant to provide program leaders recommendations, examples, and resources for increasing diversity within their programs. In the formation of our guidelines, we made co-design with program leaders and volunteers an important aspect of the process. Our intentions in doing this were to make the guidelines applicable to many different types of programs and our recommendations realistic for both programs and their volunteers.

Despite the success and influence of our project, there are a few constraints to the research. Due to the COVID-19 crisis, our study and the project as a whole had to be completed in an online format. As a result, our group was unable to interact with our sponsor, program leaders, and citizen science volunteers in person. This may have affected our ability to gather true opinions and sentiments on the state of diversity in citizen science. In addition, we were unable to gather live footage of citizen science programs to include in our video as originally planned. Another constraint in our research is that we were unable to distribute our survey to a variety of communities and demographics. Currently, our data is skewed towards educated, middle-class suburban females. This is also because our group was on a very strict timeline in order to fulfill project requirements. With more time, we could have used multiple channels to distribute our survey to ensure we gather the various factors as to why underrepresented individuals may not participate in citizen science on a larger and more complete scale.

There are several areas in which our work could be further developed or improved. If this research were to be extended by a new party, these would be the next steps:

- For one, our guidelines could be better utilized if there was an evaluation rubric to exist alongside. An evaluation rubric would be ideal to inform which specific guidelines would be beneficial to a program. This would save program leaders time and make their process more convenient.
- Secondly, the guidelines themselves would benefit from more sources for each recommendation. We provide several resources throughout the guidelines for further research. However, more resources are needed for some of the categories.

- Our guidelines were formed based on the barriers that we encountered in our research. It is entirely possible that a program may feel that there is a barrier that they encounter, such as power struggles within communities and the economic cost of diversity, that are not included in our guidelines. Therefore, another opportunity with our research could be future rounds of iteration to create more specific or customized guidelines for different types of programs or audiences.
- It is also possible that some of our recommendations become obsolete in the future. Reviewing the guidelines every few years would be beneficial to maintain relevance.
- Lastly, both our guidelines and the video promoting them would improve if they were available to more languages. The video could be subtitled, and the guidelines translated. This would allow greater reach, so that non-English speaking program leaders around the world could benefit from our research.

At the completion of our project, we reflect and note that our research has the potential to influence how citizen science programs form and manage themselves with the principle of diversity in mind. In mirroring the philosophy of citizen science, we created connections and collaborated with program leaders and volunteers from around the world. We cast a wide and inclusive net for our feedback and data collection and know that our data is high quality and applicable to the many different types of citizen science programs. Our guidelines and video were also made with implementation and impact in mind, asking for feedback from our sponsor and from stakeholders at every step. We hope that in addition to our sponsor, programs around the world can use them as a starting point to embed the principle of diversity in program design and execution. Further, we hope that these programs will be able to build from our research to design and create more inclusive citizen science for all to



# Acknowledgements

We would like to thank our sponsor, Kat Austen, for her guidance and feedback throughout this project. We would also like to thank our advisors, Professor Foo and Professor Stanlick, for being a source of constant support throughout the semester.

Following the principles of citizen science, our guidelines were created and reviewed through collaboration with citizen science program leaders and volunteers, experts in citizen science, and our sponsor. We would like to thank everyone for providing feedback and helping us create guidelines that are applicable to citizen science programs around the world. The full list of contributors is listed here:

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**Citizen Science Volunteers:**

Sha Alias, Port Phillips EcoCentre  
Tú Minh Do, Port Phillips EcoCentre

# Guidelines

The use of the term “citizen science” can cause discrepancies in the professional world between the different forms of this type of scientific research. When we began researching citizen science, we discovered many types of programs that did not define themselves as “citizen science” but identified closely with it. In the case of these guidelines, we use citizen science as an umbrella statement for simplicity. We believe any scientific program that utilizes community involvement could benefit from these guidelines.

These guidelines are intended to aid in increasing diversity within citizen science programs. In this context, diversity is defined in terms of participant demographics: for example, age, health status, location, ethnicity, sexual orientation, socio-economic status, religion, and education level. Within our research we have found that diversity is incredibly valuable for citizen science programs. It allows for diverse sets of ideas to be brought to projects, it gives projects a further reach among more communities, and several other reasons. The guidelines contain five sections: structure, recruitment, volunteer resources, communication, and relevancy. Each section contains recommendations as to how to foster diversity and provides resources and examples for programs to start the process.

## Structure

The structure of a citizen science program and/or project must be considered when attempting to foster diversity in citizen science. A program structure that emphasizes effective management of stakeholders and provides participants with options for involvement encourages different demographics to participate in citizen science.

1. The program analyzes and manages stakeholders to ensure that every stakeholder benefits in some way from the project.

\*Stakeholders: We define stakeholders as anyone with an interest in a project, or could be affected by the project. It is important to understand that stakeholders might not be directly involved in the project. The motivations of any potential volunteer, or anyone that could be affected by the research conducted, should be considered when conducting stakeholder analysis.

Recommendations:

- Conduct an effective stakeholder analysis
- Identify all stakeholders for a program
- Identify what roles all stakeholders play within a program
- Investigate the motivations of each stakeholder in the project
- Establish which stakeholders to target that would allow for a complete representation of the community surrounding a program
- Implement the motivations of stakeholders into the project
- Continue to manage stakeholders throughout the project

Resources:

- <http://conferinta.management.ase.ro/archives/2015/pdf/82.pdf>
- <https://www.tandfonline.com/doi/full/10.1080/14615517.2016.1176413>

2. The program offers various options for participation in order to accommodate for the different levels of commitment participants will have.

Recommendations:

- Provide several options for participation. Citizen science programs generally involve participants in data collection, project formation, and/or management.
- Provide training workshops for volunteers to learn about the different roles they may take as citizen scientists and the skills they would need for each.
- Partner with other organizations to provide resources for citizen scientists
- Allow more dedicated volunteers to take up leadership roles

Resources

- <https://thrivingearthexchange.org/how-it-works/>

3. The program accommodates for the various languages/cultures of the community to ensure the project is accessible to all.

Recommendations:

- Identify the demographics of the target community
- Hire a diverse staff that speak the language(s) and understand the cultures of the target communities
- Output media captioned in multiple languages
- Accommodate for cultural differences through understanding a community's values and incorporating them into the project. This can be achieved by co-designing programs with community members.
- Provide workshops in multiple languages either online or in-person.

Resources:

- EcoCentre

4. The program assigns a “point of contact” for volunteers to maintain communication

Recommendations:

- The point of contact is a representative of the community in terms of language and culture
- The point of contact is reliable and communicates with both the volunteers and organization in a timely manner

# Guidelines

- The point of contact is able to balance organization and community interests

Resources:

- Baltimore Mosquito Study

## Recruitment

Keeping the diversity of the community in mind when recruiting participants helps citizen science programs design their efforts towards including everyone or targeting specific, underrepresented communities.

1. The program both educates and advertises what citizen science is to potential volunteers.

Recommendations:

- In advertisements, include a brief overview of what citizen science is
- Work with community leaders and organizations (schools, nursing homes, religious groups) to educate groups on citizen science
- Provide volunteers a simple definition or infographic on citizen science to use when introducing the topic of citizen science to others
- Dedicate a heading on your website to describing what citizen science is and how it is used in your program

Resources:

- SciStarter's information page for citizen science:  
<https://scistarter.org/citizen-science>

2. The program recognizes the assets and needs of the community to determine the most effective recruitment strategies.

Recommendations:

- Contact community leaders and members to identify what the community wants/needs are and how the program can help them.
- Incorporate community goals into the goals of the study.
- Design the study to take advantage of and leverage particular community strengths or cultural assets
- Open source findings from the study
- Provide the affected communities with resources on how the results can be used for advocacy or policy purposes
- Include family oriented projects to include all age groups and encourage group participation

Resources:

- Baltimore Mosquito Study: "Aligning research and education with community priorities" and "Planning for co-management of the project and engaging the community at every step"  
<https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.170>
- "Braiding Science together with Indigenous Knowledge":  
<https://blogs.scientificamerican.com/observations/braiding-science-together-with-indigenous-knowledge/>
- Thriving Earth Exchange: <https://thrivingearthexchange.org/how-it-works/>

3. The program uses multiple forms of advertisement for its citizen science programs to target a variety of potential participants

Recommendations:

- Ask current volunteers to recruit people they know
- Put ads through social media and news outlets
- Reach out to community leaders to spread word through their community
- Advertise through organizations with existing networks in diverse communities (ex. Universities, religious groups, associations)

Resources:

- Baltimore Mosquito Study: "Planning for co-management of the project and engaging the community at every step" <https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.170>
- Marketing strategies for online large-scale citizen science programs:  
[https://jcom.sissa.it/sites/default/files/documents/JCOM\\_1601\\_2017\\_A01.pdf](https://jcom.sissa.it/sites/default/files/documents/JCOM_1601_2017_A01.pdf)

4. For sensitive projects, programs work to educate their community and reduce stigma in order to attract participants who may have had previous misconceptions.

Recommendations:

- Ask current volunteers to spread the word about the positive aspects of the work they are doing
- Have community and project leaders host workshops/talks to educate the public on how the program can benefit them and if applicable the misconceived notions about the project topic
- On social media and website pages, dedicate a portion of the platform to educate interested individuals on the topic
- Make research about the topic readily available to the community
- Emphasize the importance of the topic to underrepresented communities

# Guidelines

## Resources:

- The following study focuses on reducing stigma surrounding mental health, but the techniques such as education and literacy campaigns surrounding your issue may be applied to many different topics: <https://www.ncbi.nlm.nih.gov/books/NBK384914/>

5. The program considers its public image and works to highlight itself as an all-inclusive organization.

## Recommendations:

- Conduct brand analysis to better understand how your program is viewed
- Include as many demographics as you can in imagery representing your program
- Incorporate the values of diversity and inclusion into the program mission statement
- Provide brand/image training to project leaders
- Be transparent, intentional about program participation – for instance, collect demographic information to assess progress (COASST does this)

## Resources:

- Given here is an example of how to conduct a brand analysis: <https://www.cdgi.com/2018/01/conduct-brand-analysis/>.
- Brand analysis is most commonly used by businesses, but can easily be adapted to a citizen science program through interviewing volunteers rather than clients. Rather than a “competitor” analysis, it might be helpful to observe practices used in other citizen science programs.
- The Port Phillip EcoCentre works to recruit diverse individuals in both their staff and citizen scientists. In their values, they also list respect for people’s cultures: <https://ecocentre.com/vision>.

## Volunteer Resources

When programs work to identify the resources that volunteers may need to participate in their projects, potential participants gain more opportunities to be involved in citizen science.

1. The organization provides clear instructions and guidelines on data sharing practices. The organization informs participants about how their data will be used in the project and strives to use secure connections and data platforms. In doing so, the organization makes the data collection process simple and intuitive to all participants and reduces reservations about sharing data.

## Recommendations:

- Clearly state policies on data collection on the program website and any distributed media
- Ensure that there are standard data sharing practices set in place so participants can efficiently and safely transfer their data
- Ensure that there are multiple means of sharing data both online and in person. Programs can provide pre-stamped envelopes for participants to mail in data.
- Provides documentation, help services, and/or workshops to educate participants
- Limiting data sharing/giving options

2. The organization works to accommodate for its participants various disabilities/health related issues

## Recommendations:

- Make sure the sites used for events are wheelchair accessible
- Work with the volunteer to determine various ways they can be involved without compromising their health

3. The program provides workshops/training for participants to learn the skills needed.

## Recommendations:

- Provide opportunities for participants to be involved in the formation of workshop structure
- Implement participants’ interests and values into the workshops to make them more engaging
- Provide in person training for complex skills to engage participants and ensure understanding
- For more simple skills, provide online workshops to make education more accessible and less time consuming
- Being flexible with workshop location and encouraging staff to travel if needed
- Ex. giving workshops at schools/nursing homes/community centers

## Resources:

- Designing effective workshops: <https://www.nap.edu/read/25183/chapter/8#127>
- At the Port Phillip EcoCentre, volunteers are required to contact the volunteer coordinator and go through an “induction” where they learn about the EcoCentre and all their projects before choosing a program they would like to participate in. <https://ecocentre.com/volunteer>

# Guidelines

## Communication

Encouraging effective and meaningful communication amongst participants and program leaders leads to citizen science projects with a larger impact on the target communities and the scientific community.

1. The program educates its program leaders about the benefits of citizen science at every level and includes volunteers at various levels to reduce stigma against involving non-professionals in scientific research.

Recommendations:

- Programs can hold workshops or lectures to educate professionals on the structure and impact of citizen science
- Programs can provide incentives for professionals participating in citizen science
- Encourage more interactions between professionals and non-professionals

Resources:

- Here are some publications describing the benefits of citizen science in research and how it is growing as a tool:
- Irwin, A. (2018). No PhDs needed: How citizen science is transforming research. Retrieved from: <https://www.nature.com/articles/d41586-018-07106-5>
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- Hecker, S. et al. (2018). Citizen Science: Innovation in Open Science, Society, and Policy. Retrieved from: <https://discovery.ucl.ac.uk/id/eprint/10058422/1/Citizen-Science.pdf>
- Here is a study describing how citizen science programs can take steps to ensure their projects remain credible and accepted by the scientific community: <https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.6/print/>

2. The program clearly defines roles and responsibilities of both the project leaders and participants and communicates this from the beginning to clear any misconceptions or reservations potential participants may have.

Recommendations:

- Ensure that potential participants have a clear understanding of their deliverables and the time commitment involved
- Ensure that project leaders have a clear understand of their responsibilities
- Project leaders and volunteers work together to determine a list of expectations from each other
- Make a list of expectations readily available on the website, social media, flyers, and any other marketing materials
- Continuously updates its participants on what is expected of them at each stage of the project

Resources:

- iNaturalist serves as an example of a citizen science program that defines criteria for participation: <https://www.inaturalist.org/projects/city-nature-challenge-2020-north-east-england?tab=about>

3. The program provides open communication strategies between professionals and non-professionals.

Recommendations:

- Provide multiple methods for Professionals and Non-Professionals to communicate, both in person and online
- Ensure that these conversations are bidirectional
- Programs can set up an online forum on its website
- Dedicate a community liaison to communicate with participants online and/or in person. They can also highlight milestones in the project in newsletters sent out to the community.
- Programs can set up online workspaces for each project using a tool like Slack
- Programs can set up workshops for professionals and non-professionals to share information mutually
- Encourage professionals to speak in less technical terms during workshops and when engaging with volunteers
- Encourage relationships between leaders and volunteers through community events

Resources:

- Here is a study describing the importance of communication in citizen science: <https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.136/>
- Here is a guide to improving communication strategies in citizen science programs: <http://www.scivil.be.dev1.minsky.be/sites/default/files/paragraph/files/2020-01/Scivil%20Communication%20Guide.pdf>

# Guidelines

4. The program recognizes its volunteers in both its publications and media and continuously gives its participants feedback to give volunteers a sense of appreciation.

Recommendations:

- Recognize citizen science as a method used in all publications and media
- Specifically recognize participants who may have been more heavily involved in various stages of the project
- Continuously provide feedback to the participants on their contribution and praise their accomplishments
- Program leaders and/or professionals can use channels of communication to provide individual feedback to volunteers
- If the project is on a large scale, programs can set up a visualization tool for participants to see their individual contributions and milestones
- Provide challenges to to incentivize more participation
- Inform participants about how their contribution was used in the project

Resources:

- Here is a study on the value of giving feedback to volunteers for large-scale projects:  
<https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3000357>
- Here is a study on the effects of automated feedback on citizen science volunteers:  
<https://conbio.onlinelibrary.wiley.com/doi/pdf/10.1111/cobi.12705>
- The Baltimore Mosquito Study serves as an example of a smaller scale citizen science project that continuously provided feedback to its volunteers:  
<https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.170/>

## Relevancy

By keeping projects relevant to prevalent issues in the target communities, programs can generate interest from previously underrepresented groups and encourage them to participate in citizen science.

1. The organization actively works with the community to make the programs relevant to community values and interests.

Recommendations:

- Identify the motivations of the community to make the program relevant to participants
- Involve members of the local community in every stage of the project, especially the formation and planning stages
- Advertise the issue and importance of the topic the project is trying to solve
- Seek out community leaders to involve them in citizen science projects
- Encourage these community leaders to bring in volunteers they believe would contribute valuably to the project

Resources:

- The Baltimore Mosquito Study serves as an example of a successful inclusive citizen science initiative. This study is a reflection on the program, especially its design:  
<https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.170/>
- Thriving Earth Exchange is a community science program that strives to create a local impact through its projects:  
<https://thrivingearthexchange.org/how-it-works/>

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