

SUCSESSES AND CHALLENGES OF CITIZEN SCIENCE AT NATURE CENTERS

By

Stephanie Somerville Zamora

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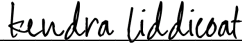
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College of Natural Resources
UNIVERSITY OF WISCONSIN
Stevens Point, Wisconsin

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APPROVED BY THE GRADUATE COMMITTEE OF:

DocuSigned by:



Dr. Kendra Liddicoat, Committee Chair
Associate Professor of Environmental Education

DocuSigned by:



Jim Buchholz

Director of Schmeckle Reserve


DocuSigned by:



Dr. Brenda Lackey

Associate Dean of the College of Natural Resources

DocuSigned by:



Dr. Chris Yahnke

Professor of Wildlife Ecology

DocuSigned by:



Megan Espe

Learning Specialist, Wisconsin Forestry Center

ABSTRACT

Citizen science, the involvement of the public in scientific research, is a powerful tool that can expand the capacity to collect data and address research questions. In addition, it can foster a sense of place and connection to nature. Citizen science programs are being implemented in formal and non-formal education facilities around the world, such as schools, universities, natural history museums, national parks, nongovernmental organizations, community organizations and nature centers. Much research has explored the definition of citizen science; its history; the controversy around the term; planning, implementation, and evaluation of specific citizen science programs; best practices; its benefits; and the motivation of volunteers. However, few studies have investigated the relationship between nature centers and citizen science. Nature centers are unique sites for citizen science because they allow community members to experience education, interpretation, scientific research, land conservation, and outdoor recreation in a single, natural location. For this study we wanted to know what factors make the implementation of a citizen science program in a nature center successful and what are some of the challenges involved in implementing citizen science programs? Data were collected by conducting semi-structured interviews with staff members from ten nature centers in Wisconsin that implement citizen science programs at their sites. Data were coded for emerging themes. Results showed that the success of a citizen science program at a nature center depends on having committed staff and volunteers. The main challenges identified were recruiting and retaining volunteers, ensuring data collection quality, and maintaining financial and human resources. Results of this study are relevant to nature centers currently offering citizen science and to nature centers considering adding citizen science to their suite of place-based programs.

Key words: citizen science, community-based monitoring, nature centers

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CHAPTER I: INTRODUCTION

Citizen science is broadly defined as the intentional involvement of members of the public in scientific research (Phillips et al., 2019). Citizen science has changed over time and is now seen as a way to engage the public in science, improve scientific literacy and interest in science, and inform participants about specific topics (Miller-Rushing et al., 2020). Citizen science projects can be categorized according to the level of involvement of the volunteers or the type of activities in which the volunteers are involved, and they can all be implemented in many places (Danielsen et al., 2020). Environmental education centers, nature centers and other non-formal education centers are some of the places that engage in citizen science and use it as a tool for furthering their missions of education, research, and conservation, as well as to connect the public with the natural world. These types of centers have used hands-on, inquiry-based learning methods to engage the public in scientific learning for a long time, but citizen science is a different approach because it involves a collaboration between the public and professional scientists, resulting in the collection of useful data that aims to advance scientific understanding and can be applied to real issues. Most importantly, current citizen science projects have a clearly defined educational component, with specific objectives and strategies to meet them (Prysby & Super, 2007).

According to Chawla and White (2018), citizen science is a unique form of place-based education that engages people in real-world scientific inquiry beyond the walls of a classroom and as true naturalists. Through citizen science, people can strengthen their sense of place, connection to nature and understanding of the world around them, all while contributing to wider scientific understanding. Local nature centers are ideal facilities to address place-specific issues through citizen science programs because they are sites that connect people and the environment

(Browning et al., 2016). Implementing citizen science programs anywhere has its challenges and barriers that must be overcome to ensure their longevity once established. The study is significant because it can provide guidance to nature centers on how best to develop successful citizen science programs.

RESEARCH QUESTIONS

1. What makes the implementation of a citizen science program in a nature center successful?
2. What are the challenges involved in the process?

LIMITATIONS

1. The study focuses on nature centers in Wisconsin and the findings may not be applicable to all nature centers looking to implement citizen science.
2. The information obtained during the research was based on the perspective of nature center staff, not the citizen scientists.
3. The selection of the nature centers was not random, instead they were selected because they had active citizen science programs.

ASSUMPTIONS

1. Nature center staff would be willing to honestly share successes, challenges, and recommendations to assist other nature centers that have similar goals.

2. Data gathered from nature center staff during the COVID-19 pandemic would include information relevant to implementing citizen science programs under other circumstances.

DEFINITIONS OF TERMS

Citizen science: The involvement of the public in scientific research – whether community-driven research or global investigations (Citizen Science Association, 2020).

Nature center: Human institutions that guide our search for a sense of place (Zimmerman & Gross, 2002). May also be called environmental education centers, discovery centers, etc.

Participants: People who participated in the study's semi-structured interviews.

Citizen scientists: People who volunteer to participate in citizen science programs.

Engagement: An emotional involvement and commitment (Merriam-Webster).

Recruitment: The action or process of enlisting new members (Merriam-Webster).

Sense of place: a collection of symbolic meanings, attachment, and satisfaction with a spatial setting held by an individual or group (Stedman, 2002)

UWSP: University of Wisconsin-Stevens Point.

CHAPTER II: LITERATURE REVIEW

The purpose of this study was to understand what makes the implementation of a place-based citizen science program in a nature center successful and the challenges associated with them. To accomplish this, literature written by scholars in a variety of fields was reviewed, focusing on the following topics:

1. The definition and classification of citizen science
2. The benefits of citizen science
3. Citizen science and nature centers
4. Citizen science and place
5. Citizen science and motivation

CITIZEN SCIENCE

Citizen science is broadly defined as the intentional involvement of members of the public in scientific research (Phillips et al., 2019). Similarly, the Citizen Science Association (2020) defines citizen science as “the involvement of the public in scientific research – whether community-driven research or global investigations.” Many other definitions exist, but for the purposes of this study, the Citizen Science Association’s definition was used.

There has been much debate on the appropriateness of using the word “citizen”. Therefore, it is also known as public participatory scientific research (PPSR), community science, and community-based monitoring (CBM). The Citizen Science Association utilizes the term citizen science and argues that the term “citizen” in this context is not used to refer to people from a particular country but as a member of the global community, for science is not limited by political borders. According to Prisby and Super (2007), the basic elements of citizen

science are that it actively involves both the public and professional scientists at some level, results in useful data that aim to advance scientific understanding, can be applied to real world problems, and has a clearly defined education component. This definition generally coincides with that of other authors.

The level of public participation varies depending on the type of project. There are many classifications, but Bonney et al. (2009) classify citizen science into three main categories: contributory, collaborative, and co-created projects. Contributory projects are generally designed by scientists, with the public helping with data collection. Collaborative projects are also conceived by scientists, but the public may aid in refining the methodology, analyzing data, and sharing results. In co-created projects, both the scientists and the public contribute to the design and share the responsibilities throughout all the stages of the project (Frensley et al., 2017). Shirk et al. (2012) added to this classification by including “contractual” and “collegial” projects. Contractual projects are where communities ask professional researchers to conduct a specific scientific investigation and report on the results. Collaborative projects are generally designed by scientists and for which members of the public contribute data but also help to refine project design, analyze data, and/or disseminate findings; These differences are relevant to this study because the level of public involvement may be tied to the success of these programs.

BENEFITS OF CITIZEN SCIENCE

Citizen science can provide benefits to researchers, individuals who participate, as well as society at large. According to Prisby and Super (2007), citizen science is a powerful tool that can expand the capacity to address many research questions and data needs for scientists. In addition, McKinley et al. (2017) argue that citizen science can increase scientific and environmental

literacy and extend public involvement in decision making. This is done by achieving management goals through specific citizen science programs such as eBird and Monarch Watch that focus on species management, or Bucket Brigade for pollution detection and enforcement.

On the other hand, participation in citizen science may result in substantial changes to individual perspectives and, by extension, that of communities. For example, interviews with participants have demonstrated that citizen science results in increases in awareness of scientific issues, the development of positive attitudes towards science, scientific thinking and scientists, the enhancement of skills (identification, analysis, presentation), and behavioral changes that lead to an effort to affect policy (Christoffel, 2020). Dickinson and Bonney (2012), argue that citizen science projects designed within the contexts of biodiversity monitoring and environmental change provide a natural bridge to connect audiences fascinated with science and technology with people who love nature but fear the effects of modern lifestyles on the environment.

At a larger scale, citizen science has the potential to impact society and policy, in addition to its contribution to scientific research. Yet, the specific effects of a project will depend on its goals (Turrini et al., 2018). For example, project outcomes can focus on scientific research through data collection, on the participants through education and the development of new skills, and on social-ecological systems, like conservation and stewardship, that may lead to the development of new policies (Alender, 2016). Establishing clear goals and providing meaningful benefits to a community may be key factors determining the success of citizen science projects.

CITIZEN SCIENCE AND NATURE CENTERS

The type of institution that supports citizen science may affect the desired outcome of a particular project. Citizen science is used in formal education institutions such as schools and universities, as well as in non-formal education centers across the world such as in natural history museums, national parks, nongovernmental organizations, community organizations, and nature centers (Mitchell et al., 2017; Sforzi et al., 2018; Wyler & Haklay, 2018). No systematic research has been conducted on the role that institution type has on project goals and how it affects a citizen science program's success.

This study will focus on citizen science in nature centers. These are human institutions that guide our search for a sense of place. Nature centers preserve or restore vernacular landscapes for learning, serve a local community, and foster sustainable relationships between people and the earth (Gross & Zimmerman, 2002). Browning et al. (2016) surveyed community members and identified values that nature centers provide: opportunities for leisure, connections with the environment, enhanced civic engagement (links people to political action, helps bring people together, and provides a place for people to gather), and community resilience (contributes to the local economy, develops a sense of pride in the local community, and makes the community a more beautiful place). Since citizen science is a bridge that connects all these values in one instrument, nature centers provide an ideal location to implement them. The synergy between citizen science and nature centers is seen in the observations of Prisby and Super (2007). Their summary from a Citizen Science Forum in November 2003 states that citizen science opens new avenues of funding for institutions, provides hands-on, memorable experiences in nature for participants, and fosters a sense of place and caring feeling towards the environment. A survey of citizen science managers identified the following factors leading to

success: intensive communication with participants, science experts within the project management team, the enthusiasm of participants, sufficient staff resources, and collaborations with other institutions. The main challenges were shortages of financial and staff resources, and recognition of citizen science by the professional scientific community (Turrini et al., 2018). This study explores whether similar factors influence success and pose challenges to implementing citizen science programs in the specific context of nature centers.

CITIZEN SCIENCE AND PLACE

Nature centers are place-based institutions, this means that they have a connection to the community they are in and the surrounding area. Although, advances in communication technology (online and mobile tools) have allowed the implementation of citizen science projects at a global scale and at any time or place (MacPhail & Colla, 2020), not all citizen science projects have that kind of global focus and application. Some citizen science projects have a more local or place-based focus and depend on the support of the local community (Newman et al., 2017). When done thoughtfully, this place-based approach to citizen science can transform humans and their environment. Similarly, Haywood (2014) argues that because most citizen science takes place and is grounded in specific sites and socioecological contexts, the relationships among citizen scientists and the places in which they explore, collect, and gather information are important to the citizen science experience. Connections between the local environment, its inhabitants, and the overall community may be strengthened through citizen science as it offers an avenue for motivated community members to actively observe their landscape and share their findings with the rest of the community (Long, 2019).

Place-based community projects, such as citizen science programs, are generally focused on improving the environment in a specific area, with participation from the local community. These participants join the projects because of their attachment to the particular location or for the potential benefits to their personal life (van Noordwijk et al., 2021). Toomey et al. (2020) explored the links between participation in citizen science programs and sense of place. Their findings showed how citizen science can connect people more closely with place, create a new understanding of what those places mean, and encourage people to participate more fully in being stewards of those places.

Newman et al. (2017) use the term “power of place” to refer to the actions motivated by the emotional, cultural, and material connection that people have for the place in which they live. From their study, they recommend that to leverage the power of place in citizen science projects, place should be explicitly incorporated into project design and implementation, because strong identification with a place can be a powerful motivator for recruiting and retaining volunteers.

CITIZEN SCIENCE AND MOTIVATION

To be successful, citizen science projects depend on the involvement and support of volunteers. One of the key questions surrounding citizen science is, what motivates people to participate? West and Pateman’s (2015) model, which summarizes the key factors for participation in citizen science, highlights three distinct stages to participation: the decision to participate, the initial participation in the project, and sustained participation. Each of these stages depends on the motivation a person has. Therefore, to have a successful citizen science project, it is important to understand what motivates a person to volunteer.

In citizen science, various theoretical frameworks based on psychological and sociocultural theories have been used to explain volunteer motivations. The Theory of Planned Behavior, developed by Icek Ajzen in 1991, was adapted and used by Wehn and Almomani (2019) as a theoretical framework to review literature and analyze the motivations of stakeholders to participate in citizen science initiatives. This theory states that three main factors – attitude, subjective norm, and perceived behavioral control – influence a behavioral intention, which in turn determines a specific behavior. “Attitude” refers to the attitude a person has towards an act or behavior. “Subjective norms” are the cultural norms or group beliefs. “Perceived behavioral control” refers to how easy or hard it is for the person to accomplish. To adapt the theory, Wehn and Almomani (2019) kept the three factors, but instead of using the term “behavioral intention” they substituted it with “willingness to participate” and “subjective norms” with “social pressure”. Consequently, they stated that attitudes, social pressures, and perceived behavioral control are what influence the willingness of a person to participate in a citizen science project, and that is what determines actual participation.

The disadvantage of using the Theory of Planned Behavior is that the model does not include other proven influential behavioral factors, such as emotions. Other researchers have used the self-determination theory (SDT) to analyze motivations. The theory, developed by Deci and Ryan (2000), classifies motivation into two types: autonomous and controlled. “Autonomous motivation” refers to what you do when you feel a full sense of willingness and choice, with interest and enjoyment. The second type, “controlled motivation”, is when you do something to get a reward or avoid punishment; you are doing it because you feel pressured. Autonomous motivation was divided into intrinsic and extrinsic motivation, which is what self-determination theory contrasts. “Intrinsic motivation” refers to doing something because it is inherently

interesting or enjoyable, and “extrinsic motivation” refers to doing something because it leads to a separable outcome (Ryan and Deci, 2000a; Ryan and Deci, 2000b).

Participant recruitment is essential for the success of a citizen science project, but keeping participants long-term is beneficial as it reduces the amount of time required to recruit and train new people, and it may lead to higher quality data collection due to their greater level of experience (Crimmins et al., 2014). As citizen science continues to expand, and with it the need for an increasing number of people to participate, the communication strategies used to inform, recruit, and engage volunteers need to be studied and refined to guarantee their long-term success.

According to Goad et al. (2020), strategies that have been used to recruit citizen science participants include 1) door-to-door personal contact and neighborhood recruitment, which is mainly used for projects that focus on a small area or aim to engage a marginalized population; 2) collaborating with other groups and organizations such as “Friends of” organizations, which already have the infrastructure that makes communication, training, data sharing, and volunteer retention easier; 3) collaborating with professional groups, non-formal education centers, and formal classrooms; 4) using events such as festivals, conferences, and public outreach events to disseminate information and pique interest in becoming a citizen science volunteer.

Another strategy includes recruiting through mass media and social media. There has been some research on the use of marketing campaigns that incorporate traditional media and social media channels to recruit new participants and retain existing ones (Crimmins et al., 2014). Some of the strategies tested did increase recruitment, but they were not as effective in increasing engagement for long periods of time.

CONCLUSION

The literature on citizen science focuses on its definition, its history, controversy around the term, planning, implementation, and evaluation of specific citizen science programs, its impact on different fields of study, and the motivation of volunteers. Many published resources also review and outline best practices for citizen science based on the success of an individual project (Lepczyk, Boyle & Vargo, 2020; Prisby & Super, 2007; Sforzi et al, 2018). While nature centers' missions often include connecting people to nature in various ways, their potential to provide a broader array of services to their communities remains largely unexplored (Browning et al., 2016). This study addresses this gap by exploring how several nature centers across Wisconsin are implementing successful place-based citizen science programs and the challenges they face.

CHAPTER III: METHODS

RESEARCH METHODOLOGY

This research used a qualitative approach. The researcher gathered qualitative data through semi-structured interviews, with transcripts coded to identify repeated ideas and themes in participants' feedback about citizen science in nature centers. The approach was reliant on socially distanced methods due to the COVID-19 pandemic.

An interview is a method of data collection that involves researchers seeking open-ended answers related to a number of questions, topic areas or themes (O'Leary, 2017). For the interviews, the researcher used a type of qualitative interview called a semi-structured interview, which has a planned list of questions but allows room for dialogue, follow-up questions, and other changes (Kendall, 2014). This type of interview is commonly used among researchers when the interviewer will not get more than one chance to interview a participant. Following the semi-structured interview guide provides a clear set of instructions that makes the qualitative data more reliable and comparable. The interview focused on addressing the research questions of this study of what makes the implementation of a citizen science program in a nature center successful, and what challenges are involved?

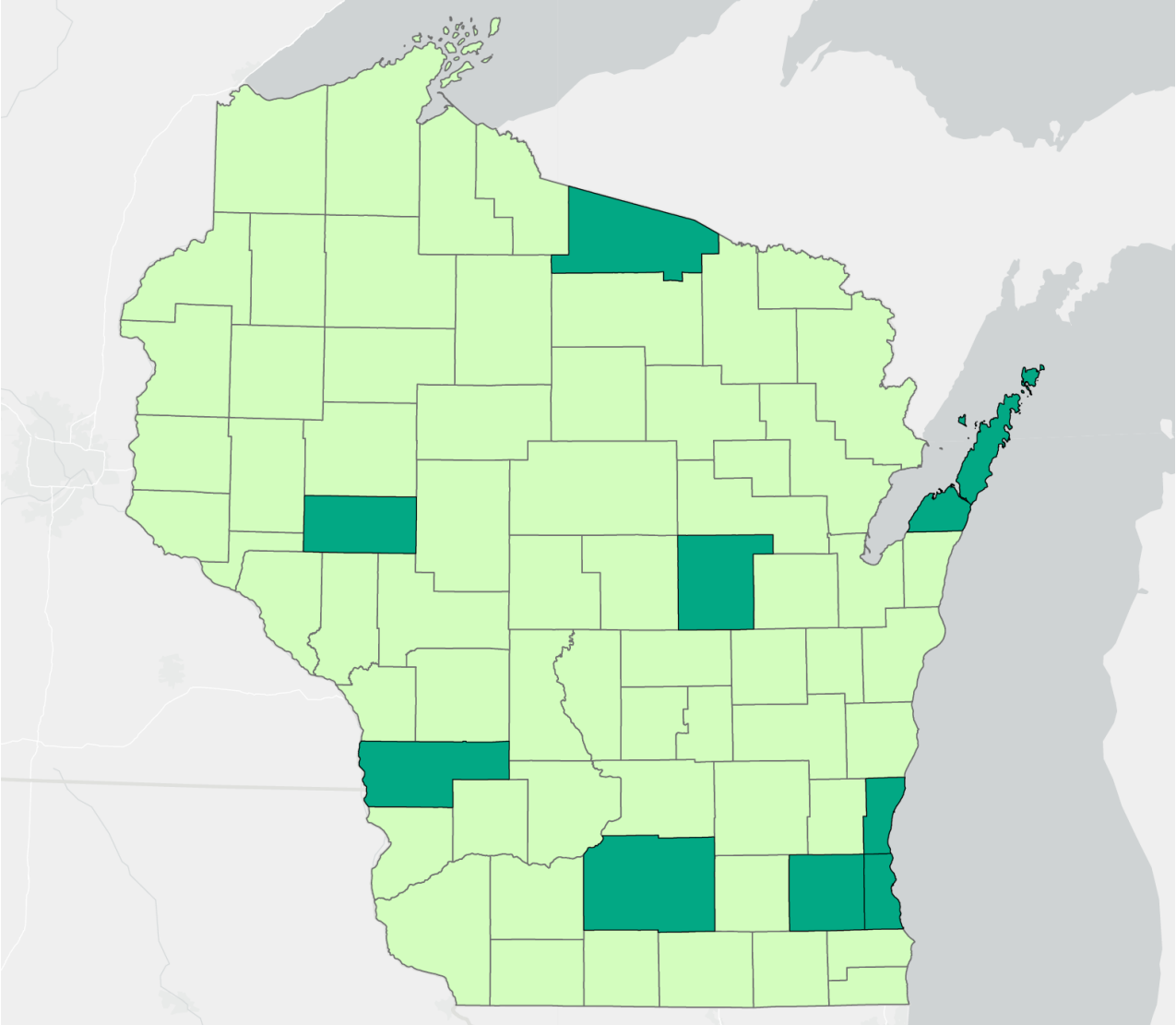
DATA COLLECTION

All UWSP human subject research projects must follow protocol established by the Institutional Review Board (IRB). The researcher completed online training pertaining to research involving human subjects and submitted a proposal detailing the research methodology, which was approved by the UWSP IRB committee in July 2020 (#2021-29).

The researcher interviewed staff members from ten nature centers located in nine counties in Wisconsin that implement citizen science programs at their sites (See Fig. 1.). Interview questions were aimed at understanding the initial successes and challenges in developing citizen science programs in nature centers. The nature centers were chosen because they had established citizen science programs that were active.

Figure 1.

Map of locations of the nature centers that participated in the study



Initial contact with these organizations was made via email. If the best person to interview was not available, each site's staff determined who that would be. The body of the invitation email included the purpose of the proposed semi-structured interview and a consent form so that the interviewee was aware of their rights as a human subject engaging in research (See Appendix A). Follow-up communication included confirmation of participation and interview scheduling.

To be consistent, an interview guide with questions was developed and used in all interviews. The set of interview questions was divided into four categories: programs, volunteers, challenges, and recommendations. The interview guide is included below:

Programs

1. How many, what type and which citizen science programs do you offer at your nature center?
2. How did your organization choose the citizen science programs that you are implementing?
3. What are the key elements that contributed to the success of your programs?

Volunteers

4. What type of citizen science programs attract more volunteers?
5. What volunteer recruitment strategies have you found to be most successful?
6. Do you share the results of the analysis of the collected data with your volunteers?
How do you share them?
7. What strategies (rewards, incentives, recognitions) do you use to keep your volunteers engaged?

Challenges

8. What are some of the challenges you faced while designing the projects and recruiting the volunteers?

Recommendations

9. What actions (or steps) would you recommend to a nature center director looking to implement a citizen science program at their center for the first time?

Interviews were conducted online via Zoom, a video communication software. Each interview lasted anywhere from 20-60 minutes (average 30 minutes). In keeping with the IRB requirements, the researcher also asked each interviewee to give oral consent at the beginning of the interview. All interviews were conducted September 2021 through March 2022.

DATA ANALYSIS

To analyze the data collected, the researcher recorded the qualitative interviews via Zoom which automatically transcribed the interviews. To ensure confidentiality, names of all interviewees were changed on Zoom prior to the recording. The transcription text files were then downloaded and reformatted into Microsoft Word. The researcher listened to the recordings and fixed mistakes in the transcriptions, removing redundancies and filler words. This was followed by condensing the interview to reduce its length by focusing on the more salient data (Saldaña & Omasta, 2016). Copies of the files were created, re-read and important information related to the study was highlighted. The highlighted text was then copied over to a new file. Finally, the documents were imported into QSR's NVivo data analysis software, which assisted the researcher in the coding process.

Coding consists of assigning codes to words or phrases relevant to the research question. A code is a word that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language based or visual data (Saldaña, 2013). The researcher used the template analytic technique in which codes are defined before an in-depth analysis of the data (Crabtree & Miller, 1999). The coding was based on the interview questions (which are considered a priori codes) but then expanded them by re-reading the interviews and creating new codes or reorganizing the codes as needed. The result was a codebook which is included in Appendix B. The researcher selected texts from the transcript documents and assigned codes from the codebook to each segment.

CHAPTER IV: RESULTS

The purpose of this study was to discover what makes the implementation of a citizen science program in a nature center successful and the challenges involved in the process. The first three chapters of this thesis offered an introduction to citizen science, a review of the literature surrounding the implementation of citizen science programs, and the methodological design that was used for this study. This chapter presents the findings that emerged from the semi-structured interviews of nature center staff. The term “participant” will be used to refer to the interviewees.

CITIZEN SCIENCE PROGRAMS

In Chapter 2, a list of alternative names used by practitioners for the term “citizen science” was stated. The nature centers selected for this study differed in the terms used as well. The traditional term “citizen science” was used by seven of the ten nature centers. Two other nature centers used the term “citizen-based monitoring”, while only one nature center used the term “community science”.

In the interview, the first question asked was, “How many, what type and which citizen science programs do you offer at your nature center?” On average, each nature center had ten active citizen science programs at the time of the interviews. The majority of programs were wildlife related, followed by plant based and water-based programs. The nature center with the smallest number of programs had two while the center with the highest number had seventeen. (See Table 1 for numbers).

Table 1.

Citizen science programs numbers per nature center

<i>Nature center</i>	<i>Number of citizen science programs</i>
NC-5	2
NC-9	6
NC-8	7
NC-6	9
NC-4	10
NC-2	11
NC-1	12
NC-10	12
NC-7	13
NC-3	17

The citizen science programs being implemented at the participating nature centers cover a wide range of topics. The most common involved monitoring of wildlife, invasive species, and water quality. Examples of these include: Monarch Watch, Wisconsin Bat Program, Wisconsin Frog and Toad Survey, Bumblebee Brigade, Audubon Christmas Bird Count, Water Action Volunteers, Citizen Lake Monitoring Network and Snapshot Wisconsin. A comprehensive list of the programs by topic can be found in Table 2. Nearly all of these programs are monitoring based, which fall under the category of “contributory citizen science program” (Bonney et al., 2009).

Table 2.*Citizen science programs list*

Citizen Science Programs	Number of nature centers that participate in each program
Wisconsin Bat Program	6
Audubon Christmas Bird Count	4
Wisconsin Bumble Bee Brigade	4
Wisconsin Frog and Toad Survey	4
Wisconsin Monarch Larva Monitoring	4
Annual Midwest Crane Count	3
Snapshot Wisconsin	3
Turtle monitoring	3
Wisconsin Odonata Survey	3
Bluebird Box Monitoring	2
Citizen Lake Monitoring Network	2
eBird	2
Great Backyard Bird Count	2
Monarch Watch	2
Phenology monitoring	2
Purple Loosestrife Biocontrol Program	2
Small mammal monitoring	2
Snakes monitoring	2
Acoustic frog call monitoring	1
Alliance for the Great Lakes	1
Asian jumping worms survey	1
Aquatic invasive species monitoring	1
Clean Boats, Clean Waters	1
Community Collaborative Rain, Hail and Snow Network	1
Ephemeral wetland monitoring	1
Frog Watch USA	1
Fungal Diversity Project	1

Citizen Science Program	Number of nature centers that participate in each program
iNaturalist	1
Journey North	1
Kestrel Nestbox Monitoring Program	1
March bird surveys	1
Meadow Monitoring	1
Orchid Restoration Project	1
Picture Posts	1
Project Budburst	1
Project FeederWatch	1
Project Monarch Health	1
Project Riverine Early Detectors project	1
Rare plants monitoring	1
Saw-whet owl banding	1
Songbird banding	1
Sucker monitoring	1
Tree inventory	1
Water Action Volunteers	1
Wolf Howl Surveys	1
Wood Duck Box Monitoring	1

CITIZEN SCIENCE PROGRAM SELECTION

In the interview, the second question asked was “How did your organization choose the citizen science programs that you are implementing?” The main answers that emerged are found in this section. Identifying the driving motivations for choosing these specific projects is key to understanding their success.

Organizational goals

The nature centers that participated in the study have clearly defined organizational goals that are part of their mission statements. Among them are the following common goals: to conduct research in order to make decisions that will affect the stewardship of their properties, to provide educational opportunities to their visitors, and to connect to their communities through outreach efforts. When asking one of the participants about why they implemented citizen science programs at their nature center, they replied that: “It’s part of our mission, it’s research, stewardship and education” (NC-5). Another participant stated the following:

We have really good educational programming, so the citizen science really fits in well with the educational programming that we're doing. I think citizen science really meets our educational and research goals and in really nice ways. It's just been a great outreach tool for us to engage people in these ways (NC-2).

Meeting the community outreach goal of the nature center was mentioned by four out of ten participants. The quote above emphasizes that citizen science serves as an outreach tool to engage people. This reasoning is reinforced in the following quote from leadership of a different nature center:

Our county, demographically speaking, has an older demographic and a lot of adults didn't have a lot of opportunities to apply their skill sets that might be involved in natural

resources or interests that they might have, so we also were looking at ways and projects that could engage our adult community to participate in something environmentally focused (NC-10).

Another institutional objective of many of the nature centers surveyed is to carry out land management and habitat restoration. The usefulness of data collected through citizen science for management was brought up by a participant who has selected to implement a diversity of citizen science programs at once:

The main driver objective behind kind of launching this with a multitaxon focused model was that there really was little to no baseline wildlife data for our parks and greenways, and we do a lot of natural land management or habitat restoration work (NC-10).

This was the only case of a participant mentioning that they implemented several citizen science programs covering different taxa at once.

Need for conservation

Another common answer regarding the choice of which specific citizen science programs to implement pointed to addressing local issues. The areas surrounding the nature centers faced specific environmental issues that affect people, wildlife, and other natural resources. This led certain participants to implement citizen science programs related to a local conservation need. For example, the following answer was given as a reason for program selection: “The selection of lake level monitoring and aquatic invasive species monitoring, that was kind of due to need in the area” (NC-4). Some community members who live near another nature center observed negative environmental changes on their own property and wanted to find out how they could help. According to the nature center participant:

“A lot of the people that can afford those homes have had those properties for a long time, and so they’ve seen the change in their waterfronts through the years and they want to counter that change (NC-6). This quote was referring to the increase in invasive species and water quality issues.

Interest in conservation needs can also come from external sources such as media that shares information about problems that wildlife species are facing, and volunteers feel drawn to help solve or mitigate the issue. A participant reported: “We do get a lot of people that want to assist with monarch research, and I think that's because monarchs are in the news. Same with bats, people are seeing bat populations drop off, so we get a group of people that are really interested in wanting to contribute to research there (NC-1).

Collaboration/networking

The creation of new citizen science programs can also arise from more opportunistic circumstances. Participants pointed out that program selection often depends on establishing networks, such as partnerships with other organizations that share interests or goals. This is particularly beneficial when other entities can provide additional resources. For example, one participant stated: “In some cases, we've had universities or counties, or even State agencies come to us and ask us for assistance in a certain research project” (NC-6). Private organizations also depend on nature centers who have the experience and necessary volunteers to carry out a project. Another participant shared: “We were approached by the [Aquarium Name] to help participate and facilitate volunteers for a program” (NC-9).

The selection of citizen science programs also came from conferences and other networking opportunities, where professional relationships were formed that lead to sharing of experiences and ideas. For example, a participant mentioned that “Our involvement with

Snapshot Wisconsin came with connections to people at the DNR and at the University, who were involved with that project” (NC-2).

Personal interest

Nature center staff and local volunteers can vary in their fields of study and personal interests, which leads to a diverse selection of citizen science programs. During the study, a participant shared the following:

Once we started talking about wanting to do more citizen science, especially our education staff was like “well, I know about this project,” and “I would like to do that project” ... It just kept growing and growing because of the interests of the staff (NC-3).

Often, volunteers or citizen scientists are interested in a particular area of study or problem that they would like to research or help solve. When they are passionate and find a project that they would like to participate in, they can bring it to management for implementation. For example, a participant shared that: “We do have several programs that have literally been grassroots started by the volunteers. Our entire bird monitoring program, which encompasses a lot, it was 100% volunteer started” (NC-6).

Place

Place was also relevant in the selection of the citizen science programs. The code “place” appeared nineteen times in the interviews. Programs were often selected that were directly related to the resources of a site or place. For example, a participant stated that: “We do a lot of wetland monitoring. We have 19% wetlands on our property, so we have a lot of different ephemeral ponds and permanent ponds” (NC-3). Additionally, another participant shared that:

A lot of the programs were developed to be place specific, so our dragonfly monitoring program started here. The Bumblebee Brigade (we were already monitoring bumblebees

here) started when a visitor came and noticed that we had rusty patch bumblebees before they were put on the endangered species list. (NC-2)

Programs were selected because of the knowledge gain that comes from studying the place. A participant shared that: “A lot of the things that are region specific, we've done just because we want to know more. We want to implement them, so that we can learn more about the place that we all protect” (NC-9).

After exploring the diverse reasons that nature centers select citizen science programs, it is important to consider how the project will be implemented. This leads to the selection or recruitment of volunteers who will help run and/or participate in the project.

SUCCESSFUL CITIZEN SCIENCE PROGRAMS

In the interview, the third question asked was, “What are the key elements that contributed to the success of your programs?” The two main categories of responses related to staff and volunteers.

Staff involvement

Nature centers highlighted the importance of having dedicated staff to motivate and support the volunteers during their activities. One participant said:

Two things that I think have also contributed to the successes are having management that is in line and sees the value in it. Another key element with a successful citizen science program is that you as an organization have to have the time resources available to invest in communication and training with volunteers (NC-10).

Not only is the element of time important, but another participant shared that staff member passion is key:

Definitely, the passion of the project leaders and then passing that on to their volunteers. I think just having a staff that is motivated and administrative staff that's supportive of those staff members wanting to do that and having the time to be able to do that (NC-3).

This sentiment was mentioned by six of those interviewed.

Good volunteers

Volunteers are the key part of the success of any citizen science program, and this was mentioned by all ten nature centers interviewed. Without volunteers it is not possible to conduct citizen science. The following quotes are what the participants considered to be important about volunteers:

Having an engaged volunteer base. A lot of the volunteers that came in to participate in these projects, they knew they were being trained to do something serious. We told them, "We want to be able to make informed decisions about how we manage this land, we need this information, here's how you can help us accurately collect it." Even for them to see projects end when they need to end and see the final result of those things is super rewarding for them. Volunteers, not only really understanding the why and the goals behind collecting data as citizen scientists, but then seeing how it comes back full circle (NC-10).

Another aspect is who you have for volunteers, I have very dedicated volunteers who come back annually, or we find new volunteers that are excited to do the work for us (NC-1).

VOLUNTEER RECRUITMENT STRATEGIES

Recruiting volunteers to participate in citizen science programs is challenging, which is why organizations look for tried and tested strategies that will make this process more efficient. In the interview, the fourth question asked was, “What type of citizen science programs attract more volunteers?” and the fifth question asked was, “What volunteer recruitment strategies have you found to be most successful?” The following strategies seemed to be the most successful at communicating their citizen science volunteer opportunities and recruiting.

A program that appeals to volunteers

Citizen science programs that have long-term projects which allow participants ongoing opportunities to be involved with them, have flexible schedules, involve charismatic species and hands-on activities, appeal greatly to volunteers. A participant said the following:

The ones where people get to use equipment and actually handle species. Also, the projects that are flexible in terms of they can be done independently at a volunteer’s own schedule. That's why wetland monitoring is very popular. You come to two series of trainings in the spring, you're given equipment, you're given a site, and then you can conduct your surveys at your own schedule. Anything that's hands on with critters in hand, tends to be very popular and people return every year to participate (NC-10).

Word of mouth

A citizen science project in which volunteers are satisfied with their work, feel like the data they are obtaining is being put to good use, and enjoy the activity will encourage participants to share their experiences with others, helping to recruit new volunteers. A participant said the following:

Sometimes it's word of mouth, it's the volunteers sharing their information with their friends or family or posting their own stories on their social media and people saying, "Well, where do you do that? I want to be involved with that too! (NC-6).

Several other participants observed a similar phenomenon. Another approach to recruiting volunteers that was mentioned by multiple participants was to ask specific individuals to participate. They targeted repeat volunteers or people who they believed would be a good fit for the program.

Marketing strategies

Each nature center had its own communication and marketing strategies that was used to recruit volunteers. These included social media (Facebook, Twitter, and Instagram), print media (newsletters and newspapers), websites, emails, and e-newsletters. Some of the nature centers interviewed used all of these methods, while others preferred to use just one or two. A select few had enough funding to hire staff dedicated to recruiting, training, and retaining volunteers.

According to one participant:

I think social media has been a big part of our success. I think we're finding we can have stuff on our website, and I know it gets some traction, so to speak, but when we post a really great picture, or something on social media and it gives the information of how they can sign up, I think that's a good grab (NC-10).

Depending on the target demographic, some strategies work better than others. This is evidenced in the following quotes: "Print too, like honestly when we get something that's printed in the newspaper it still does definitely create a draw, especially the older demographic" (NC-10) and "I think a lot of ours is more probably from our newsletter" (NC-3). While using marketing strategies that involve non-personal communication seemed to be quite successful, those

interviewed also emphasized the importance of first-hand experience. Specifically, providing opportunities to participate in a citizen science program demonstration to directly observe what the work entails and the tools that are used.

Events

Those interviewed mentioned that participating in school fairs or community events provided an outlet to share information about the citizen science programs offered and to recruit volunteers. This allows the nature centers to showcase their projects, interact with potential volunteers, and use hands-on experiences to motivate them. Sometimes these took the form of special events at the nature center as stated by the participants below:

We had a citizen science open house. It was just a day that people could come, and we had our auditorium set up. We had booths for different citizen science programs that people could do, and we had people that led projects (NC-2).

Prior to COVID, we had a kickoff event every spring, so it would be during citizen science month in April, and we would invite people to come out and learn about the projects (NC-3).

In other cases, nature centers offered more specialized outreach programs and trainings to engage people and find enthusiastic volunteers to participate in their programs. One participant shared: “We certainly have gained volunteers from outreach programs; in August we hold a Wisconsin Master Naturalist training here. Sometimes we’ll go to a university and do career fairs and find students there that are interested” (NC-6).

Among all of those interviewed, seven mentioned relying on word of mouth, eight used marketing, and three used events.

Once a person has been recruited to become a volunteer, that doesn't imply that they are going to participate in the long term. Training each new volunteer costs resources and time, so ensuring that they stay engaged and become invested in the long term is advantageous for the nature centers. Next, we will focus on the engagement or retention strategies used by the participants in their own organizations.

VOLUNTEER ENGAGEMENT STRATEGIES

The seventh interview question asked was “What strategies (rewards, incentives, recognitions) do you use to keep your volunteers engaged?” Although some of the nature centers mentioned the need to implement or improve their volunteer engagement strategies, the organizations that had active strategies to engage and retain volunteers shared their successful techniques. The most common ones used were providing incentives, recognizing efforts, giving rewards, fostering personal relationships, and sharing the results of their efforts with the public.

Incentives

Incentives used by nature centers take on a wide variety of forms. Some are financial, like discounts at a gift shop, while others are educational, such as participating in conferences or attending lectures or webinars. The following quotes mention some of the incentives provided by nature centers: “Volunteers in general across the center get a discount at our nature store” (NC-3).

We also try to do a lot of offering continued education for the bird monitoring volunteers and I try to keep them aware of conferences or have brought in specific speakers. I have sought out other facilities that we can go to learn from them and then I drive everyone over there in our work van (no one has to pay for mileage) and I take them all out to

lunch. I try to do, it's little stuff, but I still think that those are all things that make a big difference. (NC-6)

Recognition and Rewards

Some recognition strategies used by the participants involve public acknowledgement, an award, or a token that showcases the amount of time they have dedicated to their volunteer work. For example, one participant stated: "Right now, it's just recognition. We make a slide that has all their names on it and then we thank them during the volunteer appreciation event" (NC-3). Another participant mentioned that they prefer to use a physical token to recognize their volunteers' efforts: "They get a 5-, 10-, and 15-year recognition pin or something for the length of time they've been involved in some of the projects" (NC-5).

Another strategy involves tangible rewards like providing name tags and t-shirts that can single out a volunteer and make them feel proud. A participant stated that: "A couple years ago we were getting new name tags for the staff, and I was like 'hey, why don't we have name tags for those key citizen scientists?' " (NC-6). Other rewards are at a larger scale, such as a volunteer appreciation event in the form of a picnic or barbecue. For others, getting a t-shirt with the name of the project helps them feel proud to be involved. One participant said that they give out a t-shirt at the end of each year (NC-5).

Relationship building

Six of the nature centers noted that noticed that fostering personal relationships helps keep volunteers engaged in the long term. This is accomplished by maintaining constant communication and showing a sincere interest in them. One participant shared:

I am a big fan of personal relationships when I work with volunteers. It's always like, "how's your winter been?" ... I get to know them a little bit more and build a relationship

with them, which is really helpful. Staying up to date with them by sharing the results of their surveys, but also sharing results of other people's surveys, so they can see what other people are doing. Emailing them often, saying thank you, telling them where the need is and how they could help, all those little tidbits (NC-4).

Ensuring that volunteers know they are greatly appreciated and that their work doesn't go unnoticed was also important for building relationships. For example, one participant said:

I send very frequent emails to them, thanking them for their work and doing some fun summaries of what they've seen here, highlighting what each of them has seen. We don't do incentives in material things but certainly we really focus on communication with them (NC-2).

DATA SHARING

In the interview, the questions asked regarding data sharing were: "Do you share the results of the analysis of the collected data with your volunteers?", and "How do you share them?" According to the answers, another approach to keeping volunteers engaged is by sharing the results with them to show that all their hard work is meaningful. This is exemplified in the quotation below:

We do put out an annual or biannual report that kind of shows here's what was done this year, here are the notable findings, here's how that information was used. We implemented this prairie restoration at this site because you helped us document rusty-patched bumble bee. That helps the great retention of volunteers, when they see how that information is used and how it impacts those local green spaces that they have in their community (NC-10).

Among all those interviewed, five mentioned using material rewards, five recognition of volunteers, six relationship building, and eight data sharing.

A couple participants mentioned that they were working on improving how to share the analyzed data from their programs, and one stated that their focus was more on providing the volunteer with experience.

I don't have the time for that [sharing of results]. The volunteers know that they can access the data and it can always be shared with them, but I would like us to be better about just always giving that information out to them (NC-6).

CHALLENGES

In the interview, the eighth question asked was, "What are some of the challenges you faced while designing the projects and recruiting the volunteers?" Nature center participants identified numerous challenges that they faced when implementing citizen science programs. These included ensuring the quality of data being collected, finding funding, staff resources, volunteer recruitment and engagement, and implementing the projects.

Funding

Some of the more established nature centers have already included citizen science programs and needed resources into their annual operational budgets. Other centers, however, stated that funding is a major challenge. A small staff may not have the time to include additional tasks in their workload without being fairly compensated for their extra work. One participant stated:

The other thing that is a really big problem is funding; it's really tough to find funding for citizen science projects. So to buy equipment that we need to do that monitoring or just to

fund staff time to do the monitoring, it's really tough to find funding for that. I think that's probably our biggest challenge (NC-4).

Volunteer recruitment and retention

Several of the participants stated that volunteer recruitment and retention is a particularly important challenge that they face, as noted below:

It's hard to keep volunteers in the long term. People sometimes lose interest a little bit. If they're doing a monitoring project, where you don't see results immediately, it's hard for people to stay interested in that long term (NC-4).

Not only is it hard to retain volunteers, but it is also challenging to recruit new people. A participant shared that: "Recruiting is tough. You hope you get somebody to replace the one that has retired or moved away." (NC-5).

Data quality, consistency and sharing

Several participants shared the challenge of ensuring that volunteers collect and record data using the designated protocols. A participant stated:

I think one of the biggest challenges is making sure that your volunteers know the data that they're collecting, know how to record it properly. You have to be careful with that data. There's a reason it's citizen science, you know we're pulling people who don't have the background or the knowledge that we might have (NC-1).

Another participant pointed out that there is a lack of consistency and data sharing when it comes to locally based projects:

I'm trained as a scientist, so I think that it's not useful if we have so many projects and people really aren't sharing the data across. It's really not that useful to our understanding

of organisms if we don't share, so I think diffusion has become kind of a problem. While I'm all for locally based projects, I think we should also think about monitoring things on a broad scale and sharing the data broadly and using consistent message methods so that analyses are easier. There's certainly people trying to do that, but it just becomes difficult to come to conclusions when, for example, the spatial accuracy of sightings is so variable across projects (NC-2).

Project implementation

When determining projects to implement, the participants identified that it always comes down to a question of whether to choose an established project or create a new one from scratch.

One participant shared:

One of the biggest challenges is the implementation of new projects. You need a champion to implement some of those new projects, and if we don't have that, you don't really get the recruitment, so they kind of die off (NC-9).

Access

One participant commented on how the location of the nature center and the lack of public transportation leading to it made it difficult at times for volunteers to help.

My boss's dream is to have public transportation that makes a trip out here every other week or something. To bring some of those people in because we do feel that that is something that really hinders us here (NC-6).

RECOMMENDATIONS FOR STARTING CITIZEN SCIENCE PROGRAMS AT A NATURE CENTER

In the interview, the ninth question asked was, “What actions (or steps) would you recommend to a nature center director looking to implement a citizen science program at their center for the first time?” They provided the following recommendations: have a clear understanding of the goals and reasoning behind the implementation of each program, make sure there is enough funding to cover necessary purchases and staff support, and choose existing citizen science programs to implement.

Goal clarity

Defining clear goals and objectives for implementing a citizen science program was important to most participants:

Do your homework, know the why. Have a very, very clear why you would even want to do it, not only to get management and upper leadership to be supportive of it, but so that you define out very clear goals and objectives as to why you’re doing it (NC-10).

Funding

As funding was a challenge faced by many participants, it is reasonable that it was an important recommendation to consider before starting a citizen science program:

Many citizen science programs are run out of nature centers or nonprofits like us, so it’s important to assess those programs and see which will be financially feasible for you to run for a long time, or how you will support it. There’s a lot of projects that don’t require much, so you’ve got to find projects that you can sustain (staff and finances) and that is going to be of interest to your community (NC-6).

Choosing programming

When it comes down to choosing the programs to implement at a nature center, it is preferable to use popular programs that can be adapted easily to the site, instead of trying to create new ones from scratch:

The biggest thing would be to participate in well-established citizen science projects.

Work with a group that has a network that can be a resource for implementing that citizen science (NC-9).

The participants also recommended to start small with one project per season and then adding more as time progresses. The first project should be something that really catches the attention of possible volunteers:

I would say start with one that's kind of flashy that a lot of people enjoy. Start with something easy, start with something kind of flashy that grabs a lot of attention and then build it up from there (NC-4).

Also, for the citizen science efforts to be successful, it is preferable that the chosen programs have certified data collection protocols that make results easier to compare with other locations nationally and internationally. This has a greater impact in the scientific world:

Having a whole bunch of people developing their own programs doesn't help us understand the natural world, and I think that that's kind of what we should be getting out of citizen science is engaging people with the natural world but also understanding it.

Don't try to reinvent wheels (NC-2).

Most agreed that it is better to choose programs that are already established. As a participant noted: "...Google searching or state searching what projects are already available. There's no

sense in reinventing the wheel and establishing a project where you have to do all the legwork, when it's already done and it's already existing (NC-1).”

Finally, as previously stated in the “Successful citizen science programs” section, the participants reiterated that having good nature center staff and volunteers makes a big difference. Citizen science programs take a lot of time and energy, as evidenced by a participant below:

For anyone looking to start this, understand that it is a time commitment beyond just the initial recruitment and training of people. There are going to be a lot of questions of whoever's running the program, especially in the beginning and that's where you start to lose volunteers and their interest really quickly. Because if they don't feel invested in, beyond coming to this orientation and signing up and saying “yeah, I want to help.” If they don't feel that you're investing the time and responding to them, or meeting their needs, they will drop off (NC-10).

CHAPTER V: DISCUSSION AND CONCLUSION

The purpose of this research was to discover what makes the implementation of a citizen science program in a nature center successful and the challenges involved in the process. Chapter 4 provided the results obtained from the interviews of nature center staff. This chapter will interpret and discuss the value of the findings, while offering recommendations for nature centers and for further research.

INTERPRETING THE RESULTS

Although there is a lot of discussion on the use of the term “citizen science”, most of the nature centers interviewed continue to use it. This coincides with the Eitzel et al. (2017) study that found that terms such as “public participatory scientific research” (PPSR) have proven to be difficult to use and have gained less traction compared with the already established “citizen science.” One of the nature centers did use the term “community science,” which Ballard et al. (2016) indicate is a recent term intended to be more accessible while serving the same umbrella purpose as PPSR.

Citizen science is unique in that it provides opportunities to align scientific inquiry with opportunities to learn about science and environmental issues. While citizen science goals include the scientific goal of generating new knowledge, educational and citizen empowerment goals are also key aims to many projects (Turrini et al., 2018). When asked about the type of citizen science programs they were implementing (referring to the classification due to the level of public involvement), nature center staff did not differentiate between them. Reviewing the program list, most appear to be contributory citizen science programs. These types of programs involve the volunteers contributing only to the data collection part of the process. A reason for

involving citizen scientists in data-collection only projects is that the programs are easier to design and conduct (Turrini et al., 2018). Contributory citizen science programs feature larger participant numbers and large spatial and temporal coverage. The advantage is that they tend to produce data that is highly utilized and disseminated in peer-reviewed publications (Ballard et al., 2018).

The success and the challenges faced by a nature center when implementing citizen science programs at their sites vary from place to place. Not all nature centers have the same mission or goals, nor the same financial or support resources. Even the surrounding communities in which nature centers are found can vary. However, the results of this study show that the participating nature centers overlapped in many areas.

The first research question of this study was, what makes the implementation of a citizen science program in a nature center successful? To answer this, participants were asked multiple questions. According to the results, participants attribute the success of citizen science programs mainly to the level of involvement, enthusiasm, and interest of both the staff who run them as well as the quality of the volunteers or citizen scientists who choose to participate in them. Both staff and volunteers are the ones who select the programs that are implemented and who ultimately do the work. To be successful, an effort must be made to recruit and retain volunteers for as long as possible. It is recommended to use all possible recruitment strategies that are addressed in the results (print media, social media, word of mouth, events, asking directly, and providing hands on experiences). Some of these might be more costly and time consuming than others but will likely increase the chance of success. The strategies recommended by the participants coincide with those mentioned by Goad et al. (2020). Although going door-to-door

might not be possible for most centers, neighborhood recruitment efforts such as print, audio, and online media to advertise projects could be beneficial.

For the programs to succeed, not only is it important to find committed volunteers but it is best to retain participants as long as possible. To keep volunteers engaged in the long-term, results showed that sharing the analyzed data collected by them helps keep them engaged, as it shows the significance of their activity. This finding coincides with de Vries et al. (2019) who found that participants value communication of their collected data, findings of the project, and publications. Alender (2016) also noted that volunteers find communication of results very rewarding, even more so than receiving recognition for their efforts. Still, making the effort of thanking the volunteers personally or by email, recognizing them publicly, or providing them with incentives and rewards could encourage them to remain in the programs and even help get more recruits in the future, as “word of mouth” was the most mentioned recruitment strategy.

The data sharing strategies would seem to appeal to “autonomous intrinsic motivation” as classified by Deci and Ryan (2000), since citizen scientists are voluntarily choosing to participate in these programs largely due to their own interests. Therefore, targeting this type of motivation could increase engagement and retention of volunteers. However, strategies that involve rewards and recognition that fall under “autonomous extrinsic motivation” might appeal to some volunteers. Consequently, including recruitment and engagement strategies that cover as many different types of motivators as possible should increase participation.

The second research question was, what are the challenges involved in the process of implementing citizen science programs? Knowing the challenges that nature centers face can help other organizations address them before they become issues, saving time, energy, and even money. The identified challenges involve either the volunteers or the nature center itself. For the

volunteer aspect, challenges include recruitment and retention and ensuring their work is done properly so that the data can be used purposefully. Of special interest is the challenge of recruiting volunteers, especially considering that most volunteers are older adults and often retired. Nature centers struggle with finding younger people who are committed and have the time to invest in these projects. Multiple efforts to address this issue involve targeted recruitment and engagement strategies. Kobori et al. (2016) identified this challenge as well and recommended that to foster the participation of younger people, citizen science activities must meet their needs and pique their interests. They suggest a possible solution could be through collaboration with universities so that students can participate in citizen science projects as part of their coursework. To target even younger participants, connecting primary, intermediate and secondary schools to incorporate citizen science would be beneficial.

Focusing on recruiting volunteers and not how to retain them is also a challenge. Chu et al. (2012) argue that volunteer retention is equally important as recruitment because long-term data have the greatest scientific value. They view the recruiting new participants as the beginning of a cycle that involves creating materials to welcome and continue to engage them over time, and suggest the methods identified in this study such as providing print and digital publications that share news and results of the data that the volunteers have contributed to.

Another aspect to consider is that volunteers are generally not trained scientists and therefore an effort must be made to ensure that they always collect and record data properly, not just when they are directly supervised. Mitchell et al., (2017) found that engaging citizen scientists in the assessment of data quality and in analyzing the data can be effective methods to validate data sets and improve scientific literacy. This improves the quality of future data they submit.

Another challenge is obtaining the necessary human and financial resources to support citizen science programs. This includes having the necessary staff to lead programs, money to pay the staff, and the time to allocate to the position, especially when a nature center has a small staff. Funding is also required to buy equipment and materials needed to support the projects and volunteers. Blair et al. (2018) identified these same resource scarcities challenges and mentioned that most funding sources for citizen science are short-term, which prevents long-term sustainability. This is where networking and collaborating with others is useful, as resources can be shared between groups and partners, or donors can be found to help support the programs.

Almost all the citizen science programs that are being implemented at the nature centers used in this study are place-based. Long (2019) argues that projects are typically place-specific and local because they need to meet community members where they are geographically. Additionally, it helps address place-specific scientific questions and spreads the information generated by the project into the community, thereby strengthening it.

One of the participants stated that some of their volunteers got involved in citizen science through personal experience with environmental issues in their community. This coincides with van Noordwijk et al. (2021) who argue that place-based community projects are generally focused on improving the environment in a specific area with participation from the local community. Volunteers typically join the project through an attachment to their place and/or potential benefits to their personal life. Toomey et al. (2020) explored the links between participation in a place-based citizen science project and sense of place, and their results suggest that participation in the project had the potential to deepen existing place attachment. Similarly, Haywood (2016) found that participants in a citizen science project articulated a deepened sense of place arising out of their regular participation.

The websites of the participant nature centers state the diverse missions and goals they have, but education, stewardship, conservation, and connecting people to nature at their sites are among the common threads. The importance of using citizen science to meet the goals of the nature centers by selecting place-based programming was mentioned by several of the participants. Browning et al. (2018) suggest that providing a diverse suite of programs that fit squarely within the missions of nature centers can elicit community support.

REVIEW OF METHODS

Semi-structured interviews were conducted to collect qualitative data to explore the successes and challenges that nature center staff experienced when implementing citizen science programs at their sites. The sample of 10 nature centers was relatively small and those nature centers were chosen because they are known to have successful citizen science programs. These results cannot be generalized to apply to all nature centers.

The interviews took place online as opposed to in-person given the circumstances faced during the COVID-19 pandemic. This allowed for the use of a computer software that served as both the interview medium and the transcription service. The researcher had access to the video recording, audio recording, and transcription of the interviews almost instantaneously. Despite this, the researcher found it necessary to listen to the recordings a second time and fix the transcriptions, since the wording and speaker was not always completely accurate.

The data were coded and themes were identified by only the researcher and the analysis was then discussed with the graduate advisor. Although this process allowed for consistency, it failed to provide multiple perspectives from people with different expertise. Involving more people in coding the data could expand the range of the data analysis and remove subjectivity.

IMPLICATIONS FOR RESEARCH AND RECOMMENDATIONS

The first recommendation for nature center staff interested in implementing citizen science programs is to reach out to people who have gone through the experience and ask for help. Everyone who was interviewed was more than happy to talk about their experiences and offer support to others who might need it. A more exhaustive list of recommendations can be found in Figure 2.

Multiple areas of study could be explored through further research. To have a more comprehensive view of the implementation of citizen science in nature centers, it would be beneficial to conduct a study from the volunteer perspective, in addition to the staff perspective. Although numerous studies have been made about volunteer motivation in a range of fields, including citizen science, none have focused on citizen science volunteers in nature centers specifically. It would be particularly interesting to see if staff perceptions match those of the volunteers.

Additional areas of study could include evaluating the success of individual programs at each center and their impact on the nature center, in the community, and on conservation or environmental action efforts. It would also be useful to study the feasibility of developing a state-wide group that could connect nature center staff and provide support to help implement programs, standardize data collection, and secure funding.

Figure 2

List of recommendations for nature center staff.

**RECOMMENDATIONS FOR IMPLEMENTING
CITIZEN SCIENCE
IN NATURE CENTERS**
BY STEPHANIE SOMERVILLE ZAMORA

Planning on using citizen science at your nature center? Follow these recommendations from experienced nature center staff to successfully implement your programs.

- 1 Define mission and goals that can be supported by citizen science programs.
- 2 Talk to nature center staff that have existing citizen science programs.
- 3 Choose established citizen science programs.
- 4 Connect the citizen science programs to local conservation issues.
- 5 Choose one, simple and exciting citizen science program to start and gauge interest.
- 6 Determine resources needed to implement programs.
- 7 Involve staff that are passionate about citizen science and can motivate the volunteers.
- 8 Create a recruitment package that includes word of mouth, media marketing strategies and events.
- 9 Develop a volunteer engagement strategy that includes incentives, recognitions, rewards and sharing the analyzed data.
- 10 Evaluate the success of the programs.

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Appendices

Appendix A: Interview Informed Consent Form

Informed Consent to Participate in Human Subjects Research

Dr. Kendra Liddicoat and Stephanie Somerville, a professor and graduate student at the University of Wisconsin-Stevens Point would appreciate your participation in a research study designed to explore what makes implementing a citizen science project at a nature center successful and what motivates people to volunteer in place-based citizen science programs in their local nature centers. You are being asked to complete an interview online via Zoom that should take up no more than one hour of your time. Your participation is completely voluntary. The benefit of this study is a greater knowledge about the successful implementation of citizen science programs in nature centers.

We anticipate no risk to you as a result of your participation in this study other than the inconvenience of the time to complete the interview. You could, however, experience some discomfort if you have had an uncomfortable interaction during a citizen science program and your completing the interview causes you to remember this.

While there may be no immediate benefit to you as a result of your participation in this study, it is hoped that we may gain valuable information about citizen science programs that will be of value to other citizen science practitioners at nature centers.

While this information could be obtained by having you fill a survey, an interview is the best method to obtain greater depth about the subject. You may also choose not to participate as an alternative.

The information that you give us during the interview will be recorded. We will not release information that could identify you. All recorded interviews and transcriptions will be stored on a password protected computer and will not be available to anyone not directly involved in this study.

Your participation is completely voluntary. If you want to withdraw from the study, at any time, you may do so without penalty. Only anonymous information provided will be retained. All identifiable information will be removed from the study and destroyed or deleted.

Once the study is complete, you may receive the results of the study. If you would like these results, or if you have any questions in the meantime, please contact:

Stephanie Somerville
Schmeckle Reserve
University of Wisconsin – Stevens Point
715-342-4406 | ssomervi@uwsp.edu

If you have any complaints about your treatment as a participant in this study or believe that you have been harmed in some way by your participation, please call or write:

David Barry, PhD
IRB Chair
Associate Professor, Sociology
2100 Main St.
Old Main 208
University of Wisconsin, Stevens Point and Extension
Stevens Point, WI 54481
715-346-3799
irb@uwsp.edu

Although Dr. Barry will ask your name, all complaints are kept in confidence.
Proceeding with the interview represents consent to participate in the study and have your responses recorded.

Appendix B: Codebook used for qualitative analysis

Topic	Definition of each topic	Code	# of times code was referenced
Engagement	Statements that describe the actions that the nature center staff did to ensure long-term participant engagement and retention	Recognition and rewards	11
		Relationship building	8
		Meaningful work - satisfaction	7
		Incentives	4
		Need for engagement strategies	3
Program Selection	Statements that mention the reasons why a citizen science program was selected to be implement at a nature center	Volunteer interest	9
		Staff interest	6
		Collaboration-Networking	5
		Organization goals	5
		Conservation need	3
Recruitment	Statements that describe how the nature centers recruited volunteers for their citizen science programs	Word of mouth	8
		Social media	7
		Fairs	3
		Website	3
		Newsletters	3
		Print media	1
		Direct ask	1
		Hands on experiences	1
Challenges	Statements that describe the challenges involved in implementing citizen science programs in nature centers	Funding	8
		Age	4
		Data collection quality	4
		Long-term engagement	3
		Staff resources	2
		Data diffusion	1
		Access to location	1
		New projects	1
		Staff gender and age bias	1
Data sharing	Statements that describe how analyzed data was shared with citizen scientists	Emails	7
		Website	4
		Working on sharing data	3
		Newsletters	2
		On-site displays	1
		Social Media	1
		Media	1
Place	Statements that refer to place	Place	19

Topic	Definition of each topic	Code	# of times code was referenced
Program success	Statements that mention why the nature center staff thought a citizen science program was successful	Volunteer engagement	10
		Staff involvement	6
		Media influence	1
		Results	1
Advice	Statements that mention recommendations for first time citizen science implementation in a nature center	Don't reinvent the wheel	4
		Staff	3
		Goal clarity	2
		Single project	2
		Volunteers	1
		Fun-interesting	1