



# **A Democratization of Approaches**

Integrating Citizen Science  
Into the Museum Visitor Experience

Holly E. Mutascio

Museum Exhibition Planning & Design MFA Thesis  
May 2018





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Integrating Citizen Science  
Into the Museum Visitor Experience

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May 2018

A thesis submitted to The University of the Arts  
in partial fulfillment of the requirements  
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in Museum Exhibition Planning & Design

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The members of the committee appointed to examine the thesis of  
Holly E. Mutascio find it satisfactory and recommend it to be accepted.  
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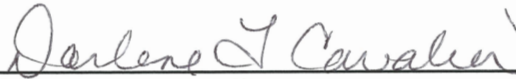


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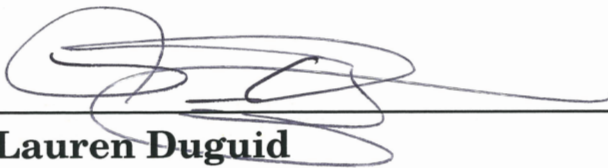


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# Abstract

Many natural history and science museums are engaging with citizen science and are beginning to explore its interpretation in their exhibitions. However, it is not always apparent to the museum visitor that citizen science is something in which they can become involved. This thesis posits that the integration of citizen science into typical museum experiences, such as exhibitions and programmatic spaces, could help to raise awareness of and encourage participation in citizen science. It would also help to communicate museums' commitment to creating a practice of citizen science with their communities. This thesis draws parallels between citizen

science as a democratic process of science and the sharing of curatorial authority through participatory design techniques such as community curation. The project application explores design considerations for interpreting and practicing citizen science within the museum environment, and proposes a schematic design solution for a hybrid exhibition-programmatic space. By fully integrating citizen science into all of their activities, museums can become crucial forums for civic engagement in science, thereby democratizing the scientific process and the process of creating exhibitions and programs.

# Preface

## Focus on nature/environment

This thesis's focus on environmental and ecological applications of citizen science is partially due to the author's academic and professional background in ecology. But it is also due to the plethora of citizen science projects in natural history fields compared to other STEM disciplines, and that nature and environment projects lend themselves well to a museum's activities. This makes it a rich case study for creating a basic theory of incorporating citizen science into museum exhibitions.

Citizen science can be practiced in any science, technology, and social science field. Its principles have even been applied to applications in the humanities<sup>1</sup> and it often parallels other disciplines such as activist scholarship.<sup>2</sup> This thesis aims to be applicable to any kind of citizen science application within any type/discipline of museum even though it focuses primarily on the natural sciences.

## Quality and integrity of citizen-collected data

The issue of whether or not non-professionals can collect high quality data is alas still a lingering focus of many when discussing citizen science. It is not the purpose of this thesis to explore this particular issue, but it is important to note that many peer-reviewed publications have demonstrated that citizen scientist-collected data are indeed usually just as reliable as those collected by professional scientists.<sup>3</sup> Any variations in accuracy can happen regardless of who is collecting the data, and ultimately this is an issue of how methodologies are developed, and how data collectors are trained. Data quality assurance should be a part of any rigorous methodology.

## Natural history museum vs. science museum/center

Science museums and centers are often differentiated from natural history museums; further, there may even be a distinction between a 'science museum' and a 'science center.' Some science museums will delve into natural history topics, while others will leave it for natural history museums to cover. Yet, most will cover the issue of climate change. Because of this, citizen science projects related to the environment may reasonably fit into the mission of a science museum. While this thesis mostly examines natural history museums, it was most useful to include science museums in its investigations and terminology.

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1. See, "Projects," Zooniverse, <https://www.zooniverse.org/projects>.
  2. Activist scholarship seeks social change, action, and justice, and includes, but is not limited to, gender and sexuality studies, anti-racism, environmental justice, and feminism.
  3. For further discussion of this, cf, Heidi Ballard et al., "Contributions to Conservation Outcomes by Natural History Museum-led Citizen Science: Examining Evidence and Next Steps," *Biological Conservation* 208 (2017): 87-97.  
  
Eréndira Aceves-Bueno et al., "The Accuracy of Citizen Science Data: A Quantitative Review," *Bulletin of the Ecology Society of America* 98, 4 (2017): 278-290.  
  
Hannah Specht and Eva Lewandowski, "Biased Assumptions and Oversimplifications in Evaluations of Citizen Science Data Quality," *Bulletin of the Ecology Society of America* 99, 2 (2018): 251-256.

# Nomenclature

**Bioblitz<sup>4</sup>**

An event where participants search for and identify as many species as possible in a designated area over a specified, usually short, period of time; thereby, providing a snapshot of the biodiversity.

**Citizen, or Community Member**

Members of the public, or any person with the rights and responsibilities that come with inhabiting planet Earth. In some uses, 'citizen' may be tied spatially to a particular community or place, but for the purposes of this thesis it does not take on a geopolitical definition.

**Citizen Science<sup>5</sup>**

Public participation in scientific research, most often in data collection, analysis, and reporting, although it can be broadly applied to any activities that help to advance scientific research. Participants are not required to have a formal background in science, thus anyone is able to participate. Some participants may consider themselves to be amateur or non-professional scientists, while others may not call themselves a scientist.

**Community Curation<sup>6</sup>**

Participation by a museum's community and/or audience in creating knowledge, content, and interpretation. Also known as 'public curation,' community curation falls under the umbrella of 'participatory design.'

**Curatorial Authority**

Being in charge of the creation of exhibitions, especially the objects, content, and interpretation.

**Interpretation**

*Of scientific results*, making sense of and drawing meaning from raw scientific data.

*At a museum or other cultural site,<sup>7</sup>* a communication process that enhances appreciation and understanding by connecting people to cultural and environmental resources. Interpretation does not just relay information: its goal is to provoke revelation rather than to instruct.



**Museums' Public Spaces**

The spaces accessible to museum visitors during a typical museum visit or event. These include but are not limited to exhibition spaces, programming spaces, grounds/gardens, walk-in laboratories, and foyers/halls.

**Participatory Experience**

In an exhibition, an experience where visitors contribute something, such as objects, ideas, questions, and opinions. For an exhibition on citizen science, this could also include being involved in 'doing' science in some way.

**Public Understanding of Research/Science<sup>8</sup>**

Comprehension of the scientific process, i.e., the process of doing research and its theoretical underpinnings.

**Scientific Literacy<sup>9</sup>**

Knowledge and understanding of scientific concepts and processes that allow a person to observe, describe, explain, and predict natural phenomena; identify scientific issues underlying decision-making; read about and comprehend science (e.g., in popular media or popular science); evaluate the quality of scientific information; use evidence to draw conclusions about an argument appropriately; and apply these abilities in decision-making, participation in civic and cultural affairs, and economic activities.

**Sharing Authority/Expertise<sup>10</sup>**

Recognizing, valuing, and giving platform to the expertise and/or viewpoints of others outside of the museum staff, such as a museum's surrounding community or outside subject-matter experts.

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4. Definition adapted from, "Program: Bioblitz," *National Geographic*, accessed April 27, 2018, <https://www.nationalgeographic.org/projects/bioblitz/>
  5. Definition adapted from, Johnathan Silvertown, "A New Dawn for Citizen Science," *Trends in Ecology & Evolution* 24, 9 (2009): 467.
  6. Definition adapted from, Benjamin Filene, "Letting Go? Sharing Historical Authority in a User-Generated World," *History News* 66, 4 (2011): 9.
  7. Definition adapted from, Mark Woolmer, "You're a What? Interpreting Interpretation to Non-interpreters," *Museums + Heritage* (blog), July 31, 2017, <http://advisor.museumsandheritage.com/blogs/youre-interpreting-interpretation-non-interpreters/>.
  8. Definition adapted from, Hyman Field and Patricia Powell, "Public Understanding of Science versus Public Understanding of Research," *Public Understanding of Science* 10, 4 (2001): 421-426.
  9. Definition adapted from, National Academy of Sciences, *National Science Education Standards*, (Washington DC: National Academy Press, 1998), 22.
  10. Definition adapted from, *Letting Go? Sharing Historical Authority in a User-Generated World*, eds. Bill Adair, Benjamin Filene, and Laura Koloski, (Philadelphia: The Pew Center for Arts & Heritage, 2011).

# **1. Introduction**

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## Relevance

Human civilization and Earth are currently facing innumerable stressors to their wellbeing. There is a pronounced need for collective action in understanding and mitigating these problems. As social institutions, museums in the 21<sup>st</sup> century should strive to be socially engaged, civic-minded places of dialogue, creation, and change,<sup>11</sup> and in doing so can contribute to this needed collective action. Natural history and science museums are situated to play an important role, given their skilled researchers and their potential to reach the public, especially as trusted institutions. However, even when museums attempt to craft engaging experiences for their visitors around contemporary issues, these experiences tend to be passive and rely on visitors taking action after they visit the museum, and it is questionable if this action indeed occurs.<sup>12</sup>

Natural history and science museums have historically kept their research activities separate from the experiences they craft for the public, engaging in one-way communication with their visitors and communities. In its “Code of Ethics for Natural History Museums,” the International Council of Museums’

International Committee for Museums and Collections of Natural History proposes a multitude of purposes for natural history museums to uphold. Natural history museums are expected to collect and maintain natural history collections, to carry out scientific research, to be a part of the greater process of science and biological conservation, to increase the public’s understanding of the natural world, and to “collaborate with the public in deriving their own meaning from the natural heritage they encounter in the museum and in nature.”<sup>13</sup> These purposes can easily come off as a checklist, where each is an item to be achieved through separate means, and where research and academics occur separately from outreach to the public. However, when these purposes work in concert with one another, this can create greater dialogue between museums and their communities.

Transiting to a place of dialogue and collective action will require museums to open up the scientific process and to synergize how their purposes are fulfilled. A way to achieve this could be citizen science. Citizen science is involving anyone, regardless of background and previous training, to collaborate in the process of doing, interpreting, and applying science.

There are many ways in which the public can be involved in supporting science, and while no one way is 'better' than another, all of these share in common that citizen scientists are contributing high-quality data, resources, analyses, and other types of support for actual research that contributes to our understanding of the world.<sup>14</sup> As such, the field of citizen science ultimately envisions itself working towards the increased democratization of science.

The idea of including museum visitors in the scientific process parallels discourse in museums surrounding civic engagement, sharing curatorial authority, and participatory design, sometimes referred to as community co-creation. Some segments of museum audiences are increasingly vocalizing a desire to participate, contribute, and be more involved when engaging with museums.<sup>15</sup> Sharing authority and expertise with audiences means going beyond participatory activities that are structured around museums providing content for which visitors share their reactions.<sup>16</sup> Rather, it requires reciprocity – an exchange of ideas, knowledge and insights – between museums and visitors,<sup>17</sup> achieved by dismantling the hierarchical structure between these players. These interactions need be incorporated into

each role of the museum, especially in its public functions. This communicates that its shared authority with the public is an authentic and meaningful partnership and not merely token, in addition to transforming the full museum experience into something more action-oriented. These conversations have often taken place and been commonly put into practice in the context of history and art museums. Although community co-creation will likely look very different for a natural history museum compared to a history museum, the theoretical underpinnings of civic engagement are applicable across museum disciplines.

Integrating citizen science with civic engagement also naturally lends itself to a more localized focus for research and interpretation at the museum. When natural history and science museums flip their approach of interpreting the globe and merely highlighting the local to a clear emphasis on the museum's local environment, situated within a global context, they increase their relevance to their communities. In this way, museums could become forums for their local communities to collectively identify and use the tools of science to tackle local environmental concerns.

## Impact

Museums can merge their educational and knowledge-producing goals with 21<sup>st</sup> century museum practice of civic engagement by adopting a practice of citizen science with their audiences. Thus, citizen science has the potential to make museums relevant and inclusive forums that collaborate with their immediate communities in learning more about their local natural world and working towards solutions to the community's – and humanity's – pressing environmental concerns.

While many museums, particularly those with active research departments, may already have opportunities for visitors to participate in citizen science, these opportunities often take place outside of typical visitor experiences.<sup>18</sup> People may need to already be aware of citizen science and know how to seek out such opportunities, or they may even participate without understanding that their experience and contribution qualified as citizen science.<sup>19</sup> Interpreting and making citizen science visible in the public spaces of museums could be one way to facilitate these goals and make for an inclusive and participatory visitor experience.

## Purpose

The purpose of this study is to explore the interpretation of and engagement with citizen science in museum's public spaces. While effective civic engagement does require museums to reach outside of their institutions and to engage audiences that are not current museum visitors, it is important for civic engagement to be integrated into all museum activities. Bringing civic engagement through citizen science into the museum visit communicates the museum's commitment to relevancy in their communities and brings new perspectives to current audiences who may not otherwise be exposed. It also fosters a more active, participatory museum experience that could lead to sustained participation in citizen science and thus could help to develop greater democracy in the scientific process overall. In addition, bringing citizen science and civic engagement into the museum experience ensures that the new audiences who have become connected to museums through experiences outside of the brick and mortar institution feel represented within the museum should they choose to visit.

## Research Questions

Can museums act as forums for civic engagement in science?

How can citizen science be interpreted in natural history and science museums?

How could community curation of citizen science manifest in natural history and science museums?

Can citizen science lead to participatory visitor experiences while visiting natural history and science museums?

Through primary and secondary research, this study posits some possible solutions that will help to strengthen citizen science experiences within museums by increasing understanding of, participation in, or connection to citizen science. This study also aims to situate citizen science in the discourse of civic engagement by museums and to lay the groundwork for ultimately a larger, more complex process of applying the community curation model to citizen science and natural history and science museums, as well as envisioning natural history and science museums as forums for civic engagement through citizen

science. Community curation is a way for museums to share curatorial authority and expertise, giving their communities a voice in interpreting topics, issues, and objects in exhibitions and programming, thereby creating relevant and meaningful experiences to connect visitors with citizen science. In the best-case scenarios, this allows the museum and the public to work alongside one another in learning and even creating knowledge.<sup>20</sup> While the most common museum disciplines to adopt community curation are the arts, humanities, and social sciences, the principles of collaborative exhibition design could theoretically be transferred to other museum disciplines. Citizen science parallels the spirit of community collaboration in that it aspires to include the public in the creation of scientific knowledge and to share expertise through a participatory and social framework.

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11. The American Association of Museums cites this as something museums are already striving to do in *Mastering Civic Engagement: A Challenge to Museums*, though Robert Janes questions if it indeed is happening in *Museums in a Troubled World*.
  12. Nina Simon, "How Do You Inspire Visitors to Take Action After They Leave?," *Museum 2.0* (blog), July 18, 2017, <http://museumtwo.blogspot.com/2017/07/how-do-you-inspire-visitors-to-take.html>.
  13. ICOM Code of Ethics for Natural History Museums, adopted on August 16, 2013. [http://icom.museum/uploads/media/nathcode\\_ethics\\_en.pdf](http://icom.museum/uploads/media/nathcode_ethics_en.pdf).
  14. One way of categorizing something as 'actual research' is if the research is/will be published, or if it contributes to something such as a natural resource management plan. However, expanding this definition may be necessary: for example, activities that result in data that are preserved/archived/managed in a database are especially needed for future studies, like ecological monitoring, that require longitudinal datasets.
  15. Graham Black, "Developing Audiences for the Twenty-First Century Museum," *The International Handbooks of Museum Studies* (2013).
  16. Kathleen McLean, "Whose Questions, Whose Conversations?," in *Letting Go?: Sharing Historical Authority in a User-Generated World*, (Philadelphia: The Pew Center for Arts & Heritage, 2011), 70.
  17. Ibid.
  18. This sentiment has been echoed by a number of museum professionals, including: Lauren Duguid (Exhibition Designer, The Academy of Natural Sciences of Drexel University) in discussion with the author, August 25, 2017; Chris Goforth (Head of Citizen Science, North Carolina Museum of Natural Sciences), in discussion with the author, September 7, 2017; and Lila Higgins (Senior Manager, Community Science), Natural History Museum of Los Angeles County), in discussion with the author, November 14, 2017.
  19. Higgins, in discussion with the author, November 14, 2017; and Caren Cooper (Research Associate Professor, and Assistant Head of Biodiversity Lab, North Carolina Museum of Natural Sciences), in discussion with the author, January 12, 2018.
  20. Filene, "Letting Go? Sharing Historical Authority in a User-Generated World," 12.  
  
Ellen Hirzy, "Mastering Civic Engagement: A Challenge to Museums," in *Mastering Civic Engagement: A Challenge to Museums*, (Washington, DC: American Association of Museums, 2002), 16.



## **2. Background & Context**



## Defining Citizen Science & Its Outcomes

Citizen science is a broad term generally used to describe scientific research that is executed and/or designed partially or completely by the public. Other terms, ranging from crowd-sourced science to community science to public participation in scientific research, are sometimes used as synonyms or even alternatives to describe citizen science. However, these terms can also signify differences in how particular projects are classified, based on how the public is involved – such as the tasks they complete – and how engaged they are in the scientific process – such as their participation in decision-making processes.

Because citizen science has yet to be a commonly understood term and widespread activity adopted and/or recognized by the public, this thesis considers a wide spectrum of activities and levels of involvement to fall under the concept of citizen science. Embracing a broad understanding of citizen science allows for flexibility in how museums can involve the public in their research activities, especially when in the early phases of developing and implementing these programs.

Although imperfect,<sup>21</sup> Mordechai 'Muki' Haklay provides a useful typology of participation in citizen science to describe the public's level of engagement as well as the dynamics between the public and professional scientists when classifying citizen science projects.<sup>22</sup> This typology was inspired by Sherry Arnstein's ladder of citizen participation<sup>23</sup> but it differs significantly in that no judgment of value should be passed from one level to the next.<sup>24</sup> Rather, the levels may be better viewed as circular or on a non-linear spectrum, where an increase in level denotes that the nature of participation becomes more complex, moving towards greater collaboration between non-professionals and professionals as well as greater ownership by citizen scientists of the project and the scientific process. With each level, too, citizen scientists increase their expertise and professionals increasingly act more as facilitators who share the ownership of the project and the expertise.<sup>25</sup>

At the lowest level of the typology,<sup>26</sup> the public provides resources or data to, or acts as sensors for, a citizen science project. They do not necessarily need to have a

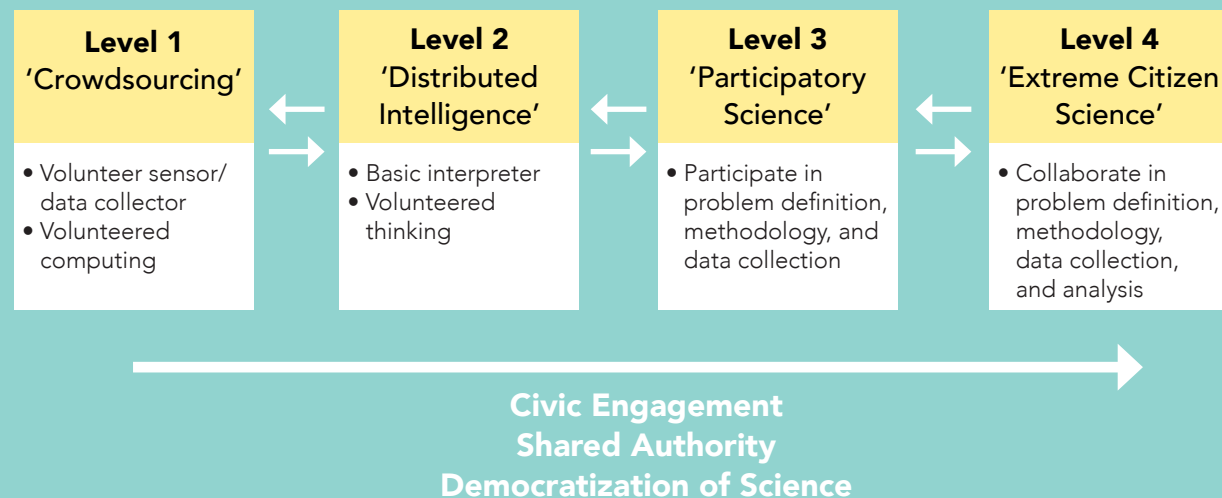
strong understanding of the project or the scientific process to successfully participate. The professional scientists maintain ultimate authority over the project and may have little to no interaction with participants. The next level of the typology<sup>27</sup> requires greater cognitive input on the participants' part to collect and/or interpret data. While the professional scientists still maintain ownership over the project, there is often more interaction with the citizen scientists. At the third level,<sup>28</sup> the public is involved in problem definition and data collection, and they consult with professional scientists in

creating methodology and analyzing and interpreting results. In the final level,<sup>29</sup> non-professional and professional scientists are equally involved, either collaboratively or separately, in the entire scientific process.

A given citizen science project can encompass multiple levels of this typology. An individual may move freely between levels over time, or several different individuals may participate together, each at different levels. In some cases, the public self-selects or changes where they lay on the typology, thus these differences

### Typology of participation in citizen science<sup>30</sup>

based on Haklay 2012



are likely in response to people's motivations for participating. However, as the construction of the typology implies, sometimes these differences in levels exist within or between projects due to the motivations and needs of the scientists, especially when in the role of project owner. The goals of using this typology, then, are not about moving the public through the typology with level 4 as an end goal. It is about creating the mindset and opportunities for the public to engage with citizen science at any level depending on their needs, interests, circumstances, or skills.

There are innumerable outcomes of citizen science. For scientists and research agendas, some of the biggest appeals include the ability to collect more data over longer timescales and geographic areas,<sup>31</sup> and even to increase the likelihood of observing rare phenomena<sup>32</sup> such as rare and endangered species, or astrological events. Similarly, harnessing the brain power of many minds can be invaluable for completing tasks that require the creativity of humans over the computational power of machines.<sup>33</sup> For the public, participation in science can increase scientific literacy and understanding of the scientific process.<sup>34</sup> It can lead to new passions and

pursuits or add new meaning to their lives.<sup>35</sup> In some applications, citizen science can be a social experience where participants may form new friendships or form greater community cohesion.<sup>36</sup>

Participation in citizen science also has the potential to positively change people's environmentally related behaviors and to garner support for conservation. Through participation in a project – and even through interactions with their peer citizen scientists – people may gain a more nuanced understanding of an environmental issue or directly observe the human impact on nature.<sup>37</sup> This may motivate people to change the behaviors they can personally control and even become more involved in finding and upholding solutions, such the creation and enforcement of new regulations or management plans.<sup>38</sup>

## Democratization of science

The potential for science to become a more collaborative, democratic process that is equally accessible and transparent to all its stakeholders<sup>39</sup> is perhaps one of the more profound outcomes of citizen science, particularly for museums of the 21<sup>st</sup> century. How science is done, the

***“...as science became more central to life in the modern world, it became more inaccessible...it became impossible for amateurs to make meaningful contributions to science, and harder to conduct well-informed public discussion of science and its social effects.”***  
***– Darlene Cavalier<sup>40</sup>***

knowledge it builds, and its power to solve problems locally, nationally, and globally impacts every person. Thus, science should be about meeting the needs and concerns of the public. Increased understanding and access to science allows the public to identify and advocate for solutions to issues impacting their communities, as is the case with environmental justice or public health concerns. In addition to setting research agendas, democratizing science also allows to public to participate in the applications of science through decision-making and policy-building.<sup>41</sup>

Of course, it is still possible for citizen science to be practiced in a way that maintains a hierarchical or authoritative structure of science. In many cases, when the public is invited to participate only

### **Citizen Science Online Databases**

**SciStarter:**<sup>42</sup> A searchable citizen science project directory and platform to record data, access tools, and track personal participation in and contributions to research.

**Zooniverse:**<sup>43</sup> A citizen science web portal where citizen scientists can join, participate in, discuss, and collaborate on projects.

**CitSci.org:**<sup>44</sup> A platform for creating and managing citizen science projects, including recording, visualizing, and analyzing data.

**CitizenScience.gov:**<sup>45</sup> Promotes citizen science across 48 US federal agencies, providing a catalog of projects and a toolkit for federal citizen science practitioners.

at levels 1 and 2 of Haklay's typology, they are simply providing unpaid labor and usually have little say in defining the project or applying its findings.<sup>46</sup> This kind of situation is not necessarily always undesirable: working together can lead to discoveries otherwise not possible.<sup>47</sup> But, some of the hierarchical structure could be at least dampened if citizen scientists are treated respectfully and as peers. Further, this level of participation could be seen as a potential stepping stone for those new to citizen science to build skills and knowledge, creating an impetus to increase their involvement and level of participation in science in increasingly democratic ways.

# Museums, Civic Engagement, & Citizen Science

Museums of the 21<sup>st</sup> century are in the midst of rethinking their ideology and practice, reflecting on how they can best remain relevant in contemporary society.<sup>48</sup> Museums are reconsidering their roles within their communities, striving to become places of dialogue instead of didactic institutions who only communicate through a one-way flow of information. Through this, museums could become facilitators who promote collective action and empower their communities to take their futures into their own hands.<sup>49</sup> When museums work to collaborate with, reflect

the voices of, and serve their communities, this is known as civic engagement.<sup>50</sup>

For natural history and science museums, civic engagement could in part be achieved by both increasing the visibility of and including the public in the scientific research that traditionally has taken place away from and without the public. This is the very definition of citizen science; thus, museums that are involved in science can civically engage through a citizen science community of practice. As Haklay's typology of citizen science revealed, citizen

## 5 Core Principles<sup>51</sup>

### 1. Museums as **memory institutions**

*History museums:* collecting, conserving, documenting, and representing cultures and life experiences of their communities, creating an inclusive environment.

*Natural history museums:* collecting, conserving and documenting the natural world of their communities, and representing their communities' concerns around issues related to the environment, natural resources, public health, etc.

### 2. Museums as **learning institutions**

*History museums:* develop informed communities who are positively involved in decision-making about their lives.

*Natural history museums:* develop scientifically-literate communities with a strong understanding of the scientific process, who are involved in decision-making about how science impacts their lives and/or how they manage and protect their natural resources and environment.

***“Engagement is needed in Museums of the 21<sup>st</sup> century — and citizen science is an excellent way for museums to engage with the public in a meaningful way.” – Survey #1 participant no. 23***

science can easily operate under business as usual structures with little collaboration between institutions and the public. Thus, museums hoping to employ citizen science as a form of civic engagement need to strategically plan for a participatory and more inclusive structure.

Many ethnic and community-based museums have begun to set a standard for how museums beginning to approach this ideology can practice civic engagement.<sup>52</sup>

In “Embedding Civil Engagement in Museums,” Graham Black proposes five core principles for urban history museums to adopt when supporting and practicing civic engagement. These principles could also be applied to natural history and science museums, especially in terms of practicing citizen science as civic engagement (see below).<sup>53</sup>

### 3. Museums as **social institutions**

*History museums:* welcome, support, represent, and partner with all voices of their communities.

*Natural history museums:* welcome, support, represent, respect, collaborate with all members of their communities in planning, carrying out, and interpreting scientific research.

### 4. Museums as **democratic institutions**

*History museums:* promote dialogue and civic participation in society.

*Natural history museums:* promote the democratization of science.

## On sharing authority

Museums are perceived by the public as authorities with expertise that can be trusted. It is somewhat a positive that the public still places trust in museums in a time when other institutions such as corporations, journalism, government, and academia are increasingly distrusted by the public.<sup>54</sup> However, the 21<sup>st</sup> century museum's responsibility to civically engage may be thwarted if they use this authority to impose an expert-novice relationship on their communities that only allows for the one-way flow of knowledge.<sup>55</sup> To create a two-way flow of knowledge, some museum professionals promote the idea of sharing authority with audiences.

### 5 Core Principles<sup>51</sup> (continued)

#### 5. Museums as **responsive institutions**

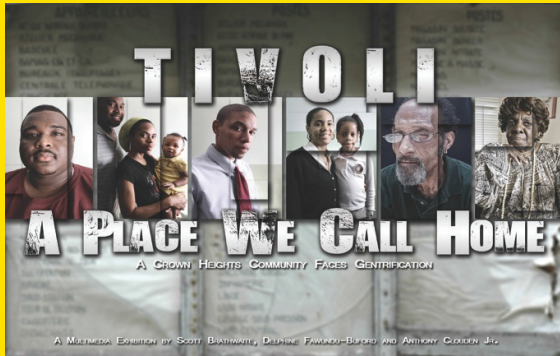
*History museums:* create an organizational-level culture that will suit the needs of contemporary society.

*Natural history museums:* create a culture within the institution that supports citizen science, especially in response to the needs of their local communities within the context of contemporary society.

One apprehension museums may have when they first begin to civically engage is the idea that they may be entirely giving up their authority and expertise.<sup>56</sup> This apprehension may perhaps be even more potent for natural history and science museums. Using the phrase 'sharing authority' in relationship to 'science' may seem like a slippery slope towards eroding the validity and trustworthiness of science. But sharing the authority of science is not about undermining the authority that science itself has, but rather it is about museums letting go of the notion that the authority of science only belongs to certain institutions. Sharing authority in this context means to foster access and assert everyone's right to the authority of science, such as in the case of environmental justice. Sharing authority also means to recognize that members of the public do not need to be professional scientists or formally employed by a museum or similar institution to have expertise. Hobby naturalists often have intimate knowledge of natural history and species identification that professional scientists who, for example, study broad evolutionary concepts, do not possess themselves.<sup>57</sup> Astronomy is another example of a field that is marked by the innumerable contributions of amateur scientists.<sup>58</sup>



## Models of Community Curation



**Brooklyn Historical Society**<sup>59</sup> and **Philadelphia History Museum**<sup>60</sup> are just two examples of museums that have designated community galleries within their exhibition spaces. Community organizations design and curate exhibitions on topics relevant to their work and neighborhoods, and the museum serves as a support system, platform, and promoter. Image credits: Brooklyn Historical Society (left) and Philadelphia History Museum (right).



Image credit: Glasgow Life, The Open Museum.

**The Open Museum**,<sup>61</sup> in Glasgow, Scotland brings its collections to the public. It works with community groups to create traveling exhibitions, and also features 'handling kits,' comprised of accessioned artifacts that can be borrowed for pop-up events or projects in public spaces such as libraries, shopping centers, and care homes.



In **Oakland Museum of California's** history gallery, the "Forces of Change" exhibit<sup>62</sup> is an installation of 24 Californians' experiences and memories from the 1960s and early 1970s. These individuals curated and designed their own displays or 'memory boxes.'

Image credit: Jason Lew, Oakland Museum of California

## On community curation

A growing number of museums are adopting community curation as a method of civically engaging and sharing authority. Community curation is a type of participatory design, where participatory design refers broadly to the inclusion of the public in the decision-making process of design,<sup>63</sup> and community curation refers specifically to inclusion of a museum's community in the decision-making process of designing museum products, processes, and experiences.<sup>64</sup> Co-creating thus facilitates an atmosphere where museums and their communities are in dialogue, sharing a diverse range of perspectives and expertise that reflects the community's needs, goals, and interests.<sup>65</sup>

Similarly to the concept of sharing authority in museums, community curation has mostly been applied to urban or public history museums, and to some extent art museums. See the sidebar on page 15 for some prominent models.

Community curation could prove a useful method for natural history museums in engaging their audiences in citizen science during typical museum visit experiences such as exhibitions and programming. Both the concepts of community curation and citizen science embrace dialogue and a shared authority where museum professionals and scientists act as facilitators and learn from and in parallel with their communities. To understand how community curation could facilitate engagement with citizen science in museums, it may be useful to consider its possible outcomes in relation to Haklay's typology of citizen science participation.

The lower levels of the typology commonly allow for science's hierarchical divisions to stay in place, where professional scientists may interact rarely with citizen scientist, and at worst may only regard them as free labor.<sup>66</sup> Community curation could help to break down these walls by encouraging professional scientists and citizen scientists

***“We had to overcome the temptation to perform at people [rather than engage] people in the artistic development. We were spending most of our time trying to convince someone that our set of values is the dominant set. What we actually denied [people was] the invitation to contribute to our work.” – Bill Redder<sup>67</sup>***

to intermingle as they work together to, for example, curate an exhibition about a research project. This could lead to conversations where the professional scientists learn from the citizen scientists: maybe citizen scientists would have ideas about how to interpret the project that the professional scientists would have never considered or understood themselves within the context of the community's perspective. These kinds of dialogues could also help to address an issue common to citizen science participation retention: often citizen scientists quit because they do not receive updates about the progress of their projects.<sup>68</sup> Building community curation into the process of a museum-led citizen science project could be one way of keeping citizen scientists abreast of the project's progress.

In facilitating the higher levels of Haklay's typology, community curation could provide a platform for citizen scientists to give voice to their communities' concerns and to share the results of the research they develop, perform, and interpret. Community curation could also lead to conversations where members of the public who are not yet engaged with citizen science share their observations and help to identify the issues in their communities that need attention. This in turn could promote

***“It is [an] interesting experience for someone who never did anything like this, and it is just [a] pity that my country[’s] museums usually don’t offer such projects” – Survey #1 participant no. 27***

collaboration among citizen scientists and between citizen scientists, museums, and professional scientists.

Community curation can also promote social interactions and even build social capital, both of which are crucial in citizen science. Some people participate in citizen science for the social experience, but sometimes citizen science projects require only independent work.<sup>69</sup> Community curation can add a layer of socialization, at the very least bringing citizen scientists, and professional scientists together to interact at specific stages of the project. Similarly, community curation could promote opportunities for citizen scientists to interact, thereby building social capital. For museum visitors experiencing the products of community curation, exposure to peer voices could be transformative. This could increase visitors' understanding of content and make for a more engaging

and rewarding experience.<sup>70</sup> Further, peer-to-peer contact is important in how people form beliefs; thus, engaging with content created by and in the voices of their peers may inspire museum visitors to participate in citizen science or even play a role in how they form beliefs about scientific issues.<sup>71</sup>

Undoubtedly, community curation is a promising technique that could take on many forms to aid in promoting citizen science within the public spaces of museums. Although conversations around community curation within the museum profession usually take place in the context of history and art museums, natural history and science museums could learn from these models. It will be a complex process to learn how community curation is best applied in the context of science, and the next sections of this thesis aim to lay a groundwork on which it can develop.

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# 3. Research





## Methodology

The overall aim for this research was to form a basis for a framework to interpret and engage with citizen science in museums' public spaces. This research is situated in the context of museum discourse on civic engagement through museum exhibition, in addition to the field of citizen science as a public science.

A selection of museums' citizen science programs and exhibitions were assessed to gain an understanding and critique of some leading examples of how citizen science has taken place within museums' public spaces and/or during a typical museum visit or experience. The assessments informed the creation of the considerations and design solutions outlined in Chapter 4, but they were also applied, in combination with the previous section's literature review, to the development of two online surveys. The first survey aimed to gauge the interests, perspectives, and needs of self-identified citizen scientists as potential collaborators in interpreting citizen science through community curation. The second survey aimed to gather the expectations and interests of museum visitors for engaging with citizen science within the context of a museum visit. These results also informed

the creation of the framework in Chapter 4. This methodology used an interpretivist approach, where the research was primarily qualitative and participant-driven, based on the participants' given experiences and contexts.<sup>72</sup> An interpretivist approach allows for theory building rather than theory testing. Museums and study participants were selected based on a theoretical sampling strategy, chosen because they had specific characteristics that were a distinct fit for this study.<sup>73</sup>

**eBird**<sup>74</sup> is a crowdsourced, online database of bird observations where bird watchers share their checklists to provide data about species distribution and abundance. Users can submit data in a number of ways

including a mobile app. The data are shared with several teams of scientists and have resulted in over 120 publications.<sup>75</sup>

**eMammal**<sup>76</sup> is to mammals as eBird is to birds, except it requires participants to use camera traps (i.e., trail cameras mounted in the field that are triggered by movement) to collect observations.

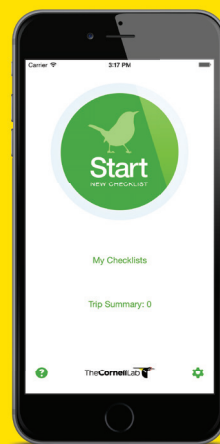


Image credit: eBird



# Exhibition & Program Analyses

## Overview

The goal of these analyses was to examine how some museums have incorporated citizen science into their typical visitor experiences and offerings. These assessments included both exhibitions and programs in order to understand how exhibitry and its interaction with programming can best support the general goal of inspiring and involving museum audiences in citizen science. Similarly, rather than focusing on a single way citizen science has been manifested in exhibitions, it was most valuable to explore the strengths and weaknesses of these different modes, each with their own goals, to help inform the development of considerations and possible design solutions presented in Chapter 4.

The case museums were first selected because they have current or past examples of exhibiting citizen science. However, it was equally important to examine their programming because of the relationship between exhibitions and programs in how they reach audiences and serve their institutions' missions. Citizen science programs also tend to pre-date citizen

science exhibitions; thus, they have often undergone several more iterations of development and refining compared to the infancy of citizen science exhibitry. This, in combination with the advantages of hands-on components and facilitation, make them important sources of inspiration.

The selected museums have also extended their citizen science activities outside of their institutions and into their neighborhoods by partnering with community organizations. This approach of civically engaging with their communities outside of the physical confines of museum is just as important as engaging with audiences within the museum. However, a discussion of these particular activities is beyond the scope of this thesis's focus on the museum visit.

The data gathered for these analyses came from open-ended interviews, secondary research, evaluations conducted by or for the museums, and site visits when it was possible.

## Case Museums & Features

\*Denotes site visit by author

1. North Carolina Museum of Natural Sciences  
Raleigh, NC
  - Exhibits in *Nature Research Center*
  - Museum-led citizen science programming and the *Prairie Ridge Ecostation*
2. Natural History Museum of Los Angeles  
Los Angeles, CA
  - *Nature Lab* exhibition\*
  - *Nature Gardens* outdoor exhibit and programmatic space\*
  - Other museum-led citizen science programming
3. San Diego Natural History Museum  
San Diego, CA
  - *Extraordinary Ideas from Ordinary People* exhibition\*
  - Museum-led citizen science programming

## Case Museum #1: North Carolina Museum of Natural Science (NCMNS), Raleigh, NC

NCMNS's relationship with citizen science began about two decades ago, incorporating projects like eBird and Monarch butterfly monitoring into their educational and outreach activities.<sup>77</sup> The Museum opened a new wing in 2012 called the *Nature Research Center (NRC)*, the sister building to the main building or *Nature Exploration Center (NEC)*, marking a conscious decision to demystify the scientific process and include their visitors in scientific discovery.<sup>78</sup> In combination with their outdoor education facility *Prairie Ridge Ecostation (PRE)* and their new citizen science coordinator, more citizen science programming and interpretation were incorporated into the Museum's activities.<sup>79</sup>

The exhibitions in the *NEC* and the new *NRC* wing are meant to work in concert with one another: the first building, to communicate what people know about the natural world, or to increase visitors' scientific literacy, and the second to demonstrate – and involve visitors in – how people know what we know.<sup>80</sup> With this

**Museum Mission**<sup>81</sup>

"To illuminate the natural world and inspire its conservation."

**Values**<sup>82</sup>

<b>Foundation</b>	Integrity, Professionalism, and Commitment
<b>Approach</b>	Inclusive, Innovative, and Collaborative
<b>Outcomes</b>	Engagement, Impact, and Sustainability

**Nature Research Center's Mission**<sup>83</sup>

"To engage the public in understanding the scientific research that affects their daily lives."

aim to increase public understanding of research, the *NRC* is interactive and hands-on, encouraging visitors to be a part of the discovery process.

**Citizen Science Center & exhibits**

NCMNS first envisioned visitors learning about opportunities to get involved in citizen science as they made their way around the museum's exhibitions.<sup>84</sup>

Then, visitors would have a culminating experience in the Citizen Science Center where citizen science would be explicitly defined and presented, providing reinforcement for what visitors had learned in the other areas of the museum.<sup>85</sup> In the Center, interpretive copy explicitly defined citizen science, stated that anyone could participate, and invited visitors to explore opportunities to get involved. Visitors could sign up for citizen science projects on SciStarter at a computer kiosk, and the original plan was to provide a chance for visitors to participate in citizen science in the exhibit space: visitors would view a webcam feed of a bird feeder at the *PRE* and use an eBird computer kiosk to enter their data.<sup>86</sup> This exhibit faced several

Location of the Citizen Science Center in NCMNS's *Nature Resource Center*.

Image credit: Screenshot from Google Maps Street View, user Tiger Lin devilgorgor.com



(Clockwise, top left): Kiosks and interpretive panels at the Citizen Science Center; a data collection event at the Micro World iLab; visitors hiking at the Prairie Ridge Ecostation; and the Genetics and Microbiology look-in lab, featuring signage promoting citizen science coordinated by the “Your Wild Life”<sup>87</sup> lab.



Image credits (clockwise, top left): North Carolina Museum of Natural Sciences (NCMNS); Deborah Bailey, NCMNS; Swanson + Associates, P.A.; and NCMNS.



technological issues related to the webcam, the Museum's network connectivity, and the need for staff monitoring to ensure that the kiosks worked.<sup>88</sup>

NCMNS's vision for the *NRC* was never fully executed: citizen science messaging did not end up being incorporated throughout the museum and the Citizen Science Center was a small room tucked away in an corner behind a staircase.<sup>89</sup> This was not an intentional decision, rather it was a product of time and resource prioritization, a common issue in any museum.<sup>90</sup> Although the Citizen Science Center was not included in the Museum's summative evaluation of the *NRC*, some staff report that visitors did not seem to understand the intent of the space, and that some actually found the space to be more of a momentary respite from museum fatigue given its lack of visitors and activity.<sup>91</sup> Further, the Citizen Science Center's square footage made it more conducive to individual or family groups over school groups.<sup>92</sup> The *NRC* is a much more active space of the Museum during the week when scientists are working in their research labs, but on the weekend, when families typically visit the Museum, the *NRC* is not always as popular.<sup>93</sup> Thus the likely, or at least defacto, target audiences for the Citizen Science Center are not

always being driven to the space.<sup>94</sup>

In 2017, the Citizen Science Center closed down because the Museum needed a space to store a new acquisition of dinosaur fossils while awaiting completion of a new floor exhibition.<sup>95</sup> The Museum is now taking this opportunity to rethink their citizen science exhibitry, with the aim of decentralizing the interpretation of citizen science and distributing the exhibitry throughout the Museum.<sup>96</sup>

### **Investigate Labs & Research Labs: Exhibits & programmatic spaces**

The *NRC* houses two types of laboratories: Research Labs and Investigate Labs (iLabs). The Research Labs are NCMNS's more traditional 'look-in' labs, where museum scientists work while visitors peak in through floor-to-ceiling windows or even get invited inside. Sometimes these labs even host data collection activities, where visitors are asked to provide data. Some examples include the Armpit Microbes,<sup>97</sup> Belly Button Biodiversity,<sup>98</sup> and Meet Your Mites<sup>99</sup> projects, where visitors' armpits, belly buttons, and face oils, respectively, were swabbed so their microbes and microorganisms could be studied.

***“I do also share the fact that though I’m a professional scientist, my area of expertise is insects. When I’m doing phenology, bird, or weather projects, I consider myself a citizen scientist right there with them! I do also like to show them that I don’t know everything about how to ID birds, for example, so they can see that they can participate even if they only know a few birds.” – Chris Goforth<sup>100</sup>***

iLabs are educational spaces with programmatic elements where visitors can learn how to use scientific tools and get more comfortable doing science.<sup>101</sup> They do not host citizen science projects, though they may sometimes promote specific projects like eMammal.<sup>102</sup> The iLabs were included in the NRC summative evaluation targeting families.<sup>103</sup> Because the four iLabs focus on different subjects, specific visitor experiences differ depending on the particular iLab. However, they all share common learning outcomes and aim to create experiences that hold visitors’ attention rather than the ‘sweep’ behavior of perhaps more traditional/typical exhibitry. The evaluation found that visitors are drawn into the space expecting an exciting experience due to the materials and tools that are visible from the outside. They spend long periods of time engaged in the activities of the iLabs relative to other exhibit areas and have satisfying and fun hands-on experiences.<sup>104</sup> The main learning

outcomes were increased familiarity with tools, content-specific knowledge, and observational skills. Secondary outcomes included learning about the scientific process and feeling like a scientist.

### **Citizen science programming & The Prairie Ridge Ecostation**

The PRE is an outdoor educational facility 6 miles from the Museum.<sup>105</sup>

Several programs, often related to citizen science, take place on its grounds. One such recurring event is Citizen Science Saturdays. Each week, visitors can spend time outside and take a simple hike while participating in a different citizen science project.<sup>106</sup> These events are led by Museum staff, but are also frequently led by volunteer citizen scientists, particularly so they have the opportunity to share their experiences and enthusiasm for citizen science with new participants.<sup>107</sup> Citizen Science Saturdays tend to attract both families and adults; families most often

attend only one event, but adults alone are more likely to be repeat attendees.<sup>108</sup>

The *PRE* also recurrently hosts training events on different citizen science projects, such as iNaturalist trainings.<sup>109</sup> These events typically attract environmental and formal educators who are specifically interested in learning how to incorporate citizen science into their lessons.<sup>110</sup> Additionally, the *PRE*'s citizen science events sometimes present opportunities for experienced citizen scientists to meet and work together.<sup>111</sup>

## Next steps & lessons learned

- The Museum is looking to distribute citizen science interpretation throughout the museum, as originally envisioned, rather than concentrating it in one area.<sup>112</sup> This is in the hopes that the more opportunities for visitors to encounter the term and concept of citizen science, the more likely they will recognize and retain it in their vocabulary and perhaps investigate ways to join.<sup>113</sup>
- The *NRC*'s computer networks make it difficult to create standalone, unmanned exhibits that provide opportunities for visitors to participate in citizen science in the exhibition spaces.<sup>114</sup> This is a crucial point for museums to contemplate with any kind of digital media in their exhibit spaces. Encountering a broken exhibit that promises an experience doing citizen science could create a negative memory associated with citizen science.

- Further, staffed experiential exhibit spaces, like the iLabs, are better at attracting participation in the galleries than unmanned spaces like the Citizen Science Center.<sup>115</sup> Programming, especially at the *PRE*, does an even better job at attracting participation, especially participation specifically in citizen science.<sup>116</sup> The latter may be due to audiences' expectations when visiting a specialized, outdoor space like the *PRE* versus their expectations of engaging with traditional exhibitry in an indoor museum gallery.
- The placement of a citizen science exhibit and its attracting features, including activity level of space, are important to consider in the context of the other exhibitions and the configuration of the building. The Citizen Science Center's location partly behind a staircase and less interactive nature compared to the other exhibitions nearby led to its low ability to attract visitors to pass through its threshold.<sup>117</sup> When citizen science is central to an institution's mission and vision, it is crucial to communicate this importance to audiences by featuring its interpretation where visitors are likely to encounter it. NCMNS aims to do so, again, by distributing citizen science interpretation throughout several exhibitions. However, if museums choose to adopt a single space devoted to citizen science, the gallery or exhibition should be unmissable: for example, the Philadelphia History Museum's Community Voices gallery, a community curated space, is prominently located at the entrance of the museum so visitors are less likely to pass it by.

## Case Museum #2: Natural History Museum of Los Angeles (NHMLA), CA

In 2001, NHMLA shifted their mission to be more about the visitor's experience and less about the institution's outputs.<sup>118</sup> The new focus of inspiring wonder and stewardship for the environment naturally led to the decision to emphasize citizen science.<sup>119</sup> To fulfill this goal, the Museum also realized that they needed to change their institutional culture: they have worked to increase collaboration and teamwork cross-departmentally, particularly to create a cohesive willingness to promote citizen science in all areas of the museum such as exhibits, programming, education, research and marketing.<sup>120</sup> For example, staff scientists are expected to incorporate citizen science opportunities into their mission, while marketing works to appeal to the public, and citizen science coordinators and educators help to bridge the gap between the public and the scientists and support the public in becoming more comfortable doing science and being in nature.<sup>121</sup>

NHMLA's main strategy in communicating their message about citizen science and inspiring participation is through

### **Museum Mission**<sup>122</sup>

"To inspire wonder, discovery, and responsibility for our natural and cultural worlds."

### **Museum Vision**<sup>123</sup>

"To inspire the widest possible audience to become stewards of the living Earth."

***"We will become...a museum of both natural history and living nature." – Dr. Jane Pisano***<sup>124</sup>

programming and their web presence. However, the Museum is making an effort to interpret citizen science during the typical museum visit with the *Nature Lab* exhibition and the related *Nature Gardens*. Aside from the normal hurdle that all museums face in reaching visitors who have never heard of citizen science, NHMLA recognized another obstacle unique to an audience located in a highly urbanized region: comfort with the outdoors and exploring nature.

### **Gateways to citizen science**

When envisioning LA's landscape, some of the first imagery that comes to mind is associated with the human built environment: indeed, in their front-end evaluation for the *Nature Lab*, NHMLA found



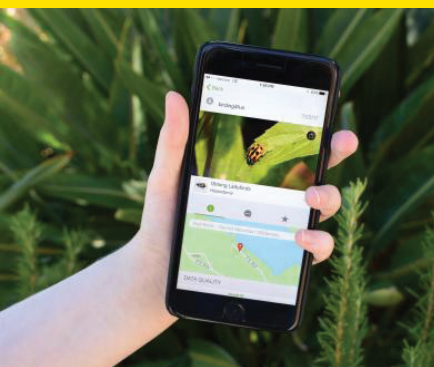
### Museum Values<sup>125</sup>

Adventurous	Curious, Bold, and Desire to Discover
Inclusive	Accessibility, Collaboration, and Respect
Authentic	Sharing Collections and Research
Intentional	Driven to Study, Educate, and Inspire

that the majority of their interviewees, when asked to describe LA's environment, mentioned aspects of a built-environment like cultural and entertainment attractions, roads, and urban sprawl, over aspects of its natural world.<sup>126</sup> The Museum recognized that much of their community may not already be comfortable exploring nature or naturally gravitate towards the doing the kind of science the Museum engaged in themselves.<sup>127</sup> NHMLA decided to meet

their audience where they were already comfortable and to slowly ease them into their citizen science projects.

NHMLA is adamant that projects labeled as 'citizen science' must have a research question behind it, or at least a clear pathway between the data collected to real research.<sup>128</sup> As such, they have developed some ways to introduce people to spending time in nature observing



**iNaturalist<sup>129</sup>** is a social platform for recording and sharing wildlife observations from a smart phone or web browser. Anyone is able to access the records; which makes it a popular, easy-to-use tool for citizen science biodiversity projects.

Image credits: (left) National Park Service, (right) iNaturalist Canada.

and collecting data, that are not citizen science per se but still help participants to develop the skills they would need in citizen science.<sup>130</sup> The main project is the LA Nature Map, which is a collection of observations of wildlife organized geographically in the greater LA region. The Museum promotes this project in the *Nature Lab*, online, and in their programming and encourages visitors to learn how to use iNaturalist to submit their observations.<sup>131</sup> However, the project will also accept submissions from several social media platforms, such as Instagram, Twitter, and Facebook, because they recognized that people are already comfortable using these platforms, and already often did so to take photographs of wildlife.<sup>132</sup> In the latter cases, the Museum will encourage people to transition to iNaturalist, outlining the benefits of it as a social media platform in and of itself.<sup>133</sup> Further, the Museum offers support in training people in how to use this app and in how to take scientific-grade photographs. Over time, as participants in the LA Nature Map become more interested, the Museum will then encourage them to submit data to their citizen science projects.<sup>134</sup>

## Citizen science programs at the Museum

NHMLA participates in several citizen science projects, many of which were designed by the citizen science and research staff of the Urban Nature Research Center, a research department of the Museum.<sup>135</sup> These projects are based around iNaturalist and social media as tools for data collection and are biodiversity studies of several taxa. Visitors can contribute data to these projects on their own time, but NHMLA also hosts events (e.g., Citizen Science Meet-Ups) at the museum or out in the community that facilitate training and participation. They also engage youth in their citizen science projects through different camps and programs, like the Nature Navigators.

## *Nature Gardens: an outdoor exhibit & programmatic area*

Around 2011, NHMLA began to develop a 3.5 acre field research site and publicly accessible outdoor space around the museum, eventually naming the space the *Nature Gardens*.<sup>136</sup> The *Gardens* are a landscaped space, but they still retain a quality of being left to nature's whims, especially in that they are an attractive spot for wildlife to convene and take root.<sup>137</sup>



The **Nature Gardens**. Chalkboard signs point out interesting features, such as equipment used in NHMLA's citizen science projects.

The *Nature Gardens* serve a number of purposes. NHMLA is located 6 miles from the downtown center of LA; thus, many of their visitors lack access to outdoor space in their day to day lives.<sup>138</sup> The *Nature Gardens* are a safe outdoor space for children to play and experience nature, building comfort with and intrigue in the outdoors from an early age. Many NHMLA staff, especially those involved in research, citizen science, and environmental education, recognize the importance of nature play in their formative years.<sup>139</sup> The *Nature Gardens* are also equally an opportunity for adults to experience nature up close, which is

especially important for those who do not have regular access to natural spaces. Further, they serve as a respite for museum visitors when museum fatigue sets in.<sup>140</sup> Visitors have access to the gardens with admission and can exit and re-enter the Museum's exhibitions from this outdoor space. The *Nature Gardens* have minimal label copy, in the form of sandwich-board style chalkboard signs. Overall, the *Nature Gardens* are a method for bringing the natural world to life in the museum setting, breaking the mold of interpreting only collected specimens behind glass.

***“8:30 P.M. August 14, Reese, who’s 9, searches for lizards in his Chatsworth neighborhood. He’s an experienced reptile stalker and has already caught a ‘bazillion lizards’ with his bare hands. The lizard he catches this evening is one for the record books. Reese knows right away it’s something different. He submits a photo to the museum and learns that this is the first Mediterranean House Gecko documented in LA.”***

***– New in Town panel, page 36.***

The Nature Gardens also serve as an important space for the Museum’s programs, especially those related to citizen science. They are also a way to demonstrate, outside of programs, the types of data collection in which the Museum’s citizen science projects engage, especially for a citizen science project called the SuperProject.<sup>141</sup> For instance, there is a malaise trap for trapping insects set up in a visible area of the *Nature Gardens*. The insects that are collected from this trap get sorted by volunteers and work study students in the *Nature Lab* (see next section), who invite visitors to ask questions and even show visitors how to

### **The City Nature Challenge<sup>142</sup>**

In 2016, NHMLA and the California Academy of Sciences started a friendly

competition to

see which city could document the most urban biodiversity over a 1-week period, modeled after a BioBlitz. Each year the competition has grown to include more cities, and in 2018 it became an international event.

### **The SuperProject<sup>143</sup>**

A conglomeration of several NMHLA-led citizen science projects that sample participants’ backyards and neighborhoods for biodiversity over a year. Participants may host insect malaise traps, camera traps, and bat monitoring devices at various points throughout the year, and they commit to actively documenting species at regular intervals.



Image credit: Nature Discovery Center.

preserve insect specimens on their own. Bat monitoring devices and camera traps are other examples of equipment that can be seen in the *Gardens* (see page 33).

### **Nature Lab exhibition**

NHMLA opened the *Nature Lab* in 2013, an exhibition that serves as a bridge between the Museum’s research and collections

and the *Nature Gardens*.<sup>144</sup> The mission of this space is to interpret the local nature of LA; the big idea is even boldly stated on one wall, LA is a biodiversity hotspot! Here's why."<sup>145</sup> The exhibition encourages exploration, providing opportunities for visitors to hone their observation skills, ask questions, and learn how to do some science. In this way, the *Nature Lab* has goals rooted in both scientific literacy and public understanding of research. There are many physical and digital interactives, natural history specimens, live animals, multimedia, and visual means of displaying content to appeal to multiple learners. To this latter point, visitors consume content through videos and traditional label copy, but also through cartoon-like illustrations reminiscent of a graphic novel. This makes the space fun, approachable, and narrative-based rather than fact-laden, perhaps driving the point home that anyone can participate in science and have a good time.

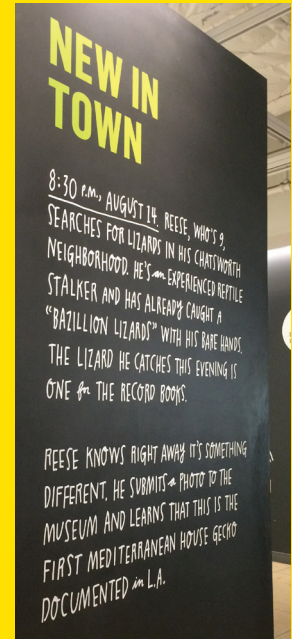
Story telling is an important element to the *Nature Lab*. Visitors hear or read about encounters with nature or how a person came about to study a particular organism. Many of these are stories of the Museum's staff scientists and educators, but some are of visitors and volunteers. A few examples include a panel about Reese, an 11 year

old who published the first documented sighting in LA of the Mediterranean Gecko in *Herpetological Review*, and a memory map of a local classroom's experience when their black-top schoolyard was converted into a greenspace (see page 36).

NHMLA primarily sees their programs as the way to get visitors actively involved in citizen science rather than this being the job of exhibitions, and namely the *Nature Lab*. However, they see exhibitions as another gateway into citizen science through the incorporation of citizen science messaging that encourages visitors to pursue these opportunities.<sup>146</sup> While many of the exhibit areas use storytelling to inform visitors about different citizen science projects hosted by the Urban Nature Research Center, the 'citizen science wall' consciously aimed to be the exhibit where visitors would find citizen science projects to join. The wall consists of a large flowchart that asks visitors to consider their interests and find a match with a project. Boxes mounted on the wall invite visitors to peer inside and discover a specimen, representing a data point that a citizen scientist submitted to the relevant project. A touchscreen in the middle of this wall displays the LA Nature Map, allowing visitors to zoom in on their neighborhoods or other areas of interest to see which



The **Nature Lab**; (clockwise from top left): Panoramas of the exhibition, showing the memory maps and citizen science wall (top left) and live animal and interactive exhibits (middle left); Close-up section of the memory map by a local elementary school; Panel telling the story of Reese's discovery of the Mediterranean House Gecko; The citizen science wall, featuring the LA Nature Map touchscreen, with a close-up of a specimen and object label about a citizen scientist-collected data point, located in one of the boxes.



species have been sighted. It is difficult to track if visitors are indeed joining these projects based on their experience with this exhibit; however, some staff members posit that it is not very successful in motivating visitors, especially since many likely walk away still unable to define citizen science. One proposed option is activating the space, perhaps with a short video providing a quick rundown of citizen science and how visitors can join in collecting data, since the multimedia and live specimens elsewhere in the exhibition compete for visitors' attention compared to this more static display.

## Next steps & lessons learned

- Creating an institutional culture of collaboration has been key to the expansion of citizen science's role at NHMLA. What started out as a small, one-person effort has grown into a five person department that interfaces regularly with several other departments such as education, public programming, exhibitions, research and marketing.<sup>147</sup> New hires in research and citizen science are asked how they will collaborate cross-departmentally and create new opportunities for citizen scientists, rather than how much publishable research they will produce within a designated timeframe.<sup>148</sup>
- NHMLA sees exhibitions' role for the time being as serving as a way to spark interest in citizen science and encourage visitors to investigate their natural world. A weakness in the Nature

Lab is the lack of a clear definition of citizen science, particularly at the 'citizen science wall' when an understanding of the term is perhaps most crucial. It is likely that visitors gain a sense that the science they are learning about in this space was generated by both scientists and the public, but it is not clear if they connect this to their own ability to participate.<sup>149</sup> In addition to the aforementioned idea of adding a video to the 'citizen science wall', other explicit messaging could be incorporated throughout the space and individual citizen scientists' contributions could be highlighted or highlighted further: in the case of Reese, a photograph of him with his published paper may resonate with more visitors than interpretive copy alone.<sup>150</sup>

- Like NCMNS, NHMLA also envisions exhibitions as potential spaces to train visitors in citizen science. Some staff have expressed an interest in VR/AR experiences that could serve as training modules,<sup>151</sup> or incorporating activities like insect sorting<sup>152</sup> in the Nature Lab. For the latter, this activity would be geared towards practicing rather than contributing to an actual citizen science project. Whichever modes NHMLA chooses, however, must stand up to their high visitation of nearly 1 million annual visitors.<sup>153</sup>
- NHMLA's focus on citizen science programming will continue to evolve both inside and outside of the museum, especially by furthering their community partnerships. Some active partnerships that are in their early-to-mid phases are with the county libraries and state parks.<sup>154</sup>

### Case Museum #3: San Diego Natural History Museum (The Nat), CA

Approximately 15 years ago, The Nat made the decision to narrow the main focus of their research, interpretation, and conservation on their local region of Southern California and the Baja California Peninsula. This marked a shift from interpreting global natural history as its main focus to emphasizing the biodiversity and richness of their region and then contextualizing it globally.

Although The Nat had already been engaging with citizen science prior to this shift, the years since have seen greater efforts to increase their citizen science activities. Its most recent 'strategic roadmap'<sup>155</sup> in 2017 noted The Nat's founding roots in citizen science and emphasized its ongoing commitment to not only projecting and practicing citizen science externally through its public activities, but to embodying citizen science internally in their institutional culture.<sup>156</sup> This has led to greater cross-departmental collaboration, notably in the co-development of programs and exhibitions and the interfacing between citizen science, education, and research.<sup>157</sup>

***“This thing we now call a museum was started by some people who didn’t have grand ambitions. They just had a grand, big, beautiful love of nature. They were regular citizens who were also part-time scientists.” – The Nat’s Strategy Roadmap, July 2017***<sup>158</sup>

In addition to their long history and ongoing relationship with citizen science programming, The Nat opened a permanent exhibition in 2016 called *Extraordinary Ideas from Ordinary People: A History of Citizen Science*.

### ***Extraordinary Ideas from Ordinary People: A History of Citizen Science***<sup>159</sup>

The big idea of this exhibition is “For much of what we know about natural history, we can thank citizen scientists.”<sup>160</sup> As the title indicates, *Extraordinary Ideas from Ordinary People* is historically driven, in part motivated by The Nat's desire to exhibit historical artifacts, such as rare books, scientific illustrations, field notes, journals/diaries, and microscope slides, dating from as early as the 19<sup>th</sup> century.<sup>161</sup> Because the exhibition is permanent, The



**Museum Mission**<sup>162</sup>

"To interpret the natural world through research, education and exhibits; to promote understanding of the evolution and diversity of southern California and the peninsula of Baja California; and to inspire in all a respect for nature and the environment."

**Purpose**<sup>163</sup>

- Emphasize region within a global perspective
- Collect and preserve for future generations
- Study biodiversity and evolution
- Make nature relevant to the community
- Integrate natural history research and education

**Museum Vision**<sup>164</sup>

"The San Diego Natural History Museum will be the premier collections-based environmental education and natural history research resource in our region. We will provide programs that are timely, user-friendly, and relevant to the real-life needs of the diverse populations of the San Diego-Baja California region today and tomorrow."

Nat has plans to allow objects to rest and will either switch entire exhibits or individual objects every two years.<sup>165</sup>

The theme of citizen science is palpable as each section focuses on the contributions of an historical amateur naturalist or group of non-professionals who either directly contributed to or indirectly influenced The Nat's research. Woven into these narratives are stories of citizen scientists from The Nat's recent history, and many of these are paired with information about present-day citizen science projects that visitors can join through the museum. Indeed, a summative evaluation determined that a third of those interviewed could determine the overall

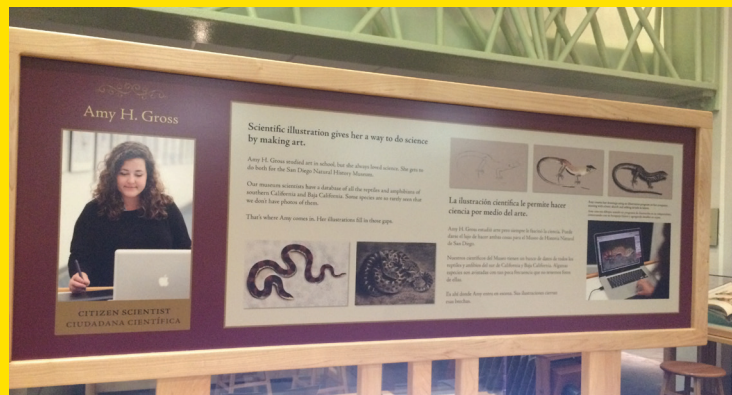
gist of the big idea without prompting, while most others understood that the exhibition was about the history of science and sensed that it promoted an inclusive view of science.<sup>166</sup>

The exhibition uses traditional exhibitry paired with digital interactives. In general, each section consists of a main content panel and a large case containing historical artifacts or books with individual or group object labels. Some sections have videos or large touchscreens, the latter of which allow visitors to look inside the rare books, zoom in on artifacts, or explore the website of a citizen science project. Most sections have stools for visitors to use,



Panorama of the main, downstairs portion of **Extraordinary Ideas from Ordinary People**. The exhibition is characterized by table-top or standing object cases, large touch screens, and bilingual panels and object labels.

TÚ puedes ser ciudadano científico.	YOU can be a citizen scientist.
Atlas de anfibios y reptiles de la California peninsular <a href="http://herpatlas.sdnhm.org">herpatlas.sdnhm.org</a>	Amphibian and Reptile Atlas of Peninsular California <a href="http://herpatlas.sdnhm.org">herpatlas.sdnhm.org</a>
Campamento en el Museo <a href="http://sdnat.org/familyprograms">sdnat.org/familyprograms</a>	Camp at the NAT <a href="http://sdnat.org/familyprograms">sdnat.org/familyprograms</a>
Celebra a las aves urbanas <a href="http://celebrateurbanbirds.org">celebrateurbanbirds.org</a>	Celebrate Urban Birds <a href="http://celebrateurbanbirds.org">celebrateurbanbirds.org</a>
Recuento navideño de aves en el jardín <a href="http://audubon.org/citizenscience">audubon.org/citizenscience</a>	Christmas Bird Count <a href="http://audubon.org/citizenscience">audubon.org/citizenscience</a>
Gran recuento de aves en el jardín <a href="http://audubon.org/citizenscience">audubon.org/citizenscience</a>	Great Backyard Bird Count <a href="http://audubon.org/citizenscience">audubon.org/citizenscience</a>
iNaturalista <a href="http://iNaturalist.org">iNaturalist.org</a>	iNaturalist <a href="http://iNaturalist.org">iNaturalist.org</a>
Chismorreo científico <a href="http://sciencegossip.org">sciencegossip.org</a>	Science Gossip <a href="http://sciencegossip.org">sciencegossip.org</a>
Zooniverse—una colección de proyectos de ciudadanos científicos basados en la web <a href="http://zooniverse.org">zooniverse.org</a>	Zooniverse—a collection of web-based citizen-science projects <a href="http://zooniverse.org">zooniverse.org</a>



(Left): Front and back, takeaway bookmarks featuring the specific citizen science projects featured in the exhibition with links so visitors can sign up back at home; (Right): Close-up of a primary panel. Each panel followed a similar format, with the name of the featured person and the title of 'citizen scientist.'

Image credit: (left) Scanned image, from The Nat.

***“Are you a citizen scientist? Are you an observer? A collector? A photographer? An artist? Throughout history, people with little or no scientific training have used their talent and love of nature to show us new things about our world. These people were citizen scientists. You can be a citizen scientist, too.”***

***– Introductory panel, page 40***

encouraging observation of the objects or engagement with the touchscreens and videos.<sup>167</sup> Coupled with the large size of the touchscreens, these stools also promote social interaction among visitors.

The written copy in this exhibition uses the term citizen science exhaustively. The introductory panel immediately defines citizen science, and nearly each person highlighted in the exhibit is referred to as a citizen scientist. The voice of the exhibition is encouraging, emphasizing that *you* can get involved in citizen science because anyone can do science. Scattered throughout the space are panels highlighting The Nat’s citizen science projects. These are paired with the content of the nearby section with the aim of funneling interest from the exhibit into

action. These panels also have takeaway bookmarks or brochures, serving as reminders post-visit of how to get involved.

Although word counts were low for each individual panel or label, the summative evaluation found that visitors were not reading most of the text: for example, only 7% of study participants read the introductory panel.<sup>168</sup> Most visitors remained unfamiliar with citizen science as a term; however, the repetitive use of ‘citizen science/scientist’ throughout the gallery did help some visitors learn the term or at least gain a general understanding of amateurs or hobbyists participating in science.<sup>169</sup> Even though the exhibition is not always successful in raising awareness of citizen science as a term, the concept of citizen science and the sense that science is inclusive does seem to translate to visitors. The evaluation found that many visitors could relate aspects of doing science to their own lives and understood that everyday people could be involved in the scientific process.<sup>170</sup>

## **Citizen science programs at the museum**

In keeping with their mission to interpret their local environment, The Nat’s museum-led citizen science projects focus on the longitudinal study of southern

California's biodiversity.<sup>171</sup> The Nat collects observations of wildlife via iNaturalist, thus most of their citizen science programming is centered around the app. The Museum promotes national citizen science projects, particularly in their camp programming, like the Christmas Bird Count, the Great Backyard Bird Count, and Celebrate Urban Birds. It is currently implementing a series of BioBlitzes of Balboa Park, where the Museum is located, over a period of ten years. In addition, one of The Nat's active museum-led citizen science projects is the Amphibian and Reptile Atlas of Peninsular California, a database of herpetological biodiversity of Southern California and Baja California, where citizen scientists upload observations via iNaturalist.<sup>172</sup>

## Next steps & lessons learned

- The Nat is currently in the process of deciding where citizen science will be within the physical structure of their website – if it will fall under education or research, or somewhere else in terms of their marketing and content structure.<sup>173</sup> At the time this thesis was written, it was difficult to find the webpages devoted to their citizen science programming or department. Thus, users have to know for what they are looking, meaning that visitors to The Nat's website who are unfamiliar with citizen science are not likely to come across it.
- *Extraordinary Ideas from Ordinary People* will rotate some of its exhibits in the near future to allow artifacts to rest. The new exhibits will take into account some of the feedback gained from the summative evaluation.<sup>174</sup>
- The videos in the exhibition had mixed reactions from visitors.<sup>175</sup> One video showed the process of making lithographic prints of scientific illustrations. Another video told the story of citizen scientist Carole Hertz who, starting in the 1970s, studied seashells and ended up forming close friendships with two other women. This video was static compared to the lithography video, because it showed brief video clips in between frames of text. Although the Carole Hertz video had a personal story and a heartwarming message, it was not visually appealing compared to the action of the lithography video.
- *Extraordinary Ideas from Ordinary People* successfully helps to bring some of its artifacts alive through its digital interpretation but struggles a bit in connecting visitors to the concept of citizen science. Although each individual panel and object label consists of brief copy, overall the exhibition is text heavy. Thus, citizen science-specific content may benefit from a different interpretive approach.

# Surveys

## Overview

This thesis used front-end, exploratory surveying to form a basis for understanding the interests and needs of citizen scientists as collaborators in creating exhibitions (survey #1), and for understanding the motivations, expectations, interests, and needs of visitors to hypothetical citizen science exhibitions at natural history and/or science museums (survey #2). Further information about the design, distribution, interpretation, and implications of each survey are described in the sections that follow, but both surveys shared some qualities:

- Both surveys were created and distributed using Google Forms.
- The surveys had opened-ended and multiple choice questions. When applicable, some multiple choice questions allowed survey participants to select more than one response to a question.
- Questions were based on findings from the literature and interviews with museum and/or citizen science professionals.
- All questions pertaining to demographics were optional so as not to deter or alienate survey participants. These questions were asked at the end of each survey, and each question was designed to be as inclusive as possible by providing participants with a range of possible answers along with a write-in option to most questions. All other questions were required, with the exception of concluding questions.<sup>176</sup>
- Some survey questions were meant to serve as proxies for a particular type of measurement; therefore, author bias may exist in the interpretation of these results. The author makes every attempt to be transparent in when and how these interpretations took place.
- Both surveys were formative and did not aim to survey their total possible populations; thus, the findings are not statistically significant or able to be extrapolated. Rather, the findings serve as a meaningful basis for this research, and the survey instruments themselves could potentially serve as tools for museums and other institutions to adopt and change according to their needs and particular audiences. The survey instruments are available in the Appendix.

## Survey #1. Study of citizen scientists as community curators

The first survey was designed for people who currently participate or in the past have participated in citizen science. Survey participants did not necessarily need to call themselves 'citizen scientists,' but they did need to be aware that they contribute or were contributing to scientific research in some way. In addition, respondents could fall on any level of Haklay's typology of citizen science participation to be eligible for the survey.

The purpose of this survey was to understand the interests, needs, and ideas of citizen scientists as community collaborators in creating exhibits about citizen science at natural history or science museums. The goals of this survey were as follows:

1. To determine citizen scientists' level of interest in participating in exhibit development and design, and/or in becoming a docent.
2. To understand how citizen scientists want themselves, their projects, and the overall field of citizen science represented at a museum.

3. To understand the needs of citizen scientists in collaborations/partnerships with museums.

Data collection took place from 2/25/18 to 3/28/18. Survey participants were primarily recruited through SciStarter's Twitter, Facebook, and LinkedIn pages. The survey link was also distributed on the Citizen Science Association listserv. Additionally, at least one professional scientist is known to have shared the survey via Facebook and some ichthyology-related web pages.

## Results & analysis

Forty-eight surveys were collected in total, but only 42 were included in analysis. Of these respondents, 3 were ineligible because they had never participated in a citizen science project,<sup>177</sup> 2 were determined by the author to be ineligible,<sup>178</sup> and 1 was a duplicated response.

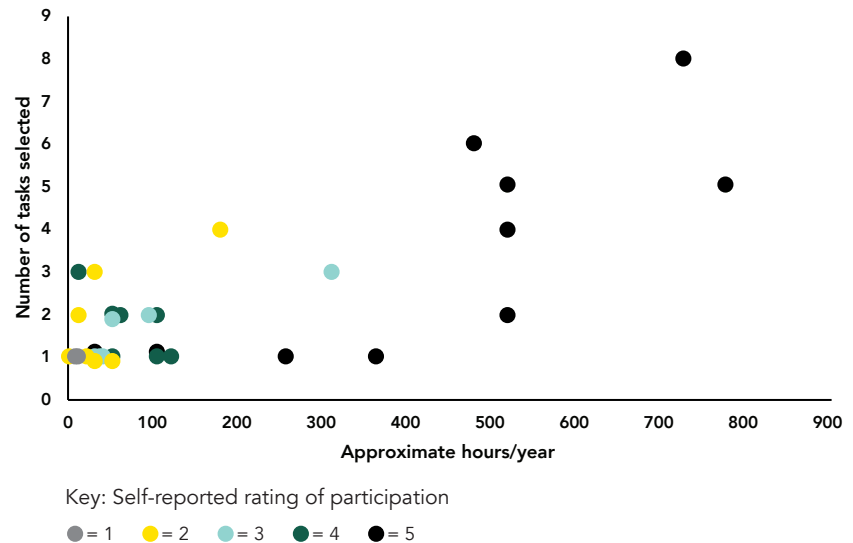
## *Overview of respondent demographics*

The majority of respondents identified as non-Hispanic white or Euro-American (71.4%, n=30, overall response rate (ORR)=85.7%) and as female (57.1%, n=24, ORR=85.7%). About half of the respondents were between the ages of 25 and 45 (54.8%, n=23, ORR=100%).



Rating	n	% survey participants
1	4	9.5
2	7	16.7
3	12	28.6
4	6	14.3
5	13	31.0

**Table 1.** Respondents' self-reported rating of participation in the citizen science project in which they participate the most.



**Figure 1.** Approximate hours of participation per year versus number of tasks respondents complete in the citizen science project in which they participate the most, grouped by rating.

More than half of the respondents had completed at least some graduate school or more (64.3%,  $n=27$ ,  $ORR=100\%$ ), and the lowest level of education completed by any respondent was an Associate's degree.

### *Overview of respondent participation in citizen science*

Most respondents were current participants in citizen science at the time they took the survey (66.7%,  $n=28$ ), and the majority of these respondents actively participated in 1-2 projects (64.3%,  $n=27$ ). The remaining respondents who had participated in citizen science in the past mostly had participated

within the past year (30.8%,  $n=4$ ) or 1-2 years ago (38.5%,  $n=5$ ).

When asked how they would rate their level of participation on a scale of '1' to '5' in the one project they currently, or the past, participate in the most, most respondents rated themselves as a '5' (30.9%,  $n=13$ ), or a '3' (28.6%,  $n=12$ ; see table 1). Participants were also asked to quantify their time commitment to this project and to indicate which tasks they complete for the project.

The average number of hours per year respondents devoted to their projects was

weakly correlated with their self-selected rating ( $r=0.625$ ), but the number of tasks they selected did not necessarily correlate with their rating ( $r=0.378$ ; see figure 1). The lack of correlation between these measures is likely due to the small sample size and the uneven representation of respondents in each rating category. Even so, there was a large difference between quantified hours, when extrapolated across a year, and number of tasks between those who rated themselves as a '5' compared to a '1' (figure 1). This suggests that respondents' self-reported ratings are a reasonable representation of their involvement for the purposes of this thesis.

Most survey respondents collected data for their citizen science projects (88.1%,  $n=37$ ). Those who rated themselves as a '1' did not select any other tasks besides collecting data. Only 2 respondents, both of whom rated themselves as a '5,' indicated that they had a hand in designing their project's questions and/or methodology and in interpreting results. The scaled rating system used in this survey is not meant to serve as an exact stand-in for Haklay's typology of citizen science participation, but these results suggest that most of the survey respondents fall under level 1 or level 2 of this typology.

### *Interests & needs in collaborating with museums to create citizen science exhibitions & programs*

Survey participants were asked about their interests in participating in the process of creating museum exhibitions<sup>179</sup> (question #10), what excited them most by this prospect (question #11), and their needs in such collaborations (#12). Each question provided participants with a list of options, of which they could select multiple responses, including a fill-in 'other' option. Question #10 gave respondents the option to select that they were not interested in being a part of such a collaboration, and 3 respondents selected this option. Questions #11 and #12 also gave respondents the option to check "I'm not interested/None of these would excite me" or "I'm not interested/No considerations would make me interested" respectively. Only 1 of the aforementioned respondents selected the respective option for all three of these questions, while an additional aforementioned respondent selected the respective option for question #11 but not #12. This suggests that only 1 survey respondent overall was not interested in taking part in the process of creating exhibitions, while 2 additional respondents were possibly indifferent or weakly interested.



The overwhelming majority of respondents (92.9%, n=39) appeared to be interested, and for some respondents perhaps enthused, by the prospect of collaborating with museums to create exhibitions and programs, especially based on the number of options they selected (average of 3.4 options for question #10, 5.6 options for question #11, and 5.2 options for question #12). The number of options selected for these questions did not strongly correlate with respondents' self-reported ratings ( $r=0.410$  for question #10,  $r=0.477$  for question #11, and  $r=0.372$  for question #12), but those who rated themselves as a '5' selected the most options on average.

The following sub-sections are a breakdown of the survey respondents' selections for each question (#10-12). Given the small sample size, it is most useful to examine the overall response of the respondents. However, tables 1-3 show a breakdown of their responses according to their ratings. It should be noted that the differences in responses by group are not very meaningful given that there is not an even distribution of responses for each rating category, and that those with a rating of '5' tended to select the most options for each question compared to the other self-reported ratings.

*Question #10: If you were to collaborate with a natural history or science museum in creating exhibits about citizen science in general and/or specific citizen science projects, how interested are you in the following?*

The top three selections<sup>180</sup> for respondents' interests were providing background knowledge about the topic of their citizen science project (61.9%, n=26), providing objects and/or images to be displayed (59.5%, n=25), and sharing their personal story about being a citizen scientist (54.8%, n=23). Most other options were selected by between 40-53% of respondents, with the exception of becoming a docent at the museum (21.4%, n=9) and creating/leading a program associated with the exhibition (33.3%, n=14). This suggests that the survey respondents were more interested in becoming involved in the behind the scenes aspects of creating exhibitions. While it is not possible to determine exactly why, one explanation may be the novelty of these options compared to the familiar volunteering/tour guide/docent options that are likely already options available to non-professional scientists.

Q10: If you were to collaborate with a museum in creating exhibits about citizen science, how interested are you in the following?												
Rating	n	Percent selected (%)										
		Knowledge/topic	Knowledge/project	Objects/images	Story	Docent	Program	Interactives	Space/interact	Develop	Design	Advise
1	4	50.0	0.0	50.0	25.0	25.0	25.0	25.0	25.0	50.0	50.0	25.0
2	7	28.6	14.3	14.3	28.6	28.6	28.6	42.9	14.3	42.9	42.9	28.6
3	12	91.7	66.7	58.3	41.7	16.7	25.0	58.3	33.3	41.7	58.3	41.7
4	6	16.7	50.0	83.3	66.7	0.0	16.7	16.7	33.3	33.3	16.7	33.3
5	13	76.9	53.8	76.9	84.6	30.8	61.5	76.9	69.2	69.2	69.2	69.2

**Table 2.** Percent selected options for question #10, grouped by survey respondents’ self-reported rating of participation in the citizen science project in which they participate the most.

Q11: What makes you excited by the prospect of collaborating with museums to create exhibits about citizen science?												
Rating	n	Percent selected (%)										
		Knowledge	Story	Awareness	Inspire	Teach/science	Teach/CS	Results	Create/CS	Interact/CS	Interact/S	Making
1	4	50.0	0.0	50.0	50.0	75.0	25.0	25.0	50.0	25.0	75.0	0.0
2	7	28.6	0.0	57.1	57.1	28.6	14.3	14.3	14.3	0.0	14.3	28.6
3	12	66.7	50.0	66.7	58.3	66.7	33.3	50.0	25.0	25.0	58.3	41.7
4	6	50.0	33.3	83.3	83.3	100.0	50.0	66.7	16.7	50.0	66.7	66.7
5	13	61.5	53.8	92.3	100.0	61.5	69.2	69.2	38.5	61.5	69.2	38.5

**Table 3.** Percent selected options for question #11, grouped by survey respondents’ self-reported rating of participation in the citizen science project in which they participate the most.

Q12: What considerations would museum staff need to keep in mind to make this a rewarding experience for you?								
Rating	n	Percent selected (%)						
		Voice	Equal	Recognized	Skills/learn	Engage/CS	Engage/Public	Fun
1	4	50.0	25.0	25.0	75.0	50.0	50.0	75.0
2	7	28.6	0.0	0.0	57.1	14.3	28.6	42.9
3	12	33.3	16.7	50.0	75.0	41.7	50.0	50.0
4	6	0.0	16.7	66.7	33.3	66.7	50.0	83.3
5	13	46.2	46.2	61.5	69.2	61.5	69.2	92.3

**Table 4.** Percent selected options for question #12, grouped by survey respondents’ self-reported rating of participation in the citizen science project in which they participate the most.

## Codes for Tables 2 – 4

Code	Question #10: Responses/Options
Knowledge/topic	Provide background knowledge about the topic of a project(s)
Knowledge/project	Provide information about the results and/or impact of a project(s)
Objects/images	Provide objects/images
Story	Share your personal story about being a citizen scientist
Docent	Become a docent at the museum
Program	Create and/or lead a program associated with the exhibit
Interactives	Create interactive experiences for the exhibit
Space/interact	Create a space for citizen scientists to interact with one another and/or the public
Develop	Determine what the exhibit would be about (i.e., development)
Design	Determine what the exhibit would like like (i.e., design)
Advise	Serve on an advisory board that reviews the progress and end product of the exhibit

Code	Question #11: Responses/Options
Knowledge	Sharing my own knowledge/expertise
Story	Sharing my own experience/story
Awareness	Spreading awareness of citizen science as a concept/field
Inspire	Inspiring museum visitors to participate in CS
Teach/science	Teaching museum visitors about science in general
Teach/CS	Teaching museum visitors how to do CS
Results	Communicating the results of a CS project
Create/CS	Creating new CS projects/tools
Interact/CS	Interacting with other CS
Interact/S	Interacting with scientists/museum staff
Making	Making/creating/designing something

Code	Question #12: Responses/Options
Voice	My voice is represented in the end product
Equal	My knowledge/expertise is treated as equal to that of a professional
Recognized	I am recognized for my contributions to the field of my project/the field of citizen science in general
Skills/learn	I gain new skills/learn something new through the process
Engage/CS	I am able to engage with other citizen scientists through the process
Engage/Public	I am able to engage with the community/public through the process
Fun	The experience is fun

*Question #11: What makes you excited by the prospect of collaborating with natural history and/or science museums to create exhibits about citizen science?*

Respondents were most excited by the prospect of spreading awareness of citizen science (73.8%, n=31), inspiring museum visitors to participate in citizen science (73.8%, n=31), and teaching museum visitors more about science in general (64.8%, n=27). Most of the moderately selected options (selected by between 40-60% of respondents) indicated that respondents were most excited by the types of information exhibitions can transmit to visitors. This is in contrast to some of the less frequently selected options – creating new citizen science projects/tools (28.6%, n=12) and interacting with other citizen scientists<sup>181</sup> (35.7%, n=15, which are actions related to the idea of exhibitions promoting co-creation of knowledge or engagement in the scientific process. It is plausible that respondents did not associate these actions with the idea or process of creating a museum exhibit.

*Question #12: What considerations would museum staff need to keep in mind to make this a rewarding experience for you?*

Respondents indicated most that they wanted to have fun (69.0%, n=29), that to

gain new skills and learn something new (64.3%, n=27), and to engage with the public (52.4%, n=22) through the process of creating exhibitions. Close behind these top three selections was the need to engage with other citizen scientists through the process (47.6%, n=20), which is contrary to their excitement to interact with other citizen scientists according to question #11. Given the small sample size, however, this discrepancy is likely not inferable.

Interestingly, the least selected options corresponded to the respondents being represented, respected, and recognized. One possible explanation for this result is that the respondents did not see exhibitions as the appropriate mode for recognizing their voice and contributions. This especially tracks with the respondents' highly selected answers for questions #10 and #11 that pertain to exhibitions as modes of transmitting information. Perhaps these survey respondents felt it was more important for museum visitors to learn about science than to learn about the achievements of individual people. However, the question specifically pertains to what museum staff need to keep in mind for the process, not necessarily only for the end product, so there are likely many explanations for why these answers were selected less.

*Question #13: Is there anything else you'd like to add about museum exhibits on citizen science and/or collaborating with museums to create such exhibits? (Optional)*

Only 4 survey participants responded to this question. Two of these respondents offered ideas of how citizen science could be represented in museums' public spaces: "Museums could provide examples of where citizen science has resulted in significant scientific advances and/or policy changes" and "I would like to see SciStarter.com's project finder integrated into the exhibit to help find projects to do at home." The first of these responses relates to the idea of providing information about the results and impact of a citizen science project (questions #10 and #11). The second of these responses relates to inspiring museum visitors to participate in citizen science (question #11), and the desire to recruit people to participate in citizen science (question # 6).

The other two responses to this question reiterated an interest in museums engaging with visitors through citizen science and including citizen scientists in this process: "Engagement is needed in Museums of the 21<sup>st</sup> century- and citizen science is an excellent way for museums to engage with

the public in a meaningful way" and "it is interesting experience for someone who never did anything like this, and it is just pity that my country museums usually don't offer such projects."

## Conclusions

These preliminary findings suggest that citizen scientists have a keen interest in participating in the creation of museum exhibitions and perhaps programming. Their most highly selected answers seem to suggest that there is an interest in being consulted with and a desire to participate in something that feels 'behind the scenes' of the museum.

Surprisingly, there was less interest in envisioning this process as a way to create opportunities for citizen scientists (and professional scientists) to meet and collaborate to further citizen science goals and scientific knowledge generation. But, this may have been due to the more commonly held idea of exhibitions as only a way to transmit knowledge, and thus a focus on what the end product of the process would be rather than what would happen during the process itself. Perhaps easing citizen scientists into the process of creating exhibitions is similar to how people with little background in science

often need to be eased into joining citizen science projects: they need to be met where they are at a given moment, and over time they can engage with the more unfamiliar and multifaceted aspects.

## **Survey #2: Study of natural history & science museum audience**

The second survey was designed for natural history and/or science museum visitors because this group serves as the main visitor audience of this thesis's application. The purpose of this survey was to gain a sense of visitors' expectations when visiting a natural history or science museum, and how they might like to engage with citizen science in this setting. The goals of this study were:

1. To understand the audience's motivations for visiting a natural history or science museum.
2. To understand the audience's prior knowledge of 'citizen science' as a term and concept.
3. To understand how the audience expects to engage with and/or what the audience hopes to learn about citizen science while visiting natural history and/or science museums.

Data collection took place from 2/19/18 to 3/28/18. Survey participants were recruited through the author's social network. The survey link was shared with the author's email contacts, and these first-degree

participants were encouraged to share the link further with their own contacts (e.g., via email or social media platform such as Facebook). This was in an attempt to spread participation several more degrees beyond the author's immediate social network. Further, if participants from survey #1 were ineligible after the first few questions, they were provided with the link to take survey #2, although it is not possible to determine how many survey #2 respondents were recruited in this manner. Despite these attempts to distribute survey #2 to a broader network, it should still be noted that the final surveyed population is representative of only a subset of the greater audience of natural history and science museums. The survey participants are likely more interested in scientific research and have higher scientific literacy than the general population given the author's academic and professional background. Although it is not possible to draw statistically significant conclusions from these data, they still provide a meaningful foundation for this exploratory research.

## Results & analysis

### *Overview of respondent demographics*

Seventy-five surveys were collected. The majority of respondents identified as non-Hispanic white or Euro-American (76.0%,  $n=57$ , ORR=97.3%). Gender identity had the lowest response rate (ORR=80.0%) of any of the demographic questions: a little over half of respondents identified as female (56.0%,  $n=42$ ), while 20.0% identified as male ( $n=15$ ) and 4.0% wrote in a specific identity ( $n=3$ ). About half of respondents were between the ages of 25 and 34 (54.7%,  $n=41$ , ORR=98.7%). All respondents had completed at least some undergraduate level college coursework, and a majority of respondents had completed at least some graduate school or more (52.0%,  $n=39$ , ORR=100%). Most respondents were located in the Mid-Western states (32.0%,  $n=24$ ) or the Mid-Atlantic states (33.3%,  $n=25$ ), reflecting the author's most recent locations of residence and employment or enrollment in universities.

### *Overview of respondent familiarity with & interest in citizen science*

Before being provided with a definition of 'citizen science,' survey participants were asked if they were familiar with it as a term (question #5). Respondents

were mostly familiar with the term (42.7%, n=32) or at least felt that they knew what the term meant (38.7%, n=29). Survey participants were also asked if they had ever participated in a citizen science project and were given a range of possible responses so as to gauge their interest (question #7). Nearly a third of respondents (30.7%, n=23) had participated in citizen science, while 45.3% (n=34) indicated that they had not yet had the opportunity to participate but would be interested. Based on the responses to question #7, respondents were segmented and categorized as interested in participating in citizen science (45.3%, n=34), not interested in participating in citizen science (24.0%, n=18), or already a participant in citizen science (30.7%, n=23).

Also prior to reading a definition of 'citizen science,' survey participants were provided with a list of 13 phrases that describe citizen science and asked to select as many as they felt apply. Respondents chose 7.2 phrases on average. Most respondents understood that anyone could participate in citizen science (81.3%, n=61) and that it could be considered a collaboration between the public and professional scientists (78.7%, n=59). They also saw citizen science as something that non-professionals

participate in, as evidenced by the lower rate of selection of "participants are professional scientists" (26.7%, n=20), and the higher rate of selection of "participants are volunteers" (76.0%, n=57). In comparison to the latter, however, respondents selected "participants are amateur scientists" at a lower rate (49.3%, n=37) which suggests that the respondents may view citizen science more as a top-down discipline, from scientists to citizen scientists, rather than a bottom-up or non-hierarchical discipline. Yet, the low rate of selection of "participants take direction from professional scientists" (41.3%, n=31) counters this possible explanation. One respondent wrote in the 'other' response that they felt that a lot of these statements applied sometimes; although giving respondents the option to check all statements that applied was meant to suggest that the statements were not mutually exclusive, this meaning may not have come across to the survey takers. It is possible that the rates of selection may have been higher for the aforementioned selections if this had been clearer.

### *Expectations when visiting a natural history or science museum*

About a third of the survey respondents reported that they visit natural history



Q3: How important are the following to you when visiting a natural history or science museum?	Overall Average Rating	Average Rating: Interested	Average Rating: Not Interested/Unsure	Average Rating: Past/Current Participants
Q3.1: Learn what is already known about science/natural history	4.1	4.1	4.1	4.3
Q3.2: Learn about recent discoveries in science/natural history	4.5	4.4	4.6	4.6
Q3.3: Learn about current research happening at the museum or affiliated institution (e.g., university)	4.1	4.1	4.1	4.2
Q3.4: Talk to a researcher about their work	3.3	3.4	2.8	3.4
Q3.5: Talk to a volunteer/docent who has general knowledge about science/natural history	3.2	3.3	3.1	3.0
Q3.6: Have a social experience with the people I'm visiting with	3.6	3.6	3.5	3.7
Q3.7: Have a social experience with other visitors at the museum	2.0	2.2	2.0	1.9
Q3.8: Participate in an activity that helps me learn something new	3.7	3.7	3.6	3.7
Q3.9: Participate in an activity that contributes something to the research done at the museum	3.7	3.7	3.2	4.0
Q3.10: Discover a new interest that I can pursue on my own or with my family, friends, etc.	3.7	3.6	3.3	4.0

**Table 5.** Overall average rating, and average ratings segmented by interest in citizen science, for question #3 pertaining to expectations when visiting a natural history or science museum.

or science museums multiple times a year (32%, n=24), while less than a third reported visitation once a year (29.3%, n=22) and nearly a quarter once every 2-3 years (22.7%, n=17). The majority of respondents go to natural history or science museums in a social context, visiting with their significant others (36%, n=27), families (30.7%, n=23), or friends (24%, n=18).

In question #3, survey participants were given a list of 10 statements about what may be important to them when visiting a natural history or science museum and were asked to rate each statement on a scale of 1-5. Respondents indicated that they were generally most interested in ‘learning’ over ‘participatory’ activities or having social experiences. ‘Learning’

statements received average ratings above 4.0, while all other statements were below 4.0 but above 3.0 with one notable exception: “have a social experience with other visitors at the museum” received the lowest rating of 2.0 (see table 5).

Segmenting these data according to respondent interest or past/current participation in citizen science revealed that participants in citizen science on average rated each statement slightly higher compared to the other respondents, while those interested in citizen science generally rated the statements around the same as the overall average, and those not interested rated them lower. The only exception was “have a social experience with other visitors at the museum,” where those interested in citizen science rated it slightly higher than the overall average and those who have participated in citizen science rated it slightly lower than the overall average.

Question #4 was an optional open-ended question, giving survey participants an opportunity to write about what else may be important to them when visiting a natural history or science museum. Nineteen respondents provided answers, and the most frequent response related

to engagement with interactives, digital media, and live demonstrations. Other answers expressed by more than one individual included taking their time to read, reflect, and discuss; their desire to learn about a specific scientific topic of interest or to relate science to their lives; engaging with social media; special events or tours; and visiting the gift shop.

### *Expectations for a citizen science exhibition*

In questions #8 and #9, survey participants were asked to rate statements about what they might be interested in learning and doing at a citizen science exhibition. In general, the average ratings for both of these questions were somewhat lower than those of question #4, suggesting either lower interest in or less familiarity with the concept of a citizen science exhibition compared to what they usually experience at a natural history or science museum. Tracking well with the respondent segmentation, survey participants categorized as disinterested in participating in citizen science rated each statement lower on average than the other survey respondents, with some variation between those who are interested and those who have participated before depending on the specific statement.

Q8: How interested are you in learning the following about citizen science at a natural history museum?	Overall Average Rating	Average Rating: Interested	Average Rating: Not Interested/Unsure	Average Rating: Past/Current Participants
Q8.1: Learn about citizen science projects at the museum or elsewhere that I can participate in after I visit the museum	3.7	3.9	3.2	3.9
Q8.2: Learn about other people's experiences doing citizen science	2.9	3.3	2.6	2.7
Q8.3: Learn the background information about a particular citizen science project	3.7	3.8	3.3	3.8
Q8.4: Learn the results/findings of a particular citizen science project	4.2	4.2	3.9	4.3
Q8.5: Learn about the policy implications of a particular citizen project	4.0	4.1	3.6	4.3
Q8.6: Learn what citizen science means in general	3.4	3.9	3.1	2.7

**Table 6.** Overall average rating, and average ratings segmented by interest in citizen science, for question #8 pertaining to learning interests in hypothetical citizen science exhibitions.

*Question 8: How interested are you in learning the following about citizen science at a natural history or science museum exhibit?*

Respondents were most interested in learning about the results and policy implications of citizen science projects (average ratings = 4.2 and 4.0 respectively; see table 6). Respondents were least interested in learning about other peoples’ stories about doing citizen science (average rating = 2.9), although when segmented, respondents who are interested in citizen science rated this option somewhat higher at 3.3. It is plausible that their interest in

citizen science suggests that they would like to learn from those who already participate.

*Question 9: How interested are you in doing the following while visiting a natural history or science museum exhibit about citizen science?*

Respondents were most interested in bringing data to the museum to be analyzed (average rating = 3.9), although all statements received average ratings between 3.1 and 3.9 (see table 7). One possible explanation as to why this statement received a higher rating than

Q9: How interested are you in doing the following while visiting a natural history or science museum exhibit about citizen science?	Overall Average Rating	Average Rating: Interested	Average Rating: Not Interested/Unsure	Average Rating: Past/Current Participants
Q9.1: Bring data to the museum to be analyzed during my visit to the museum	3.9	3.9	3.7	4.0
Q9.2: Collect data at the museum during my visit	3.6	3.7	3.3	3.9
Q9.3: Analyze data at the museum during my visit	3.7	3.9	3.1	3.9
Q9.4: Learn how to collect and/or analyze data so I can participate in a project after I visit the museum	3.7	3.9	3.3	3.7
Q9.5: Join a citizen science project I can participate in at the museum or elsewhere after I visit the museum	3.7	3.9	3.1	4.1
Q9.6: Talk to citizen scientists during my visit to the museum	3.1	3.3	2.8	3.0
Q9.7: Talk to professional scientists about their citizen science project during my visit to the museum	3.8	3.8	3.4	4.0
Q9.8: Suggest ideas for new citizen science projects	3.2	3.4	2.9	3.3

**Table 7.** Overall average rating, and average ratings segmented by interest in citizen science, for question #9 pertaining to participatory/activity interests in hypothetical citizen science exhibitions.

others is because of the personal nature of the action: bringing in one’s own data and learning more about oneself or one’s surroundings likely resonates more with museum visitors than analyzing data that may not feel tangibly related to one’s life. In fact, one survey participant’s response

to the write-in question #10 stated an interest in “The opportunity to test matter from my environment for health or public safety reasons.” Talking to citizen scientists received the lowest rating at 3.1, which tracks with respondents’ previous ratings to related statements.

*Question 10: Is there anything else you'd like to add about what you are interested in learning or doing at a natural history or science museum exhibit about citizen science?*

Only 6 respondents provided answers to this question. In addition to the statement referenced above, most of these respondents were interested in learning more about the intricacies of citizen science versus 'regular' science. This is likely an artifact of this study's specific surveyed population, who are generally more educated and even formally trained in science compared to the general population.

## Conclusions

This study's surveyed population was well-educated, and many of the participants were formally trained in science and even worked professionally as scientists.<sup>182</sup> They are not representative of the general population or the full audience of a natural history or science museum, but they still represent one segment of this audience. Their motivations to visit a natural history or science museum were educationally driven: they expected to learn from exhibitions and generally favored exhibition techniques that were less participatory or activity driven.

They were slightly more fact-driven versus learning through narratives: they were most interested in learning about the end results of scientific processes or why the research was important rather than being immersed in the process of doing science or hearing someone else's story. To the former point, this may be due to their existing familiarity with the scientific process.

Some of the lowered interest in hearing from citizen scientists may be reflective of a desire to hear from 'the expert.' If this were the case, this would be a little surprising given that the surveyed population has a demonstrated understanding of the ability of the public to contribute meaningfully to science. This could be an artifact of the natural history or science museum as an authoritative institution, where community curation models have not been as widespread compared to other institutions such as history or art museums. The survey respondents may also be biased, likely unintentionally since there was high engagement with citizen science, towards maintaining this authoritative structure given that many of them work in the scientific field. Perhaps the goals of an exhibition on citizen science targeted for this particular segment of a

museum's audience is less about inspiring participation in citizen science and more about breaking down assumptions about who 'gets' to participate in science.

The strongest interests indicated by the survey participants were related to learning more about science, especially new discoveries and current news. Survey respondents may not have hypothetically seen citizen science, and their own participation in it, as a way to learn more about science or to be a part of making new discoveries. Framing citizen science in this way could be an important strategy to appeal to museum visitors.

These results underscore the importance of understanding the different segments of a museum's audience and their varied expectations when visiting a natural history or science museum. This study reached a segment that is already visiting these museums, and their expectations are rooted in gaining more knowledge. This audience may have lower interest in engaging with the kinds of participatory interpretative techniques that some history and art museums employ, like personal narratives, but other types of audience segments may respond more positively to this approach. Further studies are

needed to understand not only how a more participatory model of curation could manifest in natural history and science museums, but also in how audiences motivations, expectations, and prior experiences with science/citizen science relate.

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152. Higgins, in discussion with the author, November 14, 2017.
153. Higgins, Smart, and Ordeñana, in discussion with the author, March 7, 2017.
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155. From, Beth Redmond-Jones (Vice President of Engagement and Education at the San Diego Natural History Museum), in discussion with the author, March 28, 2018: The Nat specifically chose to create a 'strategic roadmap' versus a 'strategic plan' so they could create a broad vision for the institution that allows individual departments to craft their own goals and work with other departments in realizing the greater 'roadmap.' It also allows for flexibility in responding to new opportunities and ideas.
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159. *Extraordinary Ideas from Ordinary People: A History of Citizen Science* encompasses two levels in the gallery. At the time the author visited, the second level consisted of rare illustrations of dragons; thus, this thesis made the decision to focus only on the first level of the exhibition.
160. Randi Korn Associates, *Summative Evaluation: Extraordinary Ideas from Ordinary People: A History of Citizen Science Exhibition*, prepared for San Diego Natural History Museum (San Diego, CA: 2017), 10.
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167. Ibid., 10.
168. Ibid., 10; 37.
169. From Ibid., 10: Some visitors gained the sense that the people in the exhibition were contributing to real science, while others did not believe they made significant contributions.
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174. Ibid.
175. Randi Korn Associates, *Summative Evaluation: Extraordinary Ideas from Ordinary People: A History of Citizen Science Exhibition*, 7-8; 26-28.
176. Concluding questions encompass "is there anything else you would like to add?" question formats.
177. The first question asked participants if they currently or in the past had participated in a citizen science project. In case participants were unfamiliar with the term 'citizen science' or were unsure if they had participated in such a project, I provided a definition and gave them the option to rethink their answer before submitting their survey. See Appendix for more details.
178. One respondent was judged to be a professional scientist who works with citizen scientists, and their answers appeared to be based on their full-time work rather than on a citizen science project they did outside of their professional work. The other respondent was a museum professional who already works as a member of an exhibition team.
179. Survey participants were asked explicitly about collaborating in creating exhibitions, but some of the options they could select referred to programmatic elements. 'Exhibits' was used in the survey so as not to overcomplicate the phrasing, but these results can generally be applied to programs as well.
180. The top three, based on the percentage of respondents who selected the option, were also the top three selected if a respondent only selected 1-3 options for the question.
181. A higher percentage of respondents did indicate that they were excited by the prospect of interacting with professional scientists and/or museum staff (57.1%, n = 24). This tracks with the similar desire of many citizen scientists to interact with professional scientists when participating in citizen science projects (Higgins, in discussion with the author, March 7th, 2018).
182. This is based on the author's social circle, the main means of recruiting survey participants.



# **4. Project Application**



Design Considerations  
& Solutions for Interpreting  
& Engaging with Citizen  
Science in Museums'  
Public Spaces

## Overview

This section provides a number of considerations and a potential design solution for incorporating citizen science into the visitor experience through exhibitry and programmatic elements that work in concert to allow for interpretation of and engagement with citizen science. These considerations and solutions are not exhaustive, nor are they meant to be absolute. As such, they are meant to be broadly applicable, and to perhaps raise even more questions than they answer.

## Design Considerations

### Aligning interpretive goals with audience motivations & expectations

Audience segments will have differing expectations for citizen science interpretation based on their motivations. A jumping off point could be to consider who is already participating in citizen science, who used to participate and no longer does so, who has yet to participate and would likely wish to, and who has

not participated and is less likely to do so. What are these audiences reasons for engaging or not engaging with citizen science? Which of these audiences are already visiting natural history and science museums, and which are not? What are their motivations and expectations for citizen science and visiting museums? What notable characteristics define them? Exploring these questions could help to elucidate not only the goals of a particular citizen science application, but also how it can best reach its intended audience.

Take for example an interpretive goal of inspiring participation in a citizen science project that can be categorized as a hobbyist or leisurely pursuit.<sup>183</sup> Citizen scientists who already participate in such projects share the characteristic of having extra time to spare.<sup>184</sup> Inspiring new participants who fit this characteristic, for example, would require a much different approach than inspiring participants with the opposite problem of little time to spare. For the former, the interpretive approach may focus on how citizen science can help participants find purpose in their lives, whereas for the latter the approach may focus on how citizen science can be a way to pause and recharge from their hectic lives.



## Empathetic design: Meeting audiences where they are at

Creating goals and objectives with a specific audience in mind and understanding their preexisting knowledge, attitudes, and needs is standard practice when creating exhibitions and programs. The same logic should be applied to interpreting citizen science and creating participatory experiences around museums' scientific activities. It is vital to put the audience at the center of the design process so interpretation and engagement will serve them where they are already at rather than forcing the audience to digest an unfamiliar set of knowledge or expectations. The latter will likely result in an immediate lack of engagement or participation. An empathetic approach reverses the notion that audiences are empty vessels to be filled: instead, they bring their own expertise and uniqueness to the table, creating a dialogue between the museum and its audience.

For example, NHMLA recognized that people like to post pictures of wildlife and the natural world on social platforms like Instagram, Facebook, and Twitter, but not everyone is familiar with iNaturalist as a social media platform in and of itself.

Instead of insisting that all contributors to their LA Nature Map submit photographs via iNaturalist, NHMLA welcomes their audience to submit in the way they are most comfortable, using the opportunity to gradually encourage them to use iNaturalist. The Museum also maintains its own active presence on Instagram, Facebook, and Twitter partially to search for quality observations themselves, recognizing that these social media platforms and their users are important sources of data that would otherwise be missed. This example is just one of many ways that NHMLA guides their audience in becoming more familiar with iNaturalist.

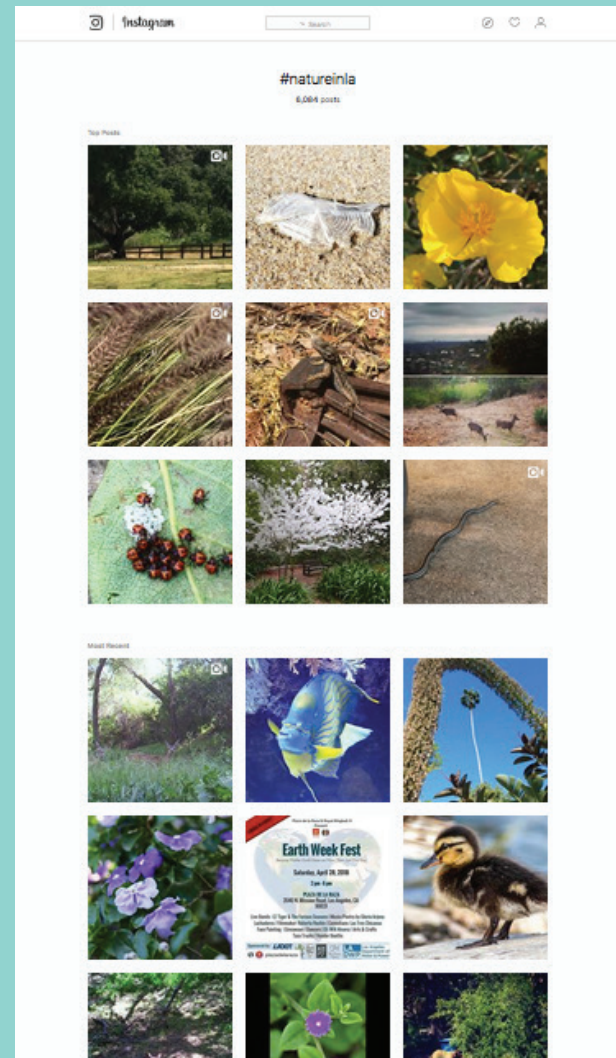
## Understanding science identities

Inspired by The Nat's use of the concept of a 'science identity'<sup>185</sup> to assess the outcomes of *Extraordinary Ideas from Ordinary People*, science identities could also be helpful in the front-end development of exhibitions and other visitor experiences. For example, science identities could help to elucidate if target audiences already see themselves as 'science people;' the reasons why or why not could help museums to understand how they could appeal to audiences

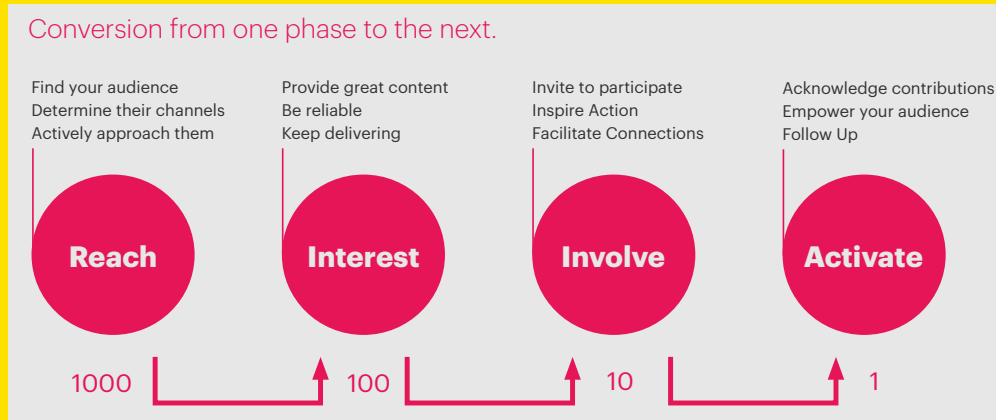
and craft approachable citizen science experiences. Science identities of target audiences could also identify the ways in which audiences use science in their everyday lives, and if they recognize these skills as science skills. This could shed light on what types of citizen science skills and topics target audiences may be comfortable with already and which skills may have lower barriers to engagement or logical pathways for introduction. As such, science identities could play an important role in the development of personas, a tool that keeps the audience at the center of the design process. Personas with science identities build empathy for audiences, serving as a reminder to exhibition and experience designers to keep their target audience's base level of scientific understanding and comfort at the center of their design processes.

## Using Haklay's typology to base goals & outcomes

Haklay's typology offers an interesting mechanism for understanding where the intersection of audiences' science identities and the low barriers to participation may lay in terms of inspiring audiences to participate in citizen science, and how these relate to the goals of a particular exhibit or programmatic element. It also



**#natureinLA** is NHMLA's hashtag for wildlife sightings in Los Angeles. The Museum will use scientific-grade photographs as data points in their biodiversity research projects.



**Phases of Engagement** From Jasper Visser and Jim Richardson's "Digital Engagement in Culture, Heritage, and the Arts," demonstrating how to reach and keep audiences engaged. Visser and Richardson emphasize that people will move through the phases at the pace they are most comfortable, and for every 1,000 people reached, only 1 will become fully activated.<sup>186</sup> Image credit: Visser and Richardson.

could help museums to organize layers of experiences or interpretation for their target audiences if individuals differ in their understanding of or participation in citizen science.

Suppose that a museum wanted to create a program that facilitated an opportunity for citizen scientists to create, lead, and report on a research project while also involving those new to citizen science in the implementation of the project. The museum could use Haklay's typology to guide the development of their goals and objectives of the different audiences for this program

and to understand the messaging they may need to use to target said audiences.

Overall, it should be reiterated that Haklay's typology is not a ranking based on value. Citizen science projects can encompass all levels of the typology simultaneously and individual citizen scientists may move between the levels or exist at multiple levels at once. Even though higher levels are not necessarily 'better,' they are still a goal that museums should work towards if they are looking to civically engage by democratizing the scientific process and sharing curatorial authority.

## Implementing phases of engagement

Designers Jasper Visser and Jim Richardson created a tool to understand how people can move through different phases of engagement with digital media: reached, interested, involved, and activated (see page 71). This tool is in fact quite flexible and could be useful for strategizing engagement in citizen science. Visser and Richardson write:

First, people are reached by your organization. With some effort from your side, they might become interested in you. Building on their interest, you can involve them. The involved audience, finally, is close to being activated to help you create more value for more people.<sup>187</sup>

Following this sequence, museums can first think about the audiences they want to begin to target for participation in citizen science and determine how they will *reach* these audiences where they are already. Next, museums can develop ways to pique their *interests* while also helping them to develop basic skills for participating in citizen science. Once this phase has been met, audiences then move into becoming *involved* in the citizen science projects, and perhaps they can move to the last phase and be *activated* citizen scientists

who take on more tasks and perhaps move to the upper levels of Haklay's typology. These participants are not only active in terms of their own engagement, but they are also an integral part in keeping citizen science programs going because they will presumably become involved in directly or indirectly recruiting other citizen scientists, introducing more people into and through the engagement phases.

Similar to Haklay's typology of citizen science participation, the sequencing of the phases of engagement seem to imply that the later phases are 'better' compared to the earlier phases. This should not be the case. In addition, the general rule of thumb is that only 10% of people engaged at one phase will be converted to the next phase.<sup>188</sup> This parallels the statistic that only a small percentage of registered citizen scientists will contribute the most data points for a given citizen science project,<sup>189</sup> suggesting that the number of level 4 and even level 3 citizen scientists is always going to be much lower than the number of level 1 and 2 citizen scientists on Haklay's typology. Thus, even small numbers of actively engaged citizen scientists within the museum still constitutes a victory for museums' goals of civically engaging through citizen science and democratized exhibition design processes.

NHMLA again serves as an example of how the phases of engagement could be implemented. Their target audience, the LA community, is generally not comfortable exploring nature given the City's urbanized landscapes and the ensuing cultural habits. With the hopes of building an efficacy of exploring the natural world and contributing reliable observations to iNaturalist, NHMLA started the LA Nature Map. As mentioned previously, NHMLA identified that their audience likes to post pictures of nature on popular social media platforms, so they *reached* their audience initially this way. The LA Nature Map got their audience *interested* in sharing observations and visualizing their data, connecting these observations to their sense of place. Some LA Nature Map participants are interested enough to become more *involved* by using iNaturalist to contribute to citizen science projects promoted by the Museum. Perhaps some of these involved audiences have or will graduate to the *activated* phase where they are 'Super Users' on iNaturalist, or participants in several other citizen science projects. And maybe some of these Super Users interact with people new to citizen science and inspire their participation.

## Repetition & reinforcement of interpretation

An important lesson learned from NCMNS's unsuccessful Citizen Science Center was the cost of relying on a single space to effectively explain and promote citizen science, with little to no reinforcement in the other exhibit spaces.<sup>190</sup> Visitors reportedly missed the space, or spent very little time engaging with the exhibits.<sup>191</sup> Although The Nat's *Extraordinary Ideas from Ordinary People* is also located in a single exhibition space, its example differs from NCMNS since it is in a visible location, attracts high percentages of visitors, and has dwell times that track well with their other exhibitions and for natural history museums in general.<sup>192</sup> The important takeaway is the success of its repetition and reinforcement within the gallery: despite low percentages of visitors who read the exhibit's copy, many visitors are able to walk away with an understanding of the concept of citizen science even if they remain unfamiliar with the exact term.<sup>193</sup> This element of repetition and reinforcement could be developed further in museums and dispersed throughout exhibits, increasing the likelihood of visitors encountering citizen science interpretation, and to provide even greater context (see: example design solution).

## When to call it ‘citizen science’?

It is crucial to maintain citizen science as an activity that supports scientific research and its end goals, such as policy development. Data collection, a common activity for museums to incorporate into their citizen science activities, should be done with a specific goal in mind, be it for a particular research study, baseline monitoring and longitudinal data, or a database accessible ideally to the public but at the very least to researchers. When programs purport to be citizen science, but the collected data are not preserved or used for study, it erodes the credibility of citizen science and causes confusion about its definition. Further, participants can deduce when their contributions are not being put towards ‘real’ science, which can lead to feelings of tokenism that can sour their experience with citizen science and even quash their interest in future participation.

Because citizen science is an attractive and effective outreach and educational tool for museums to use, museums need to be thoughtful in how they implement it. In some cases, the outreach and/or learning goals and objectives could run parallel to the citizen science activity’s scientific goals. In other cases, the outreach and/or learning

goals and objectives may actually be more important than the scientific ones, though this does not mean the scientific goals have to be sacrificed. In these situations, such as is the case with NHMLA’s LA Nature Map, the focus may be on practicing skills and building up the audience’s interest and confidence. NHMLA does not label this activity as ‘citizen science’ because they want to be transparent about the nature of the activity. However, the map is still likely valuable because all the data are preserved and tagged with detailed metadata. There could be research applications for these baseline data even though they are not collected with that end goal in mind.

# Example Design Solution

This example design solution was borne out of conversations, exhibit and program analyses, surveying, and subsequent development of design considerations undergone by this thesis. The example proposes a flexible and multifaceted community space in a dedicated area of a natural history or science museum. This hybrid space would be both for citizen scientists to carry out their activities as well as for museum visitors to witness and even participate in citizen science during their visit to the museum. This application explores ideas of how citizen science could be interpreted, how museum experiences can be more participatory for audiences, and how museums can share authority through community curation. It encompasses all phases of engagement and levels of Haklay's typology to demonstrate one way civic engagement through citizen science could potentially be achieved within a museum's four walls.

## A different kind of citizen science center

In *Mastering Civic Engagement: A Report from the American Association of Museums*, Ellen Hirzy writes,

more than venues for exhibitions and programs, museums should be more valued places at the heart of community life. Museums should explore more options for making themselves multidimensional gathering places where community comes alive.<sup>194</sup>

This thesis proposes a citizen science center that combines a community curated gallery with a makerspace/DIY lab. This hybrid space would act as a forum, a gallery, and programmatic space, combining exhibitry, programming, events, and working spaces. As such, it would act as a collective and gathering place where citizen science is carried out and interpreted by citizen scientists themselves.

The citizen science center would feature the following elements:



### Changing gallery with a community curation approach

The space would feature rotating exhibitions, curated by citizen scientists and community groups, such that the needs and the voice of the community would be reflected and new expertise would be shared, recognized, and valued. Exhibitions are vital to ensuring that the overall space will be a worthwhile experience for visitors when the other components are inactive. They also provide a platform for citizen scientists to share and communicate. These exhibitions could document citizen science projects, communicate project results and

outcomes, share personal histories, dive into the scientific concepts, and/or elicit participation from visitors. To the latter point, participation could take the form of visitors contributing data that they bring to the museum or collect on its grounds. It could even take on the form of a living experiment, where visitors provide their samples of, for example, bacteria. Other applications of participatory exhibits could also include visitors contributing ideas and responses about the content of the exhibit or the needs they see in their communities in the form of a talk-back.

### **Philadelphia Assembled: Pop-Up installations and The Philadelphia Museum of Art**<sup>195</sup>

*Philadelphia Assembled* was a civic engagement and arts initiative that took place over several years. It started as a series of installations and events scattered throughout the city, inviting participants to share their perspectives about the City's past through the present to its future. The project culminated in an exhibition that inhabited the entirety of the Philadelphia Museum of Art's Perelman Building. The exhibition was participatory and interactive, reassembling the installations that had been pop-ups in the community.

Image credit: Joseph Hu, Philadelphia Museum of Art.





### Makerspace/DIY community lab

For museum visitors, this element would create an opportunity for hands-on experiences learning how to do science and even potentially contributing to research at levels 1-2 of Haklay's typology. Programming and daily activity prompts could cycle through different citizen science projects. As a makerspace, visitors could build and learn how to use scientific/observational tools that they either use to collect data for a project at the museum or back home, or they leave behind for others to use (in this case, the space could become a sort of library of citizen scientist

instruments that others can borrow). As a laboratory, visitors could learn how to use other scientific instruments and build other skills they could apply to featured citizen science projects. They could potentially provide, code, transcribe, analyze, or visualize data. The aim would be that this participation would contribute to real research or be directly connected to research they could then participate in later or elsewhere.

For citizen scientists, this element would act more or less as a community laboratory/makerspace that provides equipment,

It was also an active space and forum where community organizations, to name a few examples, held meetings, organized discussions, put on performances, and hosted meals and cooking events. *Philadelphia Assembled* thus serves as an interesting model of civic engagement, participatory design, and forum.



Image credit: Philadelphia Museum of Art

tools, and facilities. It would promote collaboration between citizen scientists by putting them in the same physical space. Oftentimes, citizen scientists work independently, and the projects they participate in are often done in isolation from other citizen science projects. A physical space at a museum would enable citizen scientists to meet other citizen scientist and intermingle, leading to the cross-pollination of ideas, collaborations, and potentially new friendships.<sup>196</sup> The makerspace could also be the staging grounds for special programming like

hackathons, transcription events, BioBlitzes, and other related types of events.

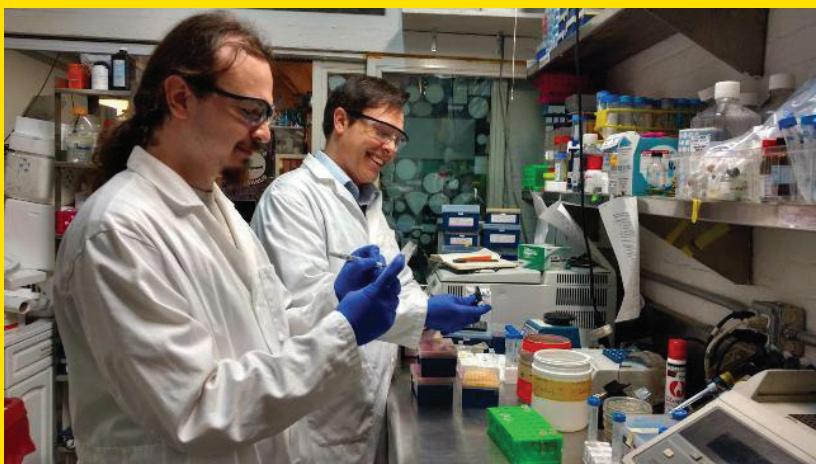
### Forum

Similar to a feature of *Philadelphia Assembled* (see sidebar on pages 76-77), a citizen science center could be a location for community members to gather to discuss pertinent issues, collaborate on problem-solving, and discuss policy implications. This could take the form of round table events, science cafes, and community gatherings. Situating it at the museum would give communities access to

### Community Labs for DIY science

Community labs are lab facilities, usually with membership programs, classes, trainings, and events. Some examples include GenSpace in Brooklyn, NY and BioCurious in San Jose, CA. Anyone is invited to join and learn how to use the lab equipment for their own projects, designs, or research.<sup>197</sup> Some community labs may also create projects for their members to collaborate on together. For example, BioCurious has an ongoing community project to create an open-source DIY cell printer.<sup>198</sup> Similar to how co-working spaces encourage conversation, collective brainstorming, and collaboration, community lab spaces may create opportunities for individuals to join forces in creating research.

Image credit: GenSpace



tools and facilitate relationships with staff scientists. Visitors who take notice of this facet, or even observe a meeting taking place, may feel inspired to participate if they are locals, or to seek out such experiences in their home communities.

### Facilitators

Many of the features of this proposed space would require facilitators who interact with and guide museum visitors. Citizen scientists and volunteers could primarily take on this role, especially in their capacity as community curators. Interacting with

a citizen scientist would give visitors the opportunity to learn about citizen science from a peer, thereby gaining a relatable perspective, or an understanding of the context from their community's standpoint.<sup>199</sup>

The results of survey #2 suggested that not many citizen scientists would be interested in interacting with the public. Yet, these types of responsibilities would be allotted to participants who are further along in the phases of engagement; thus, there are naturally fewer highly engaged participants versus participants within other phases.

### Citizen Science Vending Machine, Oakland Museum of California<sup>200</sup>

Associate Curator of Natural Sciences Sarah Seiter collaborates with scientists, and soon SciStarter, to create small, easy to use citizen science kits that are sold in a repurposed vending machine alongside basic observational tools like binoculars. The kits make use of everyday, low-cost items and include zines made by Seiter to guide people in the process of data collection and submission. The projects rotate, and in some cases relate to special exhibitions at the museum. While not a physical makerspace or exhibition per se, it is an example of a facilitated tinkering experience that leads to data collection.



Image credits: (both) Oakland Museum of California.

## Possible modes of interpretation

The following are some possible modes of interpretation that could be employed in a citizen science center. They would also lend themselves well to being incorporated into other exhibitions in a museum, especially if they were to work in concert with the citizen science center as a way to reinforce citizen science throughout the entire museum visit and to attract visitors to the citizen science center.

### Citizen science training interactives

Physical and digital interactives within exhibitions could effectively serve as learning modules for visitors to gain and practice relevant skills for data collection and even analysis.<sup>201</sup> These could be paired with takeaway information – such as a physical printout like a wallet-sized booklet/postcard, or an electronic message sent via email or text – about the relevant citizen science project, providing the steps for data collection and submission, or whatever the tasks may be. Depending on the particular tasks as well as practical considerations like volume of use, these interactives could be physical or digital. Augmented or virtual reality are up and coming technologies that could lend

Inspired by the Monterey Bay Aquarium's pocket-sized Seafood Watch guide,<sup>202</sup> The Nat created a guide for taking scientific-grade photographs on iNaturalist.<sup>203</sup>

Image credit: Lauren Duguid.



themselves well to creating fun training modules.<sup>204</sup>

### Oral histories, or stories of citizen scientists

Exhibitions are a medium for storytelling, and human stories can be a compelling means of connecting visitors to topics. Natural history and science museums do not always employ this approach, which can sometimes make for a didactic rather than a narrative experience for visitors. Learning about citizen science through citizen scientists' personal stories provides powerful insights into why citizen science matters and how it can impact not only communities and our collective understanding of the world, but also how it

***“Museums could provide examples of where citizen science has resulted in significant scientific advances and/or policy changes.”  
– Survey #1 participant no. 1***

can bring meaning to peoples’ lives. Human stories of visitors’ peers may also make for an inclusive experience, where visitors find their voices represented in the museum. For this latter point to work at its full potential, museums would need to ensure that the full spectrum of their community’s demographics is present.

### **Communicating results, impacts, and policy implications of citizen science**

Sharing the outcomes of citizen science and updating this content is important for keeping people up to date on project progress, respecting the contributions of participants, increasing peoples’ understanding of the scientific process, and even communicating important information about and impacts on the community. All of this moves towards greater transparency of the scientific process. It also allows the community to see themselves represented in the museum and gives citizen scientist/community curators ownership. The subject of museum audiences surveyed in Chapter 3 provides evidence that some visitors are especially interested in this type of content.

They were interested in what is happening now in science, thus this approach could help to frame citizen science as something that is on the cutting edge for visitors who may be skeptical. Further, people who disengage from citizen science often do so when they are not kept up to date about their projects.<sup>205</sup>

This mode of interpretation echoes the efforts of natural history and science museums to keep exhibits up to date with current research, or to have exhibitions dedicated wholly to recent research by their staff scientists. Although it is not a new idea, nor a leap to apply it to citizen science, it is easier imagined than put into practice. It can be time consuming and costly to keep content up to date; therefore, it requires careful planning and commitment that should be built into the long-term strategic plan of a citizen science center. Combining this mode of interpretation with the technique of community curation should already imply that changing content will be built into the plan for the space.

### Branding: The Arctic Fox Project & Fjällräven

The Arctic Fox Project, led by Dr. Anders Angerbjörn at Stockholm University, is a long term research project studying arctic fox population dynamics in Scandinavia. The Project often accepts volunteer citizen scientists to assist in data collection during the summer field season. Hiking brand Fjällräven, named after the arctic fox, is a financial sponsor of the Project, but it also plays an important role in raising awareness of the endangered status of this species. Fjällräven disseminates information via print materials like their catalogs and digitally through social media and their website.<sup>206</sup> The logo and name itself is immediately recognizable and instills a sense of identity and pride for the arctic fox.



Image credit: Rakuten Global Market

### Citizen science 'branding'

More so a feature of layering citizen science interpretation into all exhibitions at a museum, creating visual clues or other ways of 'branding' citizen science could help its reiteration and reinforcement. This type of design solution would guide visitors and make it easier for them to glean content, as well as create a novel visual experience to catch their attention, increase the likelihood of interaction with the content or experience, and imprint on their memories.

Branding could figuratively and literally direct visitors to a citizen science center. It could also prepare visitors new to citizen

science by providing important context: for instance, visitors may be pleasantly surprised to discover in one gallery that the monarch butterflies on display and the interesting stories about them are possible because of the contributions of people just like themselves. Perhaps they see a citizen science logo next to this interpretation and notice on the museum's floorplan that there is an entire space dedicated to citizen science. Creating those kinds of 'ah-ha' moments seamlessly within the visitor's typical or expected experience has a greater likelihood of positively impacting their understanding of and attitudes towards citizen science.



## Phases of engagement in a citizen science center<sup>207</sup>



## Phases of engagement

The infographic on page 83 envisions how Visser and Richardson's framework could be a useful tool for museums in understanding how a citizen science center would engage visitors and citizen scientists along the spectrum of citizen science participation. It also demonstrates how the interaction between citizen scientists and visitors would facilitate this participation.

## Why a single, dedicated space?

Although the exhibition analyses from Chapter 3 suggest that citizen science messaging might best reach visitors when distributed throughout the museum, a dedicated space for citizen science is still appealing for many reasons. A single space, especially as a community curated gallery, gives obvious ownership to citizen scientists and communicates to visitors that the museum is dedicated to fostering a practice of civic engagement through citizen science. In addition, this citizen science center is more than just a space for interpretation: it is also a space for citizen scientists to gather and do science.

Even though this application advocates for a single space, this is not in lieu of interpreting citizen science throughout

the museum. Indeed, the combination of these two approaches would likely make for a stronger visitor experience and further demonstrate the museum's commitment to a citizen science practice.

It is also important to point out that a dedicated space for citizen science should be placed in a highly visible portion of the museum to ensure that visitors do not miss it. Similarly, facilitators of the space could help to attract visitors, in part by activating the space, but also by encouraging visitors to participate in maker or other activities.

## Who are the stakeholders?

Implementing a citizen science center will require the cooperation of several stakeholders. At the center are the citizen scientists and museum visitors for which this space is designed to serve. Citizen scientist stakeholders include those who participate at any level of Haklay's typology. If museums are to use citizen science as civic engagement, citizen scientist stakeholders need to include not only those who participate in museum-led projects, but also those working on initiatives outside the museum. This also necessitates the inclusion of community organizations and community members as stakeholders. The specific organizations



who have a stake are endless and are dependent on the focus topic or topics of the citizen science center. Similarly, the different stakeholders may change and shift over time as the focus of the citizen science center changes or builds.

The case museums from Chapter 3 demonstrated the importance of institutional cohesion and support for citizen science. Stakeholders within the museum thus include, but are not limited to: educators, public engagement/outreach staff, citizen science coordinators, exhibition designers and developers, marketers, staff scientists, directors and other senior staff, and the museum's board members.

There are also a number of external stakeholders who could play a role in a citizen science center. These include, but are not limited to, scientists from non-museum affiliated institutions, funders, policy makers, civic leaders, and schools. When planning for such a space, it will thus be important for museums to conduct stakeholder mapping.

## Approaching implementation

A citizen science center of this complexity is likely difficult for many museums, particularly existing institutions without

plans for significant renovation, to implement all at once. Thus, it would be necessary to break down its adoption into phases, which would be dependent on the unique circumstances of the institution. First, museums could identify the features of this thesis's proposed citizen science center that they already employ at the museum. Are these features successfully meeting their goals? Are they being applied to citizen science? How could they be improved? Then, they could rank the features in terms of time and resources required to implement and develop a strategic plan for phasing them in.

183. This is in contrast to those who are motivated by social/environmental justice and activism: these participants may be very dedicated out of necessity to correct something that threatens their wellbeing. Instead of having time to spare, these individuals likely focus more on how they manage their time to include this vital work.
184. Cavalier, in discussion with the author, January 31, 2018.  
  
Cooper, *Citizen Science: How Ordinary People Are Changing the Face of Discovery*, 6-8.
185. Heidi B. Carlone and Angela Johnson, "Understanding the Science Experiences of Successful Women of Color: Science Identity as an Analytic Lens," *Journal of Research in Science Teaching* 44, 8 (2007): 1187-1218.
186. Jasper Visser and Jim Richardson, *Digital Engagement in Culture, Heritage and The Arts*, 2013, 32.
187. Ibid., 30.
188. Ibid., 32.
189. Cooper, *Citizen Science: How Ordinary People Are Changing the Face of Discovery*, 48.
190. Goforth, in discussion with the author, September 7, 2017.
191. Ibid.  
  
Cooper, in discussion with the author, January 12, 2018.
192. Randi Korn Associates, *Summative Evaluation: Extraordinary Ideas from Ordinary People: A History of Citizen Science Exhibition*, 4-5.
193. Randi Korn Associates, *Summative Evaluation: Extraordinary Ideas from Ordinary People: A History of Citizen Science Exhibition*, 4; 10-11.
194. Hirzy, "Mastering Civic Engagement: A Report from the American Association of Museums," 11.
195. "Philadelphia Assembled," *Philadelphia Assembled*, accessed March 30, 2018, <http://phlassembled.net/>.  
  
"Philadelphia Assembled," *The Pew Center for Arts & Heritage*, accessed March 30, 2018, <https://www.pcah.us/grant/philadelphia-assembled>.  
  
Stan Mir, "Ambitions and Limitations of Civic Engagement in the Museum," *Hyperallergic*, October 21, 2017, accessed March 30, 2018, <https://hyperallergic.com/406287/philadelphia-assembled-philadelphia-museum-of-art-2017/>.
196. Cavalier, in discussion with the author, January 31, 2018.
197. "Is There a Community Lab Near You? Find Lab Space, Equipment, and Training in Your Area!," *Discover Magazine* (blog), May 20, 2015, accessed March 30, 2018, <http://blogs.discovermagazine.com/citizen-science-salon/2015/05/20/community-lab-near-you-find-space-equipment-training/#.Wr0SOsgh2jQ>.
198. "Projects," *BioCurious*, accessed March 30, 2018, <http://biocurious.org/projects/>.
199. Cooper, *Citizen Science: How Ordinary People are Changing the Face of Discovery*, 164.
200. Oakland Museum of California, "Science for the People: OMCA's Citizen Science Vending Machine Makes Helping Scientists as Easy as Buying a Candy Bar," *Oakland Museum of California* (blog), September 12, 2017, <http://museumca.org/citizen-science-vending-machine>.

201. Cooper, in discussion with the author, January 12, 2018.
- Higgins, Smart, and Ordeñana, in discussion with the author, March 7, 2017.
202. "Consumer Guides," *Monterey Bay Aquarium Seafood Watch*, accessed April 27, 2018, <https://www.seafoodwatch.org/seafood-recommendations/consumer-guides>.
203. Redmond-Jones, in discussion with the author, March 28, 2018.
204. Higgins, Smart, and Ordeñana, in discussion with the author, March 7, 2017.
205. Cavalier, in discussion with the author, January 31, 2018.
206. Béatrice Rigois (Fjällräven International Marketing), in discussion with the author, January 24, 2018.
207. Visser and Richardson, *Digital Engagement in Culture, Heritage and The Arts*, 2013, 32.



## **5. Conclusion**



# Areas of Further Consideration

## **Developing community curation techniques in natural history and science museums**

This thesis only laid the groundwork for how community curation could be applied to natural history and science museums. Community curation may look different in this context, and the preliminary findings from this thesis's surveys revealed that some audiences may not be attracted to the direct application of community curation techniques that are currently used in history, art, and humanities museums (e.g., oral histories of citizen scientists) to natural history and science content and experiences. Thus, museums willing to explore this technique will need to prototype community curated efforts, reflect on audience responses, and keep iterating their ideas to learn what will resonate best with their current and intended audiences. Phasing in community curation to their design processes does not require building a designed citizen science space within their gallery floorplans: it can be implemented within their existing design activities and exhibition spaces. Indeed, gradually incorporating community curation will help in the prototyping/

ideation process because it will allow museums to respond and change direction.

## **Civic engagement beyond the walls of the museum**

This thesis focused on the museum visit within the walls of the museum. However, a crucial aspect of civic engagement is for museums to extend their missions and activities beyond their buildings. In the context of citizen science, it follows that research related to the local environment, particularly research that tackles community concerns, must take place outside of the physical museum's geographic footprint. But more importantly, if the overall goal of citizen science is to democratize the scientific process, museums need to reflect on their audiences and determine how they can reach those who are not coming to the museum. There are many reasons why underrepresented audiences are unable to or choose not to visit museums: these include but are not limited to financial, logistical, or personal (e.g., discomfort or a feeling of nonbelonging, or even competition with entertainment options) concerns. Museums need to understand the specific concerns of the particular

audiences they wish to engage first if they are to develop effective solutions for reaching them.

One solution for engaging these audiences is to partner with other public outlets that are serving these audiences already. These include but are not limited to public libraries, local parks and recreation centers, and schools and adult education centers. Museums could share resources with these organizations to help them implement citizen science, or they might co-develop programs in collaboration with such organizations. The case museums presented in this thesis and many others have already been exploring both of these approaches with community organizations and assessing these outcomes. Continuing this research will help to make these partnerships and programs stronger and help to guide other institutions getting started in this area.

To resituate this line of thinking into this thesis's research, as museums reach their underrepresented audiences out in the community, these audiences may begin to visit the physical museum, especially if museums make an effort to find ways to facilitate these visits. If this is the case, museums need to ensure that their visitor

experiences are inclusive and reflect the work done out in the community. This is also important for museums' current audiences because it exposes them to different perspectives that they may not normally encounter in their everyday lives. Thus, civic engagement inside and outside of the museum interrelate and interact.

### **Visitor evaluation**

This thesis's surveys could be useful tools for museums to base their own front-end studies to understand their audiences and their potential citizen scientist collaborators. Front-end evaluation can help museums to understand their current audiences, but it is also a tool to evaluate how museums could engage underrepresented audiences – and/or those who already participate in citizen science, and those who have yet to participate. Museums will need to ensure that their evaluative efforts reach their target audiences, which will likely require off-site research out in the community. Joe Heimlich's work in the intersection between visitors studies and evaluation<sup>208</sup> could be a valuable jumping off point for museums hoping to develop these survey instruments further or to develop their own methodologies. Incorporating science identities into formative evaluations

***“I would be interested in learning about any impacts, not just on policy, that a particular citizen science project has or outcomes.”  
– Survey #2 participant no. 23***

could help museums develop a more nuanced understanding of their audiences. Museums could start by identifying gaps in science identities between those who are already engaged in citizen science and those who have yet to be engaged, as well as current versus underrepresented audiences. To this latter point, perhaps there is an intersection between science identities and Nina Simon’s research on personal identities and representation in museums.<sup>209</sup> Another area of investigation that could prove useful is understanding peoples’ interest in science outside of formal and informal science learning experiences and how they pursue these interests.<sup>210</sup> This could help museums in knowing how to reach those audiences that would likely be attracted to the content and experiences that are offered by the museum, but who do not currently visit.

### **Expanding museums’ applications of citizen science**

This thesis alludes to other important roles that museums could fill for the field of citizen science beyond the direct

application of doing scientific research. NCMNS and NHMLA especially recognize the potential of museums as training grounds for citizen science, in that they can directly train citizen scientists and indirectly train facilitators of citizen science such as teachers and environmental educators.<sup>210</sup> Museums could identify other assets that could aid in the implementation of citizen science projects. For example, museums could serve as distribution centers/bases of operations for tools and materials needed for citizen science projects. The Oakland Museum of California’s citizen science vending machines, and the makerspace component of the proposed design solution of this thesis, are initial starting points for such an idea.

Similarly, citizen science includes the application of research to policy. Museums could explore ways to be more involved with public engagement of policy related to science and technology. This idea fits into the concept of museum as forum, a space where science is not only carried out but is also discussed and applied.



A starting point could be the Expert and Citizen Assessment of Science and Technology (ECAST) network. This group of academics, informal science education entities, think tanks, and government agencies works to engage citizens in policy analysis, serving to inform and seek input from the public.<sup>211</sup>

### **Engaging scientists in museums and civic engagement**

Many government agencies are currently promoting public engagement with science. Citizenscience.gov (see page 11) represents over 48 US government agencies that are incorporating citizen science into their work in response to the Crowdsourcing and Citizen Science Act of 2016 (15 USC 3724).<sup>213</sup> Given that museums are currently seen by the public as neutral and more trustworthy than government agencies,<sup>214</sup> museums could play an important role in helping government agencies to realize their citizen science goals. Specifically, the National Science Foundation requires project proposals to outline the public impacts, known as 'broader impacts,' of their research so their research is relevant to, and perhaps includes, the public who funds these programs and who are ultimately the beneficiaries of research applications.

Often, scientists work in institutions that do not have direct access to the public, meaning that their proposed broader impacts do not quite realize greater public engagement in science. Museums as publicly-oriented institutions could be important partners for scientists in learning how to communicate and connect with the public and in finding exact pathways to implementing their outreach and inclusive practices of citizen science.

## **Concluding Statement**

Natural history and science museums of the 21st century can become forums for civic engagement in science by merging their educational and research goals and adopting a practice of citizen science with their communities. Doing so would increase the relevancy of museums to audiences, create greater dialogue between museums and their communities, and increase the participation of museums in the needed collective action for working towards solutions for pressing environmental and scientific concerns. To work towards this greater goal, museums will need to engage with their communities both internally through the museum visit and externally by

engaging audiences that are not already museum visitors. This thesis concentrated on the former concern, focusing on ways for citizen science to be interpreted, or even practiced, during visitor experiences. Integrating citizen science into exhibitions and programs could help to communicate museums' commitment to practicing citizen science, raise awareness of citizen science, encourage participation, share the authority of science through participatory design techniques such as community curation, integrate community voices into their exhibitions and programs, and focus their interpretation and research activities on their local environments situated within a global context.

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Goforth, in discussion with the author, September 7, 2018.

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# Appendix



# Survey #1 Executive Summary

## Study of citizen scientists as community curators

The purpose of this front-end study was to understand the interests, needs, and ideas of citizen scientists as community collaborators in creating exhibits about citizen science at natural history or science museums. Forty-two surveys were collected through Google Forms, which was shared via the author’s personal networks as well as the Citizen Science Association and SciStarter between February 25, 2018 and March 28, 2018.

For a copy of the Google Form survey, the raw data, the full survey analyses, and a coded Excel spreadsheet to use for analysis, please contact the author at [holly.mutascio@gmail.com](mailto:holly.mutascio@gmail.com).

Survey respondents were highly interested in collaborating with museums to create exhibitions and programs. They were most interested in providing background knowledge about the topic of their citizen science projects, providing objects and/or images to be displayed in the museum, and sharing their personal stories about being citizen scientists. They were most excited to spread awareness of citizen science as a concept, to inspire museum visitors’ participation, and to share their knowledge of science. In general, they hoped that such a collaboration would be a fun experience, teach them new skills and knowledge, and allow them to engage with the public.

### Survey Respondent Characteristics

Ethnicity/Race: 71.4% Non-Hispanic White or Euro-American

Gender Identity: 57.1% Female

Age: 54.8% 25-45 years old

Education: 64.3% with at least some graduate education

### Survey Respondent Participation in Citizen Science

66.7% current participants in at least 1 citizen science project

30.9% self-reported a high level of participation in their citizen science project

28.6% self-reported a medium level of participation in their citizen science project



# Survey #1 Survey Instrument

## Study of citizen scientists as community curators

### Greeting:

My name is Holly and I am a graduate student studying Museum Exhibition Planning and Design at the University of the Arts in Philadelphia, PA. My thesis research explores how exhibits at natural history and/or science museums can inspire museum visitors to participate in citizen science. I am also interested in how citizen scientists like yourself can be involved in the process of creating such exhibits! The results of this survey will help me understand your ideas and needs for these types of partnerships with museums.

Your participation in this study is completely voluntary. There are no risks foreseen with this project, though if you feel uncomfortable answering any questions, you may withdraw from the survey at any point. All information is strictly confidential and no identifying information is required. If you have any questions at any time about the survey or methods, or are interested in receiving an electronic copy of my completed thesis, please contact me at hmutascio@uarts.edu at any time. Thank you so much for your time and participation.

\* = denotes a required question

**Q1:** Do you currently participate in at least one citizen science project?\*

- Yes
- No
- I'm not sure
- I've never participated in a citizen science project

### If 'yes':

**Q1a:** How many citizen science projects do you currently consider yourself to be an active participant?\*(select one)

- 1
- 2
- 3
- 4+

### If 'no':

**Q1b:** When was the last time you participated in a citizen science project?\*

- Within the past year
- 1-2 years ago
- 3-4 years ago
- 5+ years ago
- I've never participated in a citizen science project

**Q1: continued****If 'I'm not sure':**

A citizen science project is any activity that contributes time, effort, or resources to scientific research. Projects may be led by professional scientists, but they can also be created by non-professional individuals or by communities. Other terms include 'amateur science,' 'crowdsourced science,' 'volunteer monitoring,' and 'public participation in research.' If any of these apply to something you do, click the 'Back' button and choose a new answer. If none of these sound familiar or you're still not sure, click the 'Submit' button.

**If 'Back':**

**Goes back to Q1**

**If 'Submit':**

Your responses have been recorded. Thank you so much for participating! If you have any further questions, please contact Holly Mutascio at [hmutascio@uarts.edu](mailto:hmutascio@uarts.edu).

**Q1: continued****If 'I've never participated in a citizen science project' (for both Q1 and Q1b):**

I'm looking for survey participants who currently or have in the past participated in what they consider to be a citizen science project. If you'd still like to take a survey to help me with my thesis, please consider taking this one: [[link to survey #2](#)]. It's a survey for visitors to natural history and/or science museums. If you're not interested, please click submit to end this survey.

**For Q2 - Q7:**

Choose one project that you consider yourself to be the most actively involved in. This can be a project that you currently or in the past participated in.

**Q2: What field does this project fall under? (Select up to three options)\***

- Agriculture
- Animals (e.g., Birds, Insects, Mammals, Reptiles)
- Archaeology & Cultural
- Astronomy & Space
- Chemistry
- Climate & Weather
- Computers & Technology
- Ecology & Environment
- Food
- Geology & Earth Science
- Genetics
- Health & Medicine
- Humanities
- Microbiology
- Ocean, Water; Marine & Terrestrial
- Physics
- Psychology
- Social Science
- Sound
- I'm not sure
- Other:\_\_\_\_\_

**Q3: How would you rate your level of participation in this project? Participation can be defined as the amount of time you spend on this project, the amount of data or resources you contribute, how involved you feel in the project, or some combination of these.**

	1	2	3	4	5	
Participate rarely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Participate very often

**Q4: Approximately how many hours (per day, week, month, or year) do you spend participating in this project?\***

Please write a number of hours and specify if you're referring to hours per day, hours per week, hours per month, or hours per year. For example, if you participate 10 hours over the course of 1 week, please write '10 hours per week.'

---

**Q5:** How would you describe your type of participation in this project? (Please check all that apply)\*

- Collect data (provide observations, samples, etc.)
- Analyze collected data
- Interpret study findings
- Donate resources to the project (e.g., computing power, tools/equipment)
- Collaborate in designing/developing project questions, hypotheses, and/or methods
- Coordinate/recruit other citizen scientists/volunteers
- Write reports and/or journal articles
- Give presentations at meetings and/or conferences
- I'm not sure
- Other: \_\_\_\_\_

**Q6:** Which of the following describes how you usually participate in this project?\*

- I perform my tasks independently
- I perform my tasks in person with a group of other citizen scientists
- I perform my tasks online with a group of other citizen scientists
- I perform my tasks in person with professional scientists
- I perform my tasks online with professional scientists
- I perform my tasks in person with both citizen scientists and professional scientists
- I perform my tasks online with both citizen scientists and professional scientists
- Other: \_\_\_\_\_

**Q7:** Would you use any of the following terms to describe yourself? (Please check all that apply)\*

- Citizen scientist
- Amateur scientist
- Civic scientist
- Scientist
- Volunteer or volunteer monitor
- Crowd scientist
- Community scientist
- None of these
- Other: \_\_\_\_\_

**For Q8 - Q9:**

Next, I would like to ask you a couple of questions about how you may already engage with natural history and/or science museums.

**Q8: How frequently do you visit natural history and/or science museums?\***

- Multiple times a month
- Once a month
- Multiple times a year
- Once a year
- Once every 2-3 years
- Rarely
- I've never visited a natural history or science museum

**Q9: Do you engage with at least one natural history or science museum in any of the following ways? (Please check all that apply)\***

- I have a membership
- I give to the annual fund, or provide another type of monetary support
- I volunteer my time (e.g., behind the scenes, as a docent, as a tour guide, etc.)
- I participate in a citizen science project sponsored by the museum
- I'm on the board of the museum
- I'm on an advisory committee for the museum
- None of these
- Other: \_\_\_\_\_

**For Q10 - Q13:**

Now, I would like to ask you a few questions about your interests in participating in the process of creating museum exhibits and your needs in such collaborations.

**Q10: If you were to collaborate with a natural history or science museum in creating exhibits about citizen science in general and/or specific citizen science projects, how interested are you in the following? (Please check all that apply)\***

- Provide background knowledge about the topic of a project(s)
- Provide information about the results and/or impact of a project(s)
- Provide objects/images
- Share your personal story about being a citizen scientist
- Become a docent at the museum
- Create and/or lead a program associated with the exhibit
- Create interactive experiences for the exhibit (e.g., physical or digital)
- Create a space for citizen scientists to interact with one another and/or the public
- Determine what the exhibit would be about (e.g., the content, the experience visitors will have)
- Determine what the exhibit would look like (e.g., the design of the space, data visualizations)
- Serve on an advisory board that reviews the progress and end product of the exhibit

**Q10: continued**

- I'm not interested in collaborating with museums to create exhibits
- Other: \_\_\_\_\_

**Q11: What makes you excited by the prospect of collaborating with natural history and/or science museums to create exhibits about citizen science? (Please check all that apply)\***

- Sharing my own knowledge/expertise
- Sharing my own experience/story
- Spreading awareness of citizen science as a concept/field
- Inspiring museum visitors to participate in citizen science
- Teaching museum visitors about science in general
- Teaching museum visitors how to do citizen science
- Communicating the results of a citizen science project
- Creating new citizen science projects/tools
- Interacting with other citizen scientists
- Interacting with scientists/museum staff
- Making/creating/designing something
- I'm not interested/None of these would excite me
- Other: \_\_\_\_\_

**Q12: What considerations would museum staff need to keep in mind to make this a rewarding experience for you? (Check all that apply)\***

- My voice is represented in the end product
- My knowledge/expertise is treated as equal to that of a professional
- I am recognized for my contributions to the field of my project/the field of citizen science in general
- I gain new skills/learn something new through the process
- I am able to engage with other citizen scientists through the process
- I am able to engage with the community/public through the process
- The experience is fun
- I'm not interested/No considerations would make me interested
- Other: \_\_\_\_\_

**Q13: Is there anything else you'd like to add about museum exhibits on citizen science and/or collaborating with museums to create such exhibits? (Optional)**


---

**For Q14 - Q18:**

Finally, I would like to ask you a few anonymous, non-identifying questions about yourself.

**Q14:** To which gender identity do you most identify?

---

**Q15:** What is your age?

- Under 18
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-74
- 75+
- I prefer not to say

**Q16a:** What is your zip code?

If you live outside the U.S., please skip and answer the next question.

---

**Q16b:** If you live outside the U.S., what is your country?

If you live within the U.S., please skip this question.

---

**Q17:** How would you describe yourself?  
(Check all that apply)

- Non-Hispanic White or Euro-American
- Latino or Hispanic American
- Black, Afro-Caribbean, or African American
- Middle Eastern, North African, or Arab American
- East Asian or Asian American
- South Asian or Indian American
- American Indian or Alaskan Native
- Native Hawaiian or Other Pacific Islander
- I prefer not to say
- Other: \_\_\_\_\_

**Q18:** What is the highest degree or level of school you have completed? (If you're currently enrolled in school, please indicate the highest level you have received.)

- Some high school
- High school degree or equivalent (e.g., GED)
- Some college
- Associate degree (e.g., AA, AS)
- Bachelor's degree (e.g., BA, BS)
- Some graduate school
- Master's degree (e.g., MA, MS, MFA, MEd)
- Professional degree (e.g., MD, DDS, DVM)
- Doctorate (e.g., PhD, EdD)
- I prefer not to say

# Survey #2 Executive Summary

## Study of natural history & science museum audience

The purpose of this front-end study was to understand audience expectations when visiting natural history and science museums and how they might like to engage with citizen science in the museum setting. Seventy-five surveys were collected through Google Forms, which was shared via the author’s personal networks between February 19, 2018 and March 28, 2018.

For a copy of the Google Form survey, the raw data, the full survey analyses, and a coded Excel spreadsheet to use for analysis, please contact the author at [holly.mutascio@gmail.com](mailto:holly.mutascio@gmail.com).

Survey respondents were generally more interested in passive learning over active and social experiences when visiting natural history and sciences museums. In terms of citizen science content and interpretation, they were most interested in learning about the results and policy implications of citizen science projects and somewhat less interested in the personal stories of citizen scientists. In terms of citizen science activities, they were most interested in bringing data to the museum to be analyzed and somewhat less interested in having social experiences with other visitors or citizen scientists.

**Survey Respondent Characteristics**  
Ethnicity/Race: 76.0% Non-Hispanic White or Euro-American  
Gender Identity: 56.0% Female  
Age: 54.7% 25-34 years old  
Education: 52.0% with at least some graduate education

**Survey Respondent Interest in Citizen Science**  
45.3% interested in participating in a citizen science project  
24.0% not interesting in participating in a citizen science project  
30.7% already have participated/are current participants in a citizen science project



# Survey Instrument

## Study of natural history & science museum audience

### Greeting:

My name is Holly and I am a graduate student studying Museum Exhibition Planning and Design at the University of the Arts in Philadelphia, PA. My thesis research explores how citizen science can be represented in natural history and science museum exhibits. I am interested in learning more about you as a visitor to a natural history and/or science museum, as well as what you already know about citizen science and what you may expect to learn and do at such an exhibit.

Your participation in this study is completely voluntary. There are no risks foreseen with this project, though if you feel uncomfortable answering any questions, you may withdraw from the survey at any point. All information is strictly confidential and no identifying information is required. If you have any questions at any time about the survey or methods, or are interested in receiving an electronic copy of my completed thesis, please contact me at hmutascio@uarts.edu at any time. Thank you so much for your time and participation.

\* = denotes a required question

### Q1: How frequently do you visit natural history and/or science museums?\*

- Multiple times a month
- Once a month
- Multiple times a year
- Once a year
- Once every 2-3 years
- Rarely
- I've never visited a natural history or science museum

### Q2: With whom do you typically visit natural history and/or science museums? If you haven't visited one before, with whom would you most likely visit?\*

- My family
- My significant other
- My friends
- My colleagues
- My students
- By myself
- I wouldn't visit a natural history or science museum
- Other: \_\_\_\_\_

### If 'I wouldn't visit a natural history or science museum':

I'm looking for survey participants who have or would like to visit a natural history or science museum. Thank you for your time!

**Q3:** How important are the following to you when you visit a natural history or science museum? If you haven't visited one before, how important would the following be?\*

	Not at all important	Slightly important	Somewhat important	Moderately important	Extremely important		Not at all important	Slightly important	Somewhat important	Moderately important	Extremely important
Learn what is already known about science/natural history	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Have a social experience with the people I'm visiting with	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learn about recent discoveries in science/natural history	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Have a social experience with other visitors at the museum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learn about current research happening at the museum or affiliated institution (e.g., university)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Participate in an activity that helps me learn something new	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talk to a researcher about their work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Participate in an activity that contributes something to the research done at the museum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talk to a volunteer/docent who has general knowledge about science/natural history	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Discover a new interest that I can pursue on my own or with my family, friends, etc.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Q4:** Are there any other kinds of things you like to do when visiting natural history or science museums? (Optional)

---

**For Q5 - Q7:**

Next, I'm interested in what you might already know about citizen science.

**Q5:** How familiar with citizen science as a term or concept do you consider yourself?\*

- I am very familiar with the term and have used it, read about it, etc.
- I think I know what the term means or I think I could guess
- I am not at all familiar with the term and I'm not sure if I could guess

**Q6:** Which of the following do you think might describe citizen science? (Check all that apply)\*

- Anyone is able to participate
- Participants are volunteers
- Participants are amateur scientists
- Participants are professional scientists
- Participants follow the same protocol
- Data can be used by professional scientists to make scientific conclusions
- Data can be used by anyone, including members of the public, to make scientific conclusions
- It's about collecting data
- It's about analyzing/interpreting data

**Q6: continued**

- It has to do with creating policy of or relating to science
- It is community driven/driven by the public
- It's a collaboration between the public and professional scientists
- Participants take direction from professional scientists
- None of these
- Other: \_\_\_\_\_

**Q7:** Have you ever participated in a citizen science project?\*

- Yes
- No, I had the opportunity, but did not wish to participate
- No, I have not had the opportunity, but would be interested in participating in one
- No, I have not had the opportunity, and I am not interested in participating in one
- I'm not sure

**If 'yes':**

**Q7a:** How did you become involved in or learn about the citizen science project you participated in?

If you cannot remember, please write "I don't know."

---

**For Q8 - Q10:**

For the next section of the survey, I will now provide you with a definition of citizen science and ask you questions about attending an exhibit on citizen science.

Citizen science is public involvement in inquiry and discovery of scientific knowledge, usually in data collection, analysis, and reporting. Participants are not required to have a formal background in science, and any member of the public is invited to participate.

**Q8:** How interested are you in learning the following about citizen science at a natural history or science museum exhibit?\*

	Not at all important	Slightly important	Somewhat important	Moderately important	Extremely important		Not at all important	Slightly important	Somewhat important	Moderately important	Extremely important
Learn about citizen science projects at the museum or elsewhere that I can participate in after I visit the museum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Learn about the policy implications of a particular citizen project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learn about other people's experiences doing citizen science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Learn what citizen science means in general	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learn the background information about a particular citizen science project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>						
Learn the results/ findings of a particular citizen science project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>						

**Q9:** How interested are you in doing the following while visiting a natural history or science museum exhibit about citizen science?\*

	Not at all important	Slightly important	Somewhat important	Moderately important	Extremely important		Not at all important	Slightly important	Somewhat important	Moderately important	Extremely important
Bring data to the museum to be analyzed during my visit to the museum (e.g., soil sample from your backyard, cotton swab of bacteria from your toilet)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Join a citizen science project I can participate in at the museum or elsewhere after I visit the museum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
						Talk to citizen scientists during my visit to the museum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Collect data at the museum during my visit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Talk to professional scientists about their citizen science project during my visit to the museum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Analyze data at the museum during my visit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>						
Learn how to collect and/or analyze data so I can participate in a project after I visit the museum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Suggest ideas for new citizen science projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Q10:** Is there anything else you'd like to add about what you are interested in learning or doing at a natural history or science museum exhibit about citizen science?

---

**For Q11 - Q15:**

Finally, I would like to ask you a few anonymous, non-identifying questions about yourself.

**Q11:** To which gender identity do you most identify?

---

**Q12:** What is your age?

- Under 18
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-74
- 75+
- I prefer not to say

**Q13a:** What is your zip code?

If you live outside the U.S., please skip and answer the next question.

---

**Q13b:** If you live outside the U.S., what is your country?

If you live within the U.S., please skip this question.

---

**Q14:** How would you describe yourself?  
(Check all that apply)

- Non-Hispanic White or Euro-American
- Latino or Hispanic American
- Black, Afro-Caribbean, or African American
- Middle Eastern, North African, or Arab American
- East Asian or Asian American
- South Asian or Indian American
- American Indian or Alaskan Native
- Native Hawaiian or Other Pacific Islander
- I prefer not to say
- Other: \_\_\_\_\_

**Q15:** What is the highest degree or level of school you have completed? (If you're currently enrolled in school, please indicate the highest level you have received.)

- Some high school
- High school degree or equivalent (e.g., GED)
- Some college
- Associate degree (e.g., AA, AS)
- Bachelor's degree (e.g., BA, BS)
- Some graduate school
- Master's degree (e.g., MA, MS, MFA, MEd)
- Professional degree (e.g., MD, DDS, DVM)
- Doctorate (e.g., PhD, EdD)
- I prefer not to say

## Interviews/Personal Communications

- Cavalier, Darlene, via phone, January 31, 2018.  
Cavalier, Darlene, Philadelphia, PA, April 3, 2018.  
Cooper, Caren, via Google Hangouts, January 12, 2018.  
Duguid, Lauren, West Philadelphia, PA, August 25, 2017.  
Goforth, Chris, via phone, September 7, 2017.  
Goforth, Chris, via email, March 31, 2018.  
Goforth, Chris, via email, April 6, 2018.  
Higgins, Lila, via phone, November 14, 2017.  
Higgins, Lila, Los Angeles, CA, March 7, 2018.  
Ordeñana, Miguel, Los Angeles, CA, March 7, 2018.  
Redmond-Jones, Beth, via Skype, March 28, 2018.  
Rigois, Béatrice, via email, January 24, 2018.  
Smart, Richard, Los Angeles, CA, March 7, 2018.



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# Image Credits

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*Tivoli: A Place We Call Home.* Courtesy of Eye & I Inc., 2010. <http://www.eye-andi.org/2015/06/21/tivoli-a-place-we-call-home/>

*View of Family Interrupted: Community Connected, in the Philadelphia Voices: Community History Gallery.* Courtesy of the Philadelphia History Museum, 2012. <http://www.philadelphiahistory.org/exhibition/family-interrupted-community-connected/>

*Image of children and adults interacting with artifacts in a shopping center.* Courtesy of The Open Museum. <https://prodglportalv2.azureedge.net/cache/3/8/e/c/e/3/38ece3cb75cc1fe58b174c82864d6847c6755599.jpg>.

*Image of the "Forces of Change" exhibit.* Courtesy of Oakland Museum of California, 2011. Photo: Jason Lew.

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*eBird mobile app.* Courtesy of eBird, The Cornell Lab of Ornithology. <http://help.ebird.org/customer/portal/articles/1848031-ebird-mobile-apps-overview>

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Screenshot from Google Maps Street View, user Tiger Lin [devilgorgor.com](http://devilgorgor.com), of the North Carolina Museum of Natural Sciences Nature Research Center.

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*Citizen science center.* Courtesy of North Carolina Museum of Natural Sciences.

*A chock-full and busy Micro World iLab on Title I Night.* In Debra Bailey. "iLabs: Title I Night - Never a Dull Moment!!" *NCMNS Education Blog* (blog), August 8, 2014, <https://naturalscienceseducation.wordpress.com/2014/08/08/ilabs-title-i-night-never-a-dull-moment/>

*The Genomics & Microbiology Research Lab.* Courtesy of North Carolina Museum of Natural Sciences, <http://naturalsciences.org/research-collections/genomics-microbiology-lab>.

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*Photo of people hiking on a trail at the Prairie Ridge Ecostation.* Courtesy of Swanson + Associates, P.A. Landscape Architecture, 2010. <http://www.swansonlandscapearchitecture.com/prarieridge.html>

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*iNaturalist app.* Courtesy of Kaibab National Forest. <https://www.fs.fed.us/working-with-us/citizen-science/kaibab-national-forest-2017-citizen-science-project>.

*Infographic on how to use iNaturalist.* Courtesy of iNaturalist Canada. <http://inaturalist.ca/pages/getting-started-inaturalist-canada>.

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Scanned from a take-home bookmark, from March 9, 2018, available at the Extraordinary Ideas from Ordinary People exhibition, San Diego Natural History Museum.

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Instagram, search parameters: #natureinLA

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*The Sovereignty gallery in the Philadelphia Assembled exhibition.* Courtesy of Philadelphia Museum of Art. Photo by Joseph Hu. <http://philamuseum.tumblr.com/tagged/Philadelphia-Assembled>.

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*Toward Sanctuary Dome, conceived and realized by Traction Company, Mayada Alhumssi, and the Philadelphia Assembled Sanctuary Stewards, and Sanctuary Working Group collaborators.* Courtesy of Philadelphia Museum of Art. <http://philamuseum.tumblr.com/tagged/Philadelphia-Assembled>.

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*Genspace members working on their projects in the lab.* Courtesy of Genspace. In "Genspace - DIYbio Labs Project." *Open Philanthropy Project*. <https://www.openphilanthropy.org/focus/global-catastrophic-risks/biosecurity/genspace-diy-bio-labs-project>.

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*Citizen science vending machine (2 photographs).* Courtesy of Oakland Museum of California. <http://museumca.org/citizen-science-vending-machine>

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Photograph of The Nat's iNaturalist pocked guide. Courtesy of Lauren Duguid.

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*Fjällräven Save the Arctic Fox Kånken Mini backpack.* Courtesy of Rakuten Global Market. <https://global.rakuten.com/en/store/atmos-girls/item/23496/>





