



Hiking Acadia: Incorporating Citizen Science Programming into Acadia National Park

An Interactive Qualifying Project Report
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by:

Carlee E. Irish

Billy Mitchell

Leo Quick

Shea Sullivan

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Professor Frederick W. Bianchi

Abstract

The purpose of this project was for the Worcester Polytechnic Institute 2018 Citizen Science Team to incorporate a way of increasing citizen science within Acadia National Park. Citizen science helps to bridge the gap between scientists and volunteer citizens, as well as create an opportunity to increase informal learning within the park. The team found that using the already established social media platform of iNaturalist was the best platform to use as an introductory citizen science program. The team created an umbrella project for the entire National Park in order include the 26 peaks within the park and establish boundaries within iNaturalist. The project is meant to track the increase in iNaturalist participants, as well as log the vast biodiversity that occurs on Acadia's mountain trails.

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Executive Summary

In this day and age, it is an everyday concern of how our actions, as a society, affect the world we live in. Scientists around the globe are continuously doing research and collecting data on nature and how it has been changing over time. This is where citizen science becomes an exceptionally useful tool. Scientists themselves could never collect all the data they need for their research, instead citizen science allows the general public to collect and analyze data from the natural world for specific projects. This not only allows everyday people who are interested in science and the natural community around them a chance to become involved, but it also gives professional scientists and researchers loads of analyzed data to further their studies. Citizen science projects can be found almost anywhere but especially in national parks. Acadia National Park is not exception to this. With 26 peaks and over 120 miles of hiking trails, Acadia National Park has hosted its' share of citizen science projects, from different teaching workshops to BioBlitz's run by Schoodic Institute and even certain ranger led tours.

Project Goal and Objectives

First and foremost, our overall project goal was to enhance the visitor experience, specifically through the use of online citizen science programming. This programming allows visitors to collect data for professional scientists and become involved in the nature around them. To make this an achievable task for tourists and nature enthusiasts, several online platforms were explored until our team found iNaturalist to be the best fitting resource for our project. From there, our project primarily became two major phases, creating citizen science activities in iNaturalist and then marketing these activities to the public. With this, other primary objectives for this project also included:

- increasing the use/interest of informal learning
- developing more of a social media aspect for those interested in science and nature through the online portion of our project
- making the information collected useful to researchers and scientists
- giving visitors a pre-planned activity to further enhance their park experience
- suggesting activities located on the quieter side of the island as to help reduce congestion in the more popular areas of the park

Methodology

The goal of the 2018 Worcester Polytechnic Institute Citizen Science team was find a solution that would incorporate each of these objectives while also focusing on the main project goal of enhancing visitor experience with online citizen science programs. Our team set up and implemented our citizen science activities over the course of seven weeks, ranging from June 17th to August 4th, within Acadia National Park. Prior to our arrival to Acadia, our team researched and analyzed the various citizen science platforms that were already established. Of the existing platforms, the team chose to use iNaturalist (iNaturalist, *iNaturalist.com*) to meet our project goals, along with the following research objectives:

1. *Adventure Criteria and Location Identification/Selection*
2. *Implementing Citizen Science Activities*
3. *Introducing Our Citizen Science Adventures to Acadia*
4. *Test the Success of Adventures & Implementation of Citizen Science*
5. *Publishing Adventure Models/Citizen Science Activities Online*

iNaturalist is a citizen science program that allows for people to connect all across the world to share the various observations that they make on their hikes. The team also chose iNaturalist because it allows the user to create projects and set specific boundaries for different trails. The team then researched and decided before arriving to Acadia which trails they were going to cover and choose to implement into their citizen science adventures. The trails were picked based on difficulty level, in order to provide a wide range of choices for the citizen volunteers to be able to choose from.

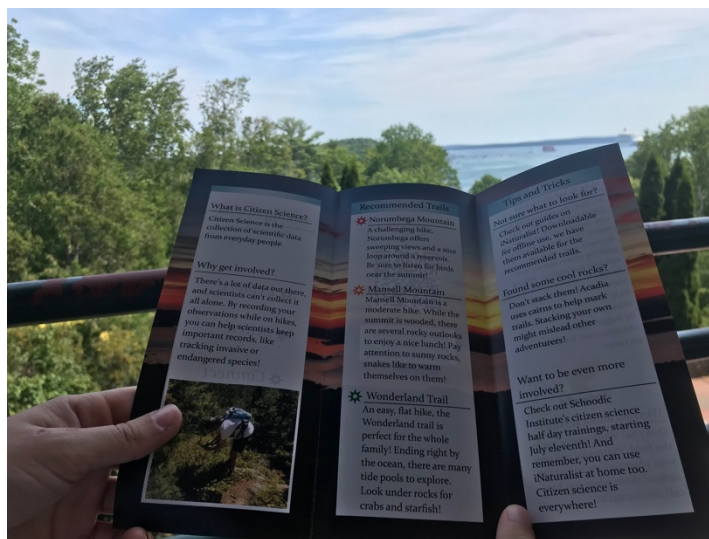


Figure 1: Visual of Brochure

Project Results

After establishing our methodology for carrying out our project, we then went on to follow our methodology. Our team found that we were able to implement the citizen science into the three original trails very well. iNaturalist allowed us to create boundaries of the trails so that they could be their own collection projects. We were able to test these three original trails with our fellow classmates and found that they enjoyed using iNaturalist on these trails. We then found that we could expand the entire umbrella project to cover all of Acadia National Park's 26 mountain peaks. We made each peak an individual collection project that lived under the Hiking Acadia Citizen Science umbrella project. Our team then went on to learn more about how to introduce citizen science to the public and how to hold an informational session on instructing iNaturalist. For example, we went to the Schoodic Institute citizen science training where we learned a lot about how to structure a training session. From this we had many takeaways in terms of what we liked, didn't like, and how we would structure our own sessions. We also went on a ranger led botany walk in which we realized a citizen science training session could easily be incorporated.

Our focus then shifted to the marketing of our citizen science project. We created pamphlets that would help to inform the public of the opportunity to go out into the park and use iNaturalist as a fun, informational tool. We then distributed these pamphlets throughout downtown at different visitor centers. Following the initial distribution of the pamphlets, we then tracked the number of iNaturalist users on our umbrella project and found that the number of observers on our project went up, proving our pamphlets to be effective.

Recommendations

After completing our implementation of citizen science into the national park, and finishing up our seven weeks, we were able to come up with some recommendations. Our group came up with four main recommendations to help continue implementing iNaturalist into the park, which are as follows:

1. Continue marketing iNaturalist throughout the park. Our team was only able to focus on the marketing aspect of our project for a short period of time. In that short period of time we saw an increase in observers, so we believe with more time spent on marketing, the number of users can increase drastically over time.

2. Use the ranger led tours as a way to teach people about citizen science. The ranger led tours could be a great opportunity to get people comfortable with using the various citizen science platforms and get them started on going out and making their own observations within the park.
3. Implement the other citizen science platforms into the National Park. Along with iNaturalist, Map of life, eBird, and Nature's Notebook are all great citizen science platforms. They all have their own strengths and could all be utilized as great platforms.
4. Continue working on this project with future WPI groups. If another WPI group were to work on this project, then they could focus on the marketing aspect and help to increase the citizen science involvement in their own creative way.



Figure 2: iNaturalist Logo

Chapter 1: Introduction

Citizen science is a method of informal scientific education, where members of the general public collect scientific data for professional scientists. This provides a method for citizens to become involved with the natural world and develop a deeper understanding of the impact science has on their lives. Multiple citizen science programs have been developed for Acadia National Park by Friends of Acadia and the Schoodic Institute.

Friends of Acadia is a nonprofit organization that promotes citizen stewardship of Acadia National Park (Friends of Acadia, <https://friendsofacadia.org/>). Working with the park, Friends of Acadia have developed various citizen science models, including Technology Team and Acadia Quest (Acadia Quest, <https://friendsofacadia.org/events/acadia-quest/>). Both projects are aimed at getting younger generations involved in citizen science.

Schoodic Institute is another nonprofit partner of the park, whose mission is to promote education and research at Acadia National Park (Schoodic Institute, <https://www.schoodicinstitute.org/>). One of their most successful citizen science models is the annual BioBlitz. Each summer for one weekend, visitors are encouraged to document arthropod species (Schoodic Institute, <https://www.schoodicinstitute.org/>). In recent years, this documentation has taken place on iNaturalist, an online social network for observation and species identification.

Though Friends of Acadia and Schoodic Institute have had success getting a number of visitors involved, they have not been effective at encouraging participants to remain involved after the program has ended. Our research is focused on engaging visitors with scientific projects, and generating an interest in science that continues after visitors leave the park. Making citizen science activities readily available, by using technology for implementation, makes visitors more likely to participate (Birkett, 2018). Online platforms make connections between visitors by providing a place to post and view scientific observations, as well as interact with people across the globe.

Another issue that previous citizen science programs have failed to address is overcrowding. Spanning 49,000 acres, Acadia National Park is visited by roughly 2.5 million people each year (*Foundation Document for Acadia National Park*, 2016). The park has many popular destinations, including Cadillac Mountain, Thunder Hole, and the Park Loop Road, a 27-mile loop leading to many well-known hiking trails (*Foundation Document for Acadia National*

Park, 2016). Implementing citizen science programming in less well known areas may help to relieve the heavy visitor congestion by providing interesting activities in less crowded areas.

Chapter 2: Background

Acadia National Park's main goal is to provide a meaningful and positive experience to its visitors. As technology advances, the park wants to take advantage of new social media platforms to benefit visitors' overall experiences associated with the park. This is because Acadia is interested in continuing to interact with visitors after they leave the park, as well as increasing the general scientific literacy of the populace. In order to do this, Acadia has begun to look at citizen science programming. Citizen science will help to fulfill this dual purpose, especially through the use of electronic platforms.

2.1: Acadia National Park

Acadia National Park was established in 1916 as one of the many parks Woodrow Wilson founded in his effort to preserve and maintain our country's natural wonders. Specifically, Acadia was uniquely formed through the "vision and donations" of private citizens like George B. Dorr and Charles W. Eliot who "anticipated the dangers that over-development would bring to this coastal wonderland" (Hartford, 2001). Today, Acadia is located on 49,000 acres (35,332 acres owned by the National Park Service and 12,416 acres privately owned) within Desert Island and Schoodic Peninsula. Acadia, known for its vastly diverse attraction sites ranging from beaches to high peaks and dramatic cliffs, is one of the top ten most visited national parks in America with over 2.5 million visitors in the past year (Acadia National Park, <https://www.nps.gov/acad/index.html>)

2.1.1: Mission Statement and Message

The mission of Acadia National Park is to protect "ecological integrity, cultural history, scenic beauty, and scientific values within the Acadia archipelago and Schoodic Peninsula" and offers visitors "a broad range of transformative and inspiring experiences among the park's diverse habitats, glacially sculpted mountains, and bold, rocky coastline" (*Foundation Document for Acadia National Park*, 2016). Indeed, a crucial goal of the organization is to further any and all research possibilities that its land covers. However, Acadia's main focus/goal is that of its visitors and their overall experience which is evident through their core values of "shared stewardship, excellence, integrity, tradition, and respect" (*Foundation Document for Acadia National Park*, 2016). As we developed projects that aimed to improve the park as a whole, it was important to maintain these values.

2.1.2: Partnerships

The 49,000 acres of Acadia National Park has many different attractions and events throughout the year that are aimed to further the interests of science and nature to its visitors for future generations. The National Park Service partners with several outside entities in order to better manage the many tasks that go into maintaining a national park (*Foundation Document for Acadia National Park*, 2016).

The first of these organizations is Schoodic Institute, located on the Schoodic Peninsula. Acting as the primary educational resource partner, Schoodic “helps achieve the original vision for Acadia National Park as a destination for science and as an inspiration for further conservation” (Schoodic Institute at Acadia National Park, <https://www.schoodicinstitute.org/>). Schoodic’s primary role in this unique partnership is to create, lead, and facilitate research goals and excursions while Acadia provides the land and supplementary resources required for said research. Schoodic’s close proximity to Acadia allows for “research and life-long learning opportunities within one of the world’s great natural laboratories” (Schoodic Institute at Acadia National Park, <https://www.schoodicinstitute.org/>).

Perhaps one of Acadia’s most prominent and important partnerships is with Friends of Acadia. Their mission, similar to Acadia’s, is to “preserve, protect, and promote stewardship of the outstanding natural beauty, ecological vitality, and distinctive cultural resources of Acadia National Park and surrounding communities for the inspiration and enjoyment of current and future generations” (Friends of Acadia Journal, <https://friendsofacadia.org/>). Their aim is to “identify places and projects where FOA’s effective mix of private philanthropy, volunteerism, innovative leadership, and strong partnerships will most benefit the park’s critical needs” (Friends of Acadia Journal, <https://friendsofacadia.org/news-publications/friends-of-acadia-journal/>). To achieve this, FOA has four main programs of focus: Wild Acadia, Tomorrow’s Stewards, The Acadia Experience, and Trail and Carriage Roads (Friends of Acadia Journal, <https://friendsofacadia.org/>).

Maintaining an awareness of the partnerships Acadia currently holds was vital to the success of our project. These partnerships were of great use as we built and promoted different areas, activities, and programs that are run/funded by these separate partnerships, especially as we looked to incorporate their pre-existing programming into our project.

2.1.3: Acadia Education

As previously mentioned, one of Acadia's main goals is to educate. They look to inspire, inform, and teach visitors about the environment and natural wonders the park holds. To do so, Acadia and their partnerships with Schoodic and Friends of Acadia have programs already in place to help educate visitors. The programs, ordered by partnership and program, are as follows:

1. **Schoodic:** Aims to advance ecosystem science and learning for all ages through a unique partnership with Acadia National Park
 - a. **Bioblitz** - a signature citizen science program for Schoodic Institute at Acadia National Park. During BioBlitz, huge numbers of arthropod species are documented, many never having been previously observed at Acadia National Park. (Schoodic Institute at Acadia National Park.)
2. **Friends of Acadia**
 - a. **Acadia Quest:** a series of outdoor experiences in Acadia National Park that encourage youth to explore, learn, and protect national parks and other conserved lands. 2018 marks the 11th year with the Acadia Quest: Pathmakers Edition (Friends of Acadia, <https://friendsofacadia.org/>), which focuses on Acadia's historic trails and the people who maintain them. The team activities this year will be chosen by featured trail crews. The challenges are designed to appeal to all ages. A Speed Quest (Friends of Acadia, <https://friendsofacadia.org/events/acadia-quest/>) is also offered, which is designed for visitors who are in Acadia for as little as three days.
 - b. **Conservation corps:** (AYCC) employs 16 high school students and four Acadia National Park leaders for eight weeks each summer. FOA provides the salaries and equipment, while the park provides leadership and training. In 1999, the AYCC program was endowed by an anonymous gift to Friends of Acadia. (Friends of Acadia, <https://friendsofacadia.org/what-we-do/tomorrows-stewards/aycc/>)
 - c. **Technology Team:** Friends of Acadia has partnered with the park to hire and equip a team of teenagers and their college-age leaders with iPads, apps, and other

digital tools and send them outdoors in Acadia to explore how youth might use technology to engage with the park and with nature. (Friends of Acadia, <https://friendsofacadia.org/what-we-do/tomorrows-stewards/acadia-youth-technology-team/>)

2.1.4: Areas of Concern within the Park

Each year, many problems arise within the park due to large numbers of visitors. Mainly, the park struggles with heavy traffic congestion, especially around popular sites on Mount Desert Island (Acadia National Park, <https://www.nps.gov/acad/index.html>) Increased visitor traffic decreases the visitor experience due to vehicle congestion. The park is very invested in trying to get tourists interested in visiting a wider array of locations. This would help to reduce the heavy congestion that occurs in the popular locations such as Cadillac Mountain, Jordan Pond, and other popular locations of the park (*Foundation Document for Acadia National Park*, 2016).

Another issue that the park is interested in is documenting the non-native invasive species in the park (*Foundation Document for Acadia National Park*, 2016). The park has issues with invasive species causing harm to the native species. Finding out where the invasive species are appearing and the quantity in which they are occurring can help the park to find a solution to their problem.

The park is also experiencing increased levels of rock art through cairns and graffiti. Rock cairns are used to help hikers to stay on the trail paths and can provide them with a tool to use if they were to get lost in the park. However, some visitors build errant rock cairns. This could contribute to confusion with trail markers, as well as disturbing the natural beauty of the park. Similarly, there has been an uptick in rock graffiti in Acadia, in the form of spray painted messages on boulders. This also disrupts the natural beauty, and may be harmful to the environment. Citizen science can help educate people on what rock cairns are, and emphasize the importance of keeping the trails in pristine condition (*Foundation Document for Acadia National Park*, 2016).

2.2: Introduction to Citizen Science

Citizen science is a method of gathering data by utilizing citizen volunteers. It has been compared to crowdsourcing. It gives the public the ability to assist scientists by providing a wide source of information, that would be difficult to gather without volunteers. Citizen Science

programs also “create a bi-directional flow of knowledge between scientists and citizen volunteers; this flow democratizes science in order to create an informed public” (Fischer, 2017). Participation in citizen science enhances learning and understanding the role of scientific research.

2.2.1: History of Citizen Science

Many years ago, most scientists made their living under a different profession and conducted research as a hobby (Silvertown, 2009). These were the first citizen scientists, people who had a passion for science and recorded their observations of the natural world. The oldest continuous citizen science project is the Christmas Bird Count, which was started in the 1900s, and has helped to track migratory patterns of many bird species (National Audubon Society, <http://www.audubon.org/conservation/history-christmas-bird-county>). The Christmas Bird Count has helped connect bird-watchers, also known as ornithologists, from all over the world. Today, there are many groups that aid in data collection for global citizen science projects, including eBird, iNaturalist, and the Cornell Lab of Ornithology. These websites allow people from all over the globe to report their findings, and view all of the gathered data for free. Many of these platforms, especially iNaturalist, also allow their users to interact with each other, helping to increase the scientific accuracy of observations.

2.2.2: Effectiveness of Citizen Science

There are several ways to measure the effectiveness of citizen science. One method is to take a baseline measurement of scientific literacy of participants. Their awareness and interest in the environmental and scientific worlds are also taken into account. After completion of citizen science activities, a secondary measurement of the same topics can be taken to confirm that the programming is successful (Bonney et al., 2009). Administering surveys to volunteers can be difficult because park visitors may only want to get out on trails and enjoy their vacations. Assessing the collected data for quality is an easier way to ensure that the citizen science program is effective, as it doesn't require the volunteers to do any extra work. Ensuring a high level of data quality is a very important issue, as poor data will negatively impact scientific projects (Bonney et al., 2009). By making sure all procedures are clearly explained, poor quality data can be avoided. Similarly, outlining specific criteria for what is considered high quality data, and providing methods to improve existing data such as verification of identifications, can serve the dual purpose of keeping users involved in the process while improving quality.

Tracking the frequency collected data is used in scientific publications is another valid method of measuring the effectiveness of the program (Bonney et al., 2009). This can be done by tracking the number of scientific articles that use or cite the collected data. Additionally, quantifying the contributions in a citizen science database gives researchers a sense of how effective a program is (Bonney et al., 2009). Using this method also does not require extra effort from citizen volunteers, which makes it an attractive alternative.

2.2.3: Benefits of Citizen Science

Implementing citizen science programming provides many benefits to both the organization implementing the program and the volunteers participating in the program. For the organizations, it makes sense to implement citizen science programming because citizen science initiatives help to increase awareness and interest in local conservation efforts (Evans et al., 2005). Increasing interest in local conservation efforts is vital to ensuring the beauty of the natural environment is preserved for future generations, something Acadia National Park is invested in. Acadia also has scientists who have received grants conducting research in the park. Implementing citizen science framework is vital because the National Science Foundation has made conducting “project related science outreach” a condition for these grant recipients (Silvertown, 2009). This condition was created to ensure that the public understands and appreciates the projects their tax money helps to fund (Silvertown, 2009). By participating in citizen science activities, the public will not only be participating directly in research they are helping to fund, they will also be fostering an understanding of, and appreciation for these projects.

Acadia National park is home to multiple rare and endangered species (*Foundation Document for Acadia National Park*, 2016). These species are directly impacted by park management decisions. Citizen science data tracks “population trends, range changes, and phenology shifts for a wide variety of plant and animal species” (Bonney et al., 2009). This type of information is very valuable to Acadia, because it can help to make informed management decisions, as well as reduce the environmental impact of such decisions.

2.2.4: Disadvantages of Citizen Science

There have been some issues with citizen science with regards to data quality, as previously mentioned in section 2.2.2. Many of these issues arise from volunteer biases; citizens have a tendency to “over-report certain species and underreport others,” and there is a

“reluctance to make reports when common species or no species are observed” (Bonney et al., 2009). However, this was easily remedied by ensuring that all information and procedures are clearly outlined, and readily available to participants. It was also beneficial to inform volunteers that it is just as helpful to report common species, or not observing species, as it is to report rare species. Shifting the focus away from identifying rare species and towards informal learning also helped with this issue.

The other main concern with citizen science programming is the cost. “An effective citizen science program requires staff dedicated to direct and manage project development; participant support; and data collection, analysis, and curation. Such a program can be costly; Cornell Lab of Ornithology's current citizen science budget exceeds \$1 million each year” (Bonney et al., 2009). It is important to note that this cost is for high level citizen science programming, which was not the goal of this project. On a small scale, as programming at Acadia National Park is, citizen science activities should not have a high maintenance cost, though developing proper framework for projects may have an associated cost. Though, “considering the quantity of high-quality data that citizen science projects are able to collect once the infrastructure for a project is created, the citizen science model is cost-effective over the long term” (Bonney et al., 2009). With proper development and clearly outlined procedures, citizen science programming has few drawbacks, and myriad benefits.

2.2.5: Challenges with Using Citizen Science

The main challenge with implementing citizen science was that scientific terms are not usually understood by the general public. Scientists historically struggle with translating their procedures into the vernacular, which leads to confusion when citizens encounter unfamiliar terms. Steps were therefore taken to ensure that both citizens and scientists understood each other clearly, especially when communicating project goals and procedures. Clarifying scientific terms, and plainly outlining procedures also helped to produce high quality data.

There was some disparity in participation in citizen science with different demographics. Factors that influenced this were standard demographic issues, such as income and education levels (Evans et al., 2005). People who live in urban areas specifically, are usually underrepresented in citizen science programming. It is important to take steps to ensure that underrepresented demographics participate in citizen science research, and are not limited in their ability to participate due to financial or educational constraints. By incorporating citizen

science programming into Acadia National Park as part of a normal visit, we were able to make it easily accessible for people that come from a wide variety of backgrounds.

2.2.6: Motivation for the Public to Participate in Citizen Science

It was somewhat challenging to generate interest in citizen science initially. Other studies have found that people volunteer to participate in citizen science programming because they are personally interested in it, but that they continue to participate due to interactions with staff members (Evans et al., 2005). Ensuring valuable positive visitor to staff interaction was key to a successful citizen science program. Since Acadia National Park already had staff who were experienced in interacting with visitors and cultivating interest in scientific activities through existing programming in the park, this was relatively easy.

A multitude of learning opportunities exist within citizen science, even for volunteers who have previous scientific knowledge and experience. One study interviewed citizens who participated in a bird-watching citizen science activity. They found that many participants learned about new bird species just by observing birds in their own yards (Evans et al., 2005). Even highly experienced bird-watchers reported learning something new as a result of participating (Evans et al., 2005). For that study, 87% of participants reported an increased scientific literacy in birds and bird behavior, and 83% reported an increased sense of place or belonging (Evans et al., 2005).

2.3: Activity Design Principles

There are many different factors that play into creating an effective activity that has informal learning. By taking some of these factors into consideration, we were able to create activities that were more engaging and had a higher educational value.

2.3.1: How People Learn Through Interactive Activities

A study conducted by Harvard professor Eric Mazur, found that students encounter a point where they feel that they are not retaining information they are trying to learn. Mazur believes this is because they are not challenged on a deep enough level (Anderson, 2014). He explains that though the concept is learned, the thinking behind the concept is not questioned. Interactive learning encourages people to question the experiences that they go through in order to gather data and make observations about the environment that they are in. Citizen science is a viable method to introduce interactive learning to Acadia National Park. Such programming will

lead to citizens developing a deeper understanding of scientific research through experiential learning.

Interactive learning and collaboration between two groups can also be used to provide a solid groundwork for developing concepts on a deeper level. Professor Mazur would have his students attempt to change the minds of other student's by having them question each other's reasoning, in order to develop a new level of thinking about the reasoning for different answers (Anderson 2014). Encouraging visitors to Acadia to not only participate in citizen science activities, but also to join a global online community provided opportunities for people to collaborate, as well as question and explain findings. This lead to a deeper understanding of scientific research.

2.3.2: Children's Attention Span

When working across all demographics, it is difficult to bridge the gap between younger and older generations. The growth of technology has provided numerous distractions, which means keeping the focus of younger generations is becoming more difficult. There are many factors to take into account when developing citizen science activities that appeal to children. The first is that children are more likely to have interest if there are visuals present. By providing a poster or picture as a reference point, children are able to see examples that can help them develop a deeper understanding and knowledge about the given topic (Fisher, 2017). Children are also able to focus for longer periods of time if they are active and moving (Fisher, 2017). In order to keep younger children interested in citizen science activities, the activities were hands-on and interactive.

2.3.3: Role of Social Media in Education

Due to high technological growth in the last few decades, social media platforms such as Facebook, Instagram, Twitter, etc., have become a large aspect of daily life. Social media can help to bridge the gap between experts on various topics and everyday people, as well as encouraging national and global interactions (Dlamini, 2017). Engaging with social media both during and after participation in citizen science activities can help people to share their experiences and findings, as well as allow them to easily interact with other participants. Interacting within this online community encouraged citizens to remain interested in citizen science activities long after they left the park.

2.4: Case Studies

Case studies provide helpful insight into how others have researched citizen science as an issue at national parks. By looking at the various methods that other people have used to try to implement citizen science, we can learn what worked and also what failed. We can analyze and learn from these case studies to learn why different strategies of implementation failed in order to avoid making the same mistakes. We can attempt to build off of what has already been done in order to have success with our implementation of citizen science into Acadia National Park.

2.4.1: Denali

The case study conducted by Heather A. Fischer in partner with Arizona State University at Denali National Park in Alaska concluded that there were many shortcomings with the implementation of citizen science in National Parks. One such shortcoming was the lack of consideration for the demographics of visitors (Fischer, 2017). The research group recommended taking into account the different limitations visitors may have due to their backgrounds, such as age, health, income levels, local knowledge, and visiting status. In order for citizen science programming to be effective, the activities presented must be of interest to all demographics. The research group also found that there were no set standards to assess the quality of citizen science data sets (Fischer, 2017). Citizen science has only recently become a popular method of gathering data across a wide set area, which makes determining high and low quality data difficult. One of the ways Arizona State University was able to combat this was through the use of the online volunteer friendly program “Map of Life.” This is an app that provides an easy to access and user friendly mobile platform which can be used across a wide demographic area.

2.4.2: Taiwan

Another case study investigated interpretive services offered in Taiwanese national parks. The researchers identified two types of interpretive services, attended and unattended. Attended interpretive services include lectures, activities with leadership from staff, information provision in person, discussion, and active interaction with guides in the park (Hwang, Lee, & Chen, 2005). Unattended interpretation come in forms of signage, exhibits, self-guided trails, and scientific articles (Hwang, Lee, & Chen, 2005). Both of these forms of guidance play an important factor in developing a strong sense of place for visitors. The researchers found that developing a strong sense of place allowed visitors to become attached to the park, which had a strong positive influence on their experience.

At the end of the study, the researchers recommended that future program development should include a way for visitors to share their experiences, as well as view other participants' experiences. They believed that this would also contribute to the development of place attachment, and help to increase visitor enjoyment. This type technological integration encouraged visitors to remain engaged with the park after their visit.

2.5: Conclusion

The next chapter of this paper is the Methodology which will document the steps that were taken to implement citizen science into Acadia National Park. The previous chapter laid the foundation for developing these steps. All of the procedures to further develop citizen science in the methods section focus around the goals we used for our research in this section of the paper. These goals were: investigating the level of awareness of current citizen science programs in Acadia, determining the locations with the most potential for citizen science implementation, developing and implementing three citizen science models, and finally, testing the effectiveness of the models.

Chapter 3: Methodology

Our project goal was to develop and implement strategies that enhance visitor experience through the use of online citizen science platforms. In order to achieve this goal, we developed the following research objectives:

1. Identify activity design criteria and locations
2. Implement three adventure models of varying difficulties
3. Introduce Acadia park staff and visitors to our citizen science adventures
4. Market our citizen science adventures to visitors via social media platforms
5. Test the Success of the Adventures

In this section, we describe the methods we utilized to accomplish each of our five objectives.

3.1 Objective 1: Adventure Criteria and Location

Identification/Selection

Our first objective was to identify locations that would be optimal for citizen science program implementation. We did this by identifying underutilized areas, designating trail difficulty levels, and identifying activities to fit the needs of the National Park.

3.1.1 Identifying Underutilized Areas

The Acadia National Park is bisected by the Somes Sound, near the middle of Mount Desert Island. Many of the most popular destinations, including Cadillac Mountain and Sand Beach, are located on the eastern side of the park. The western side, colloquially known as the “Quiet Side,” receives far fewer visitors. However, the Quiet Side offers many beautiful hikes, in a wide range of difficulty levels, that often end in sweeping views of the Somes Sound. By implementing programming on the Quiet Side, we were able to encourage visitors to explore different areas of the park. We were also able to feature varying levels of difficulty, which helped to keep visitors of all ability levels engaged.

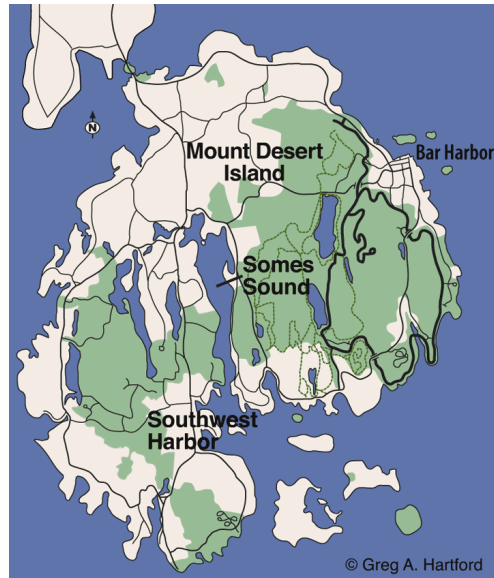


Figure 3: Map of Somes Sound in Acadia

3.1.2 Separation of Adventures and Locations

We designed a citizen science program that could be implemented on three different trails. This allowed us to include a range of difficulty levels to engage a wider variety of participants. The easy trail we selected has very level terrain, suitable for families with young children. The medium trail features a slightly longer hike, and appeals to people looking for more of an elevation change than the easy trail offered. Finally, we selected an advanced trail, which has a challenging, and physically strenuous climb. This trail appeals to more expert level hikers. Implementing citizen science program on these three trails allowed us to reach a wide demographic range.

3.1.3 Identifying Activities that Fit Acadia’s Needs

The final step of Objective One was to determine the data collection needs of Acadia National Park, which were outlined in the Foundation Document. To fulfill these collection needs, we designed activities that would informally educate participants about species the park was interested in. This helped to increase scientific literacy among park visitors, and contributed to the growth of citizen science databases.

3.2 Objective 2: Implementing Citizen Science Activities

Our second objective was to implement the programming we developed using the information gathered from Objective One. We also describe the development of our adventure model in this objective.

3.2.1 Three Adventure Models

Using the information from Objective One, we selected three locations to implement our citizen science program. Each trail we selected was located on the Quiet Side to avoid compounding the overcrowding issue. We selected the Wonderland Trail for the easy level, Mansell Mountain Trail for the medium level, and Norumbega Trail as the challenging level. These trails were well suited for our proof of concept project because they were clearly differentiated in difficulty of terrain. These trails also accounted for the wide demographic variety of park visitors, from families with young children to avid hikers and explorers. This helped fulfill the main project goal of enhancing the visitor experience by designing citizen science activities that appealed to a wide variety of demographics.



Figure 4: Three Initial Trails Chosen by Team

3.2.2 Incorporation of iNaturalist

Through our research, we identified iNaturalist as a platform for us to implement our adventures. iNaturalist is an online social media platform, developed to “map and share observations of biodiversity across the globe” (Projects, iNaturalist.com). iNaturalist has several different features that we were able to take advantage of. The first is a “collection project.” A

collection project allows users to “gather and visualize observations” and automatically includes any observation that meets the parameters set by the project (Projects, iNaturalist.com). One of the parameters that can be set is a geographic limit. For each of our three trails, we were able to create collection projects that automatically pull any observations that were made on the trail. The other feature that we were able to take advantage of is an “umbrella project.” An umbrella project allows users to “compare statistics across two or more collection projects,” and provides a home for the collection projects (Projects, iNaturalist.com). We created an umbrella project, appropriately named “Hiking Acadia Citizen Science,” which had the three collection projects for the Wonderland Trail, Mansell Mountain, and Norumbega Mountain nested under it. iNaturalist also allows users to make identification suggestions on other user’s observations. Acting as a social media network, users can comment on observations with questions and explanations. If more than 2/3rds of users agree on an identification, the observation then becomes “research grade” and can be used for scientific research.

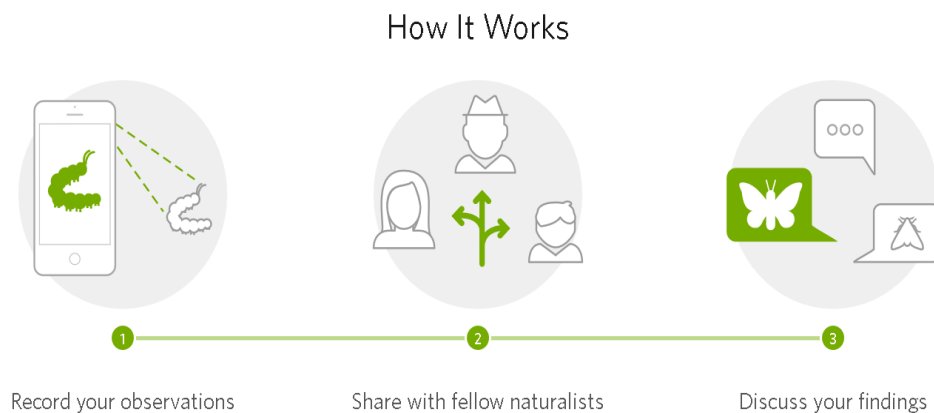


Figure 5: “How it Works” iNaturalist Diagram

3.3 Objective 3: Introducing Our Citizen Science Adventures to Acadia

Our third objective was to introduce our citizen science project to the Acadia National Park. In order to accomplish this, we needed to inform both National Park Staff and visitors of our project.

3.3.1 Introducing Our Citizen Science Adventures to Staff

The first step of Objective Three was to introduce Acadia National Park Rangers to our citizen science program. Through the connections of our sponsor, Dr. Abe Miller-Rushing, we sent out a brief overview of our project through an internal staff email. The email detailed the trails that we planned to implement the adventures on, as well as our data collection goals for the adventures. Informing the staff of our project meant that they were more likely to encourage visitors to participate in our project, which helped market our project to the general public.

3.3.2 Introducing Our Citizen Science Adventures to Acadia Visitors

The second step of Objective Three was to inform the general public of our project. Though this was partially accomplished through informing park rangers, we also wanted to market directly to visitors. The primary method we selected to achieve this was creating an informational brochure. The trifold brochure explained what citizen science is and how visitors can become involved. In the centerfold, we included brief descriptions of the three trails we selected in Objective Two. On the back of the brochure, we added a QR code (a quick response code) that visitors could scan with their cell phone camera to be taken directly to a link to download iNaturalist. We also partnered with the Public Outreach Division of Acadia National Park to utilize the verified social media accounts to promote our adventures. We created brief, one page pamphlets that described our adventures. These pamphlets were designed as shareable images, well suited for Facebook, Twitter, and Instagram. We drafted social media posts to engage with users, including on each draft post a direct link to the Hiking Acadia Citizen Science umbrella project on iNaturalist.

3.3.3 Brochure Distribution

The final step of Objective Three was to get the brochures out to the general public. After our design was approved by our sponsor, we looked into printing. We selected Full Circle Printing Solutions in Ellsworth, Maine after getting quotes from three different printing companies. Once the brochures were printed, we obtained approval from the Bar Harbor Chamber of Commerce to place our brochures in their two visitor centers, located in Bar Harbor, and Trenton. We gave each location 50 brochures, and checked back weekly to replenish the supply. We also were approved to display our brochures in the Acadia National Park visitor center, also located in Bar Harbor. They also received 50 brochures, with weekly visits to replenish supplies.



Figure 6: Our Brochure Featured in Bar Harbor Acadia National Park Visitor Center

3.4 Objective 4: Test the Success of the Adventures and Implementation of Citizen Science

Our fourth objective was to implement our citizen science adventure program. The goal of this objective was to gain participant's feedback on our adventures to see how they could be improved.

3.4.1 Practice Run of Three Adventure Models

The first step of Objective Four was to test our program ourselves to ensure that each location was suitable for citizen science implementation. We were able to troubleshoot issues that participants may experience on our trails, including poor cellular connectivity. Testing the adventures ourselves also allowed us to create guides on iNaturalist, showcasing the species we encountered while hiking. This gave participants an idea of what to expect to see when they hike the trail.

3.4.2 Testing Adventure Models with Classmates

The second step of Objective Four was to seek volunteer participants from among our peers at the Bar Harbor Project Center. We elected to seek volunteers from our peers because it was easier to get direct feedback on the program design. Our peers were also quite familiar with our project goals from in-class presentations, and were able to tell us if we were accomplishing these goals. This feedback was gathered through both surveys and informal

interviews/conversations. Though we did not directly seek volunteer participants from the general public, it was always our intention and final goal to have participation from the public. However, in the event that we were unable to publically launch our project, we wanted to ensure that we had valuable feedback.



Figure(s) 7 & 8: WPI Students Participating in Citizen Science using iNaturalist

3.4.3 Surveying Classmates/Citizens that Partake in Adventures

In order to gain feedback on our citizen science adventure, we administered surveys with our peers who volunteered to participate in Section 3.4.2. Through these surveys, we were looking to find if our program was fun, interactive, and if participants would be willing to engage with future citizen science opportunities. We also hoped to learn how participants felt about iNaturalist, and if they would continue to use it in the future. The specific questions we asked were as follows:

1. In what ways did you enjoy your experience on this adventure?
2. Do you feel as though you have learned something new through this experience?
(Yes/No)
3. Would you participate in other citizen science activities in the future? (Yes/No)
4. Did you experience difficulty using iNaturalist? (Yes/No)

- a. If yes, where did you have difficulty?
5. Do you think you will continue to use iNaturalist in the future? (Yes/No)
6. Do you have any other feedback?

The specific information we hoped to acquire from each question was:

1. What participants enjoyed during their experience. This information helped us to understand what excited participants about citizen science programming, and how to encourage people to continue using citizen science.
2. One of our goals was informal education of participants. By asking participants if they feel as though they have learned something new, we could find if we accomplished this goal.
3. Another of our goals was to generate a lifelong interest in citizen science. We determined if we accomplished this goal by asking participants if they were willing to participate in further citizen science activities.
4. It was important to understand if participants enjoyed using iNaturalist as a platform. We also needed to know if participants had difficulty understanding the mechanics of iNaturalist, so we could recommend better explain the mechanics of the platform in future revisions.
5. Again, one of our main goals was to generate a lifelong interest in citizen science. If participants are willing to continue using iNaturalist, we have accomplished this goal.
6. Asking for miscellaneous feedback allowed us to generate specific issues/positives which helped us make recommendations for future citizen science activities.

3.5 Objective 5: Publishing Adventure Models/Citizen Science

Activities Online

Our fifth objective was to publish our citizen science adventures online for the general public. We planned to publish our program on the official website of the Acadia National Park.

3.5.1 Adding the Citizen Science Project Adventures to the Park's Website

The first step of Objective Five was to use the connections of our sponsor, Dr. Abe Miller-Rushing, to add our project to the park website. On the Acadia National Park website,

under “Maps,” there is an interactive map which details all of the activities in the park. We planned to add our citizen science adventures to this map. When an individual clicks on our adventures on the interactive map, they are taken to another page, which has more detailed descriptions of our program.

3.5.2 Page Features

Each adventure page began with an explanation of citizen science, and why it is important to the park. The page then describes iNaturalist, including helpful information for using the platform. There is a description of the level of difficulty for each trail, and specific hints for where to find different flora and fauna. Each adventure page links to the collection project for that trail, and encourages users to download iNaturalist on their cellular devices prior to hiking the trail. iNaturalist also offers “guides,” which are lists of every species observed along a trail. We created guides for each of our three trails, and linked them on the website as well. These guides are available for users to download, so that the guides are still viewable when there is no connectivity.

Chapter 4: Results

4.1 Location Selection and Project Expansion

Prior to arriving to Acadia National Park, we had identified three trails to implement our citizen science adventures on. However, as we hiked the trails, moving through our methodology, we realized that there was ample time to expand our project to cover more areas in the park.

4.1.1 Implementation of Three Original Trails

The first step when we arrived in the Acadia National Park was to hike the three trails that we had initially identified. We tested iNaturalist on each of the trails, and noted the species that we observed while hiking.

We began with Norumbega Mountain, our challenging trail. Norumbega is a strenuous hike, with the first 1.2 miles up the Goat Trail having steep rock face for hikers to navigate. There we observed a variety of plant-life, as well as many arthropod species. The peak of the mountain, opening to sweeping views, was filled with birdsong. We enjoyed a lunch at the peak and were able to observe several different bird species, as well as various rodents. We then descended Norumbega via the Lower Norumbega Trail, which led through beautiful evergreen forest, circling a reservoir. Though the trail does not have cellular connection throughout, we found that iNaturalist saved our observations, which we were able to upload once we reconnected to Wi-Fi.

The second trail we hiked was our medium level trail, Mansell Mountain. Slightly less challenging than Norumbega Mountain, Mansell Mountain is a 2.5-mile hike through dense forest. We observed multiple species of lichen, as well as several animal species. Mansell Mountain had less cellular connectivity than Norumbega, however, we were again able to upload our observations once we reconnected to Wi-Fi.

Finally, we hiked the Wonderland Trail, designated as our easy level hike. Located on the southwest harbor of Mount Desert Island, Wonderland is a flat 1.5 mile walk through the forest that leads to the shoreline. On the shore, there are many tide pools that we explored, finding multiple new aquatic species that we had not documented on the previous two trails. Wonderland

Trail was a fantastic addition to our project because it allowed us expand the variety of habitats we covered.

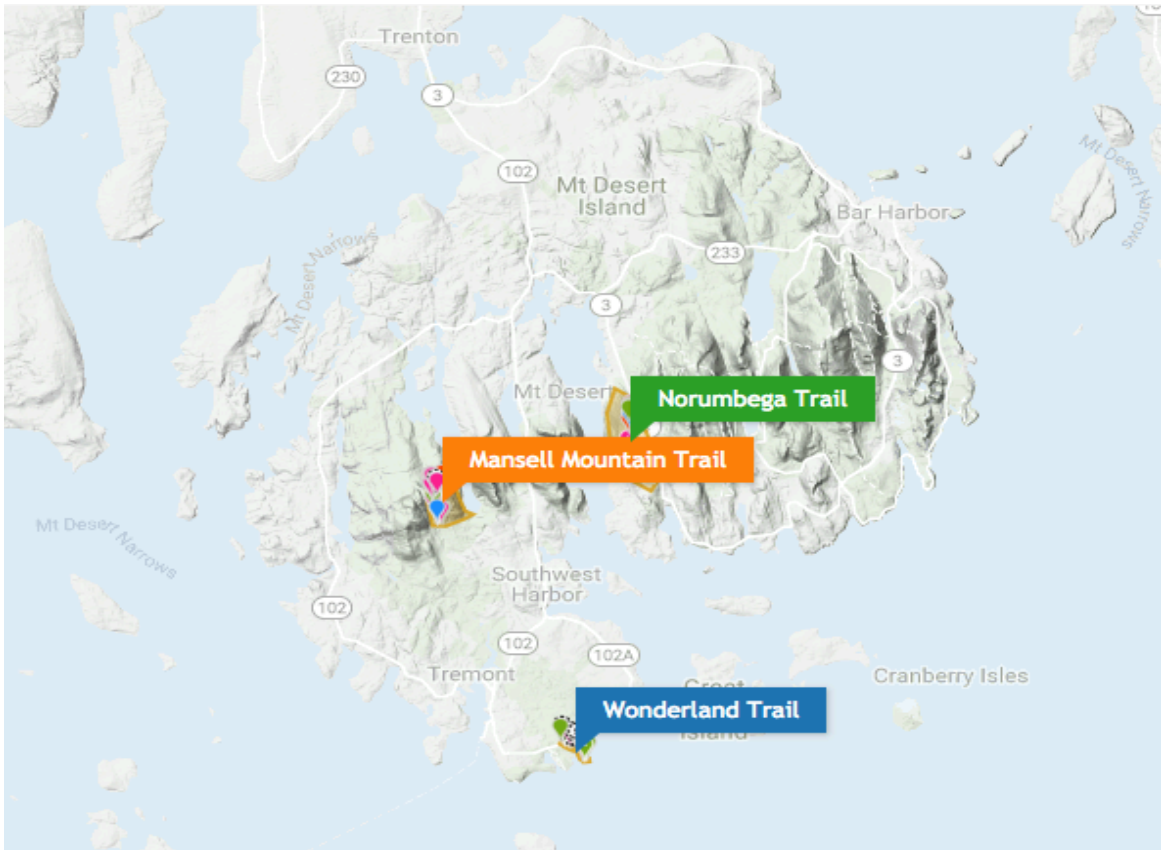


Figure 9: Three Initial Trails on iNaturalist

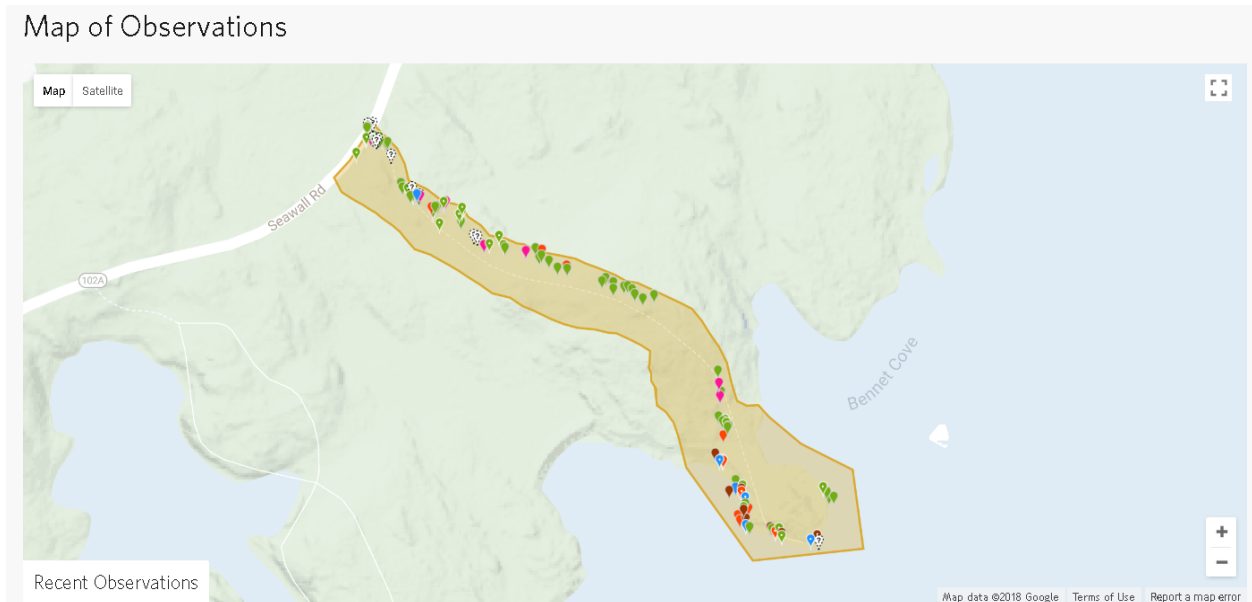


Figure 10: Wonderland Trail Close-Up

4.1.2 Addition of the Entire Park

After finishing the initial three hikes, and constructing the framework for our project on iNaturalist, we realized that it was not necessary for us to hike each trail to add it to the project. We had already determined that there was an active iNaturalist community on Mount Desert Island. However, there were no further geographical designations on iNaturalist, other than the Acadia National Park. To allow researchers looking at this data to specify where they wanted to look, we decided to move forward with designating each of the 26 mountain peaks in the Acadia National Park. We also included the Ship Harbor Trail, as well as the Wild Gardens of Acadia. For each new geographic designation, we created a collection project. All of these collection projects were added to our “Hiking Acadia Citizen Science” umbrella project, allowing us to cover a far greater area of the park.

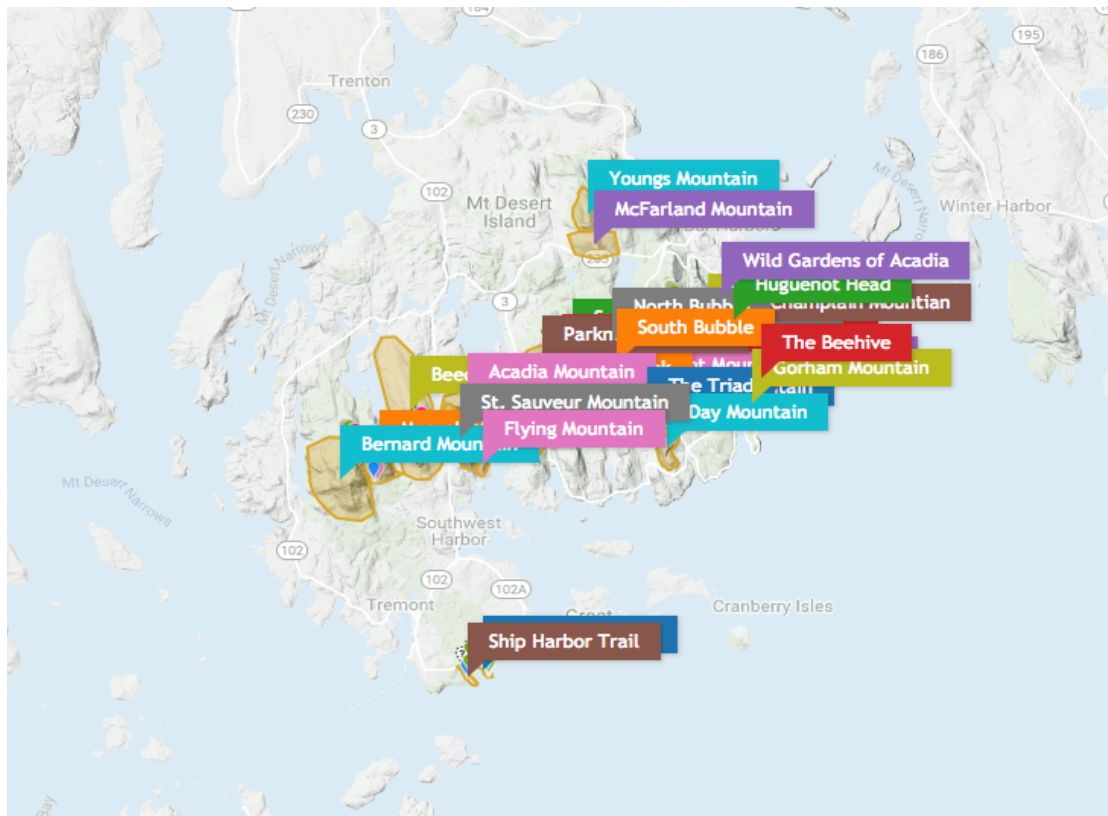


Figure 11: Addition of 26 Mountain Peaks to iNaturalist

4.2 Working with the Park

While developing our project, we took advantage of the multiple resources the Acadia National Park offers. This enabled us to see what was being done with citizen science in the

park, and helped us understand how our project would fit into the greater context of the pre-existing programming.

4.2.1 Attending Schoodic Institute Citizen Science Training

Our sponsor, Dr. Abe Miller-Rushing, directed our attention to a citizen science training at the Schoodic Institute. We decided to attend this training, which we believed would help us to have a better understanding of how citizen science is taught. The 4-hour training covered three citizen science platforms: Nature's Notebook, eBird, and iNaturalist. After this training, we concluded that we would structure training sessions for iNaturalist with more time outside on trails to allow participants to practically practice using the application.

4.2.2 Attending Ranger Led Tours

To understand the current structure of programs at Acadia National Park, our team also attended a botany walk at the Wild Gardens of Acadia. The 1.5-hour walking tour was led by park ranger Mary Beth. She elaborated on the natural forces that shaped Mount Desert Island and how those forces lead to the plant-life currently on the island. While identifying different plant species, Ranger Mary Beth gave clear explanations of what we were observing, and ways to identify the species in the future. After attending this walk, we felt that a ranger led walk would be ideal for encouraging people to use iNaturalist. Even incorporating iNaturalist into sections of the pre-existing programs would spark an interest in iNaturalist, and increase usage.

4.3 Implementation of Citizen Science

After understanding how Acadia National Park currently structures its' programs, we moved towards implementing our program, as well as publicly marketing it.

4.3.1 Practice Run with Other Project Teams

After completing the Mansell and Norumbega hikes as a team, we decided to invite other site project teams, as well as our professor, to join us on our hike of the Wonderland Trail. We encouraged our classmates to download iNaturalist prior to the hike, and asked them to use the app while on the trail. This was a roaring success, with many of our peers greatly enjoying the citizen science adventure. Several of our classmates said that they would continue to use iNaturalist in the future.

4.3.2 Pamphlets

It had always been our intention to design trifold brochures to enhance our project, however the content of the brochures shifted multiple times. Initially we had visualized three pamphlets, one for each trail, as detailed in 3.3.2. These would have worked as guides for each trail, and directed visitors to specific locations along the trail where they could make observations. However, once we explored iNaturalist in greater depth, we realized that there was a built-in feature that would do nearly the same thing. We also realized that if people make observations in our defined locations, those observations are automatically pulled into our project. That meant that we did not have to advertise our project specifically, but rather increase overall iNaturalist usage in the park. In light of this, we shifted from our methodology in section 3.3.2, and designed a single tri-fold brochure that explained what iNaturalist is, where to download it, and how it relates to citizen science. The brochure also briefly outlines our three original trails to encourage people to hike those. We printed 250 copies of the brochure, and distributed them at each of the park's visitor centers.

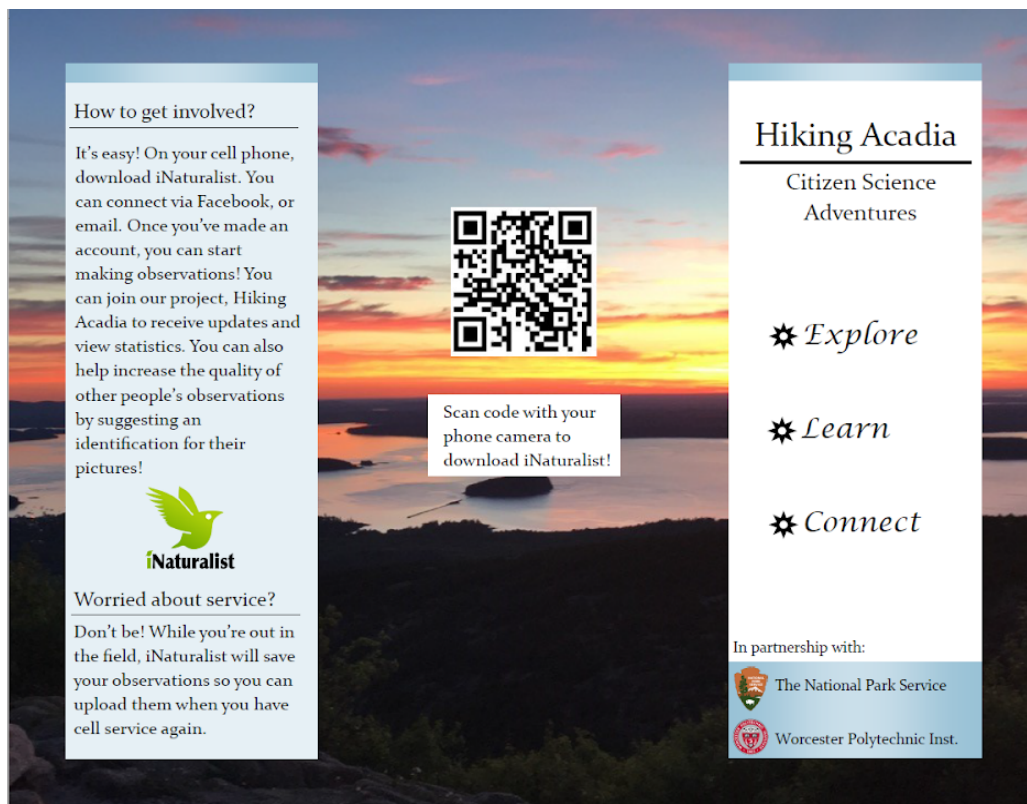


Figure 12: Pamphlet Side A

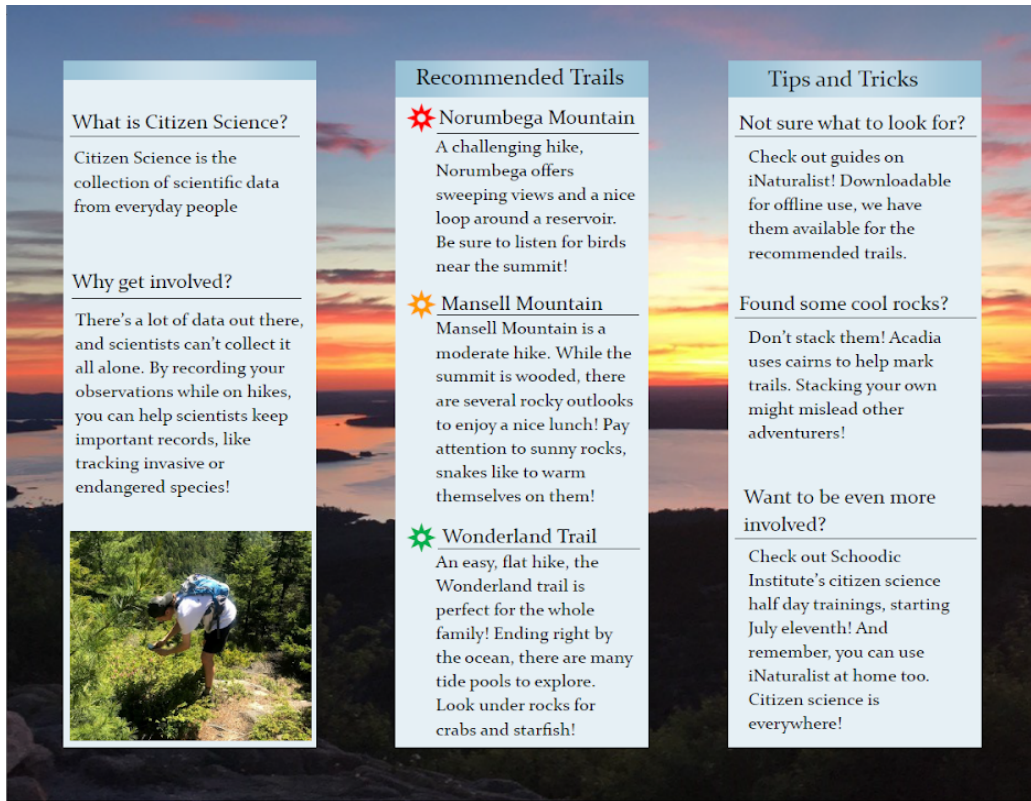


Figure 13: Pamphlet Side B

4.3.3 Result of Pamphlets

After distributing our pamphlets at various places within Bar Harbor, there was an increase in iNaturalist observations and observers in our Hiking Acadia project. From June 17th to July 10th, our group was responsible for the majority of observations. From July 11th to July 18th, there was no increase in users or observations because our group did not go out into the field. Then, on July 18th, our group distributed the pamphlets that we created promoting our project. From there on, there was a clear increase in observers and observations, which can be credited to the pamphlet distribution. It is also important to note that our group was not responsible for any of the observations past July 11th, so all of these observations were due to new users.

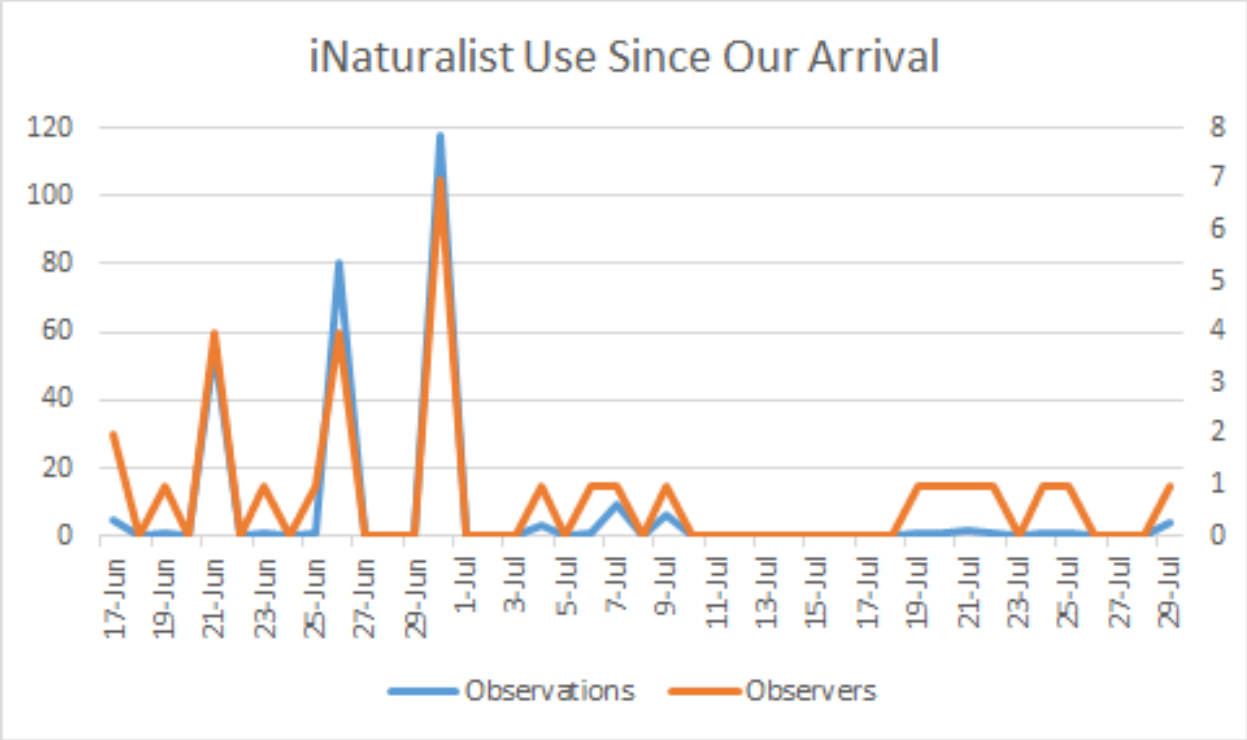


Figure 14: Graph of Pamphlet Impact

4.3.4 Work at the Gardens

While exploring the Acadia National Park, we discovered the Wild Gardens of Acadia. The gardens have different sections for each of the habitats around the park, including meadow, marsh, forest, etc. Each section has a selection of plants that grow in that habitat, with identifying markers on each plant. The area also has good cellular connection, so people using iNaturalist are able to load suggestions while using the app. We decided that this area would be an optimal place to connect directly with the public, introduce and teach iNaturalist, and therefore increase usage of iNaturalist around the park.

4.4 iNaturalist Statistics

As we explored the different aspects of iNaturalist, we discovered a feature that allows users to export observations from a project, like Hiking Acadia Citizen Science, into an excel spreadsheet. iNaturalist also allows researchers to use different filters, so that specific information can be extracted. For example, the table below shows our data export of our team specifically looking for mollusks on June 30th, 2018.

id	observed_on	time_observed_at	latitude	longitude	scientific_name	common_name
13933427	6/30/18	2018-06-30 22:32:37 UTC	44.22857741	-68.31256164	Littorina littorea	Common Periwinkle
13933434	6/30/18	2018-06-30 22:33:44 UTC	44.22837821	-68.31244203	Littorina littorea	Common Periwinkle
13933544	6/30/18	2018-06-30 22:36:53 UTC	44.22827943	-68.31265192	Strombidae	True Conchs
13933550	6/30/18	2018-06-30 22:37:22 UTC	44.22821259	-68.31261403	Strombidae	True Conchs
13933664	6/30/18	2018-06-30 22:42:00 UTC	44.22804872	-68.31190517	Littorina littorea	Common Periwinkle
13980167	6/30/18	2018-06-30 22:37:43 UTC	44.22811414	-68.3124199	Littorina littorea	Common Periwinkle
13982849	6/30/18	2018-06-30 22:29:38 UTC	44.22861593	-68.31257364	Littorina littorea	Common Periwinkle

Figure 15: iNaturalist Mollusk Excel Data Export

Other export options, besides time and species type, included searching by location (longitude and latitude coordinates.), trail or mountain, taxon, media upload type, etc. Overall, this feature of iNaturalist allows the scientist or volunteer naturalist to be as detailed with exporting information as they want which could be really beneficial to future research.

Chapter 5: Recommendations

5.1 Areas of Success

Based on our initial methodology that we developed prior to arriving to Bar Harbor, we succeeded in setting up a system to involve tourists in citizen science within Acadia National Park. We were able to create a proof of concept with our three initial hiking trails, as well as expand the project to cover the 26 mountain peaks that Acadia has to offer. Another area of success that we had involved our marketing of our project. We were able to create informational pamphlets that directed people to iNaturalist and our specific project. We only had a short period of time to pursue the marketing aspect of our project, but with more time we believe that further marketing would only increase the tourist involvement with iNaturalist.

5.2 Moving Forward Recommendations

After completing our implementation of citizen science into the national park, and finishing up our seven weeks, we were able to come up with some recommendations. Our group came up with four main recommendations to help continue implementing iNaturalist into the park, which are as follows:

1. Continue marketing iNaturalist throughout the park. As a group, we were able to begin marketing our project toward the end of the project, however, we felt that if we had more time to make the project, then the citizen involvement would have increased largely. Then this would involve continuing to distribute the pamphlets that we created, making most, if not all, rangers/staff aware of the opportunities our project presents.
2. Use the ranger led tours as a way to teach people about citizen science. The ranger led tours could be a great opportunity to get people comfortable with using the various citizen science platforms and get them started on going out and making their own observations within the park. By using the ranger led tours, people could see the citizen science platform being used in action and make it easier to understand how to do it on their own.
3. Implement the other citizen science platforms into Acadia National Park. Along with iNaturalist, other platforms like Map of life, eBird, and Nature's Notebook are all great citizen science platforms. They all have their own strengths and could all be utilized as

great platforms. By utilizing all of these platforms, the park can let people choose what they want to be involved in, which would lead to more people participating in citizen science.

4. Continue working on this project with future WPI groups. If another WPI group were to work on this project, then they could focus on the marketing aspect and help to increase the citizen science involvement in their own creative way. One idea would be to set up a table at the Wild Gardens of Acadia and lead their own information session on how to use iNaturalist.

Chapter 6: Conclusion

Overall, our goal as the Citizen Science Team was to create citizen science adventures that can help to solve issues that the park is having. These issues are overcrowding in areas of the park that are more well-known than others and a lack of informal learning that occurs in the park among the visitors. In order to solve these issues, we hope to create our adventures in areas of the park that are less crowded but equally enjoyable. Secondly, we hoped to provide a platform for informal learning among the visitors that allowed them to have an engaging and fun experience with the park while at the same time helping to gather data that can contribute to the greater good of science.

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