ACADIA TRAILS:
THE INTERACTIVE ONLINE EXPERIENCE

Acadia National Park 2023

ABSTRACT

In the modern era, websites are the preeminent method for connecting people to new experiences and perspectives. For Acadia National Park, inequalities in accessibility, safety concerns, and environmental changes motivated the development of an interactive online tool to share its stunning hiking trails with the world. In this project, the *Acadia Trails* website was transformed into a state-of-the-art hub for immersive panoramic tours of the 125+ miles of trails in the park. To accomplish this, the website was reconstructed with a user-focused design perspective, and many panoramic tours were recaptured or reprocessed to improve their quality. Using several evaluative methods, the updated website was found to be navigable, informative, and compelling for a wide audience.

TEAM MEMBERS

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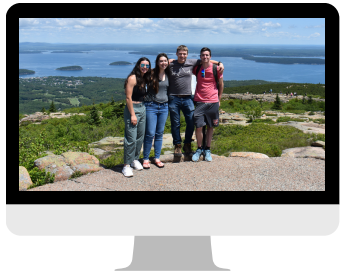

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Adam Gibson
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https://acadiatrails.wpi.edu/

INTERACTIVE QUALIFYING PROJECT

An Interactive Qualifying Project submitted to the faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the Degree of
Bachelor of Science

July 31, 2023

This report represents the work of four WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review. For more information about the projects program at WPI, please see: http://www.wpi.edu/Academics/Projects.

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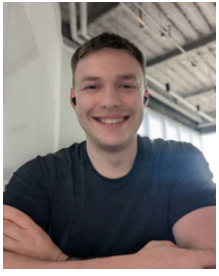
- **Abe Miller-Rushing**, **Adam Gibson** (project sponsors), and **Acadia National Park administration**, for their support and facilitation of this program;
- **Professor Stephen McCauley** (project co-advisor), for his thoughtful feedback and fresh perspective on the project work;
- **Professor Frederick Bianchi** (project co-advisor), for his creative suggestions and extensive knowledge of previous Acadia IQPs;
- **Ermal Toto** (technical consultant), for his prompt and helpful technological support;
- **Alejandro Manga** (preparatory class instructor), for helping the team understand the social implication and imperative of the project work;
- **Karen Lupa Coghlan** (library consultant), for her earnest support of our project and for giving us candy.

The team would also like to express special thanks to the **College of the Atlantic community**, for comfortable accommodations, lovely workspaces, and welcoming attitude; it was a pleasure to live and work in your beautiful campus.

Authorship

Hey there! My name is Grace Baumgartner, and I am from Seattle, Washington. I am currently pursuing a double major in Chemistry and Mathematical Sciences at WPI. This project has been a great experience for me to learn about web design and develop my writing, teamwork, and project management skills. It also helped me cultivate a renewed appreciation for National Parks and the outdoors. I will take these lessons with me into my scientific career. I am proud of the website my team has developed, and hope that it will be a valuable resource for people to experience Acadia the same way we did.

Hi everyone! My name is Juliana Porto, and I am from Salem, NH. I am in the BS/MS program at WPI with my BS in Computer Science and my MS in Management. Throughout my time in Acadia National Park, I have developed my skills in website design and development as well as teamwork and leadership. In addition to these academic pursuits, I was able to enjoy spending time in nature through hiking and rock climbing. I am thankful for this experience as I can take what I have learned into my professional career and feel satisfaction through knowing our team has made a real impact on visitors of the park.



Hello! My name is Benjamin Cobb, I'm from Catonsville, MD, and I'm currently pursuing a degree in Aerospace Engineering at WPI. During my time here I was able to improve my skills in writing, teamwork, and project management while also improving upon a valuable resource for visitors of Acadia National Park. Being an avid hiker, biker, and climber, working on a project in a national park was especially rewarding for me. I'm grateful to the park for sponsoring this research opportunity and look forward to seeing how future teams continue to improve this project over the years.

Hello everyone! My name is Nicholas Prayner, and I am from Wasilla, Alaska. I am currently pursuing a mechanical engineering degree at WPI. This project has been a wonderful experience learning website design, 360 panoramic tour development, and teamwork skills. It also has taught me the importance of sharing the beauty of nature with others. As an Alaskan resident, I have always enjoyed the outdoors and believe everyone should have equal access to it. I am grateful for the opportunity to make a lasting impact on park visitors and hope our website can allow everyone to enjoy Acadia National Park's beauty.

Executive Summary

Background

In today's society, most people are disconnected from the natural world, which causes harm to both their physical and mental well-being (Douglas et al., 2017). The National Park Service plays a key part in combating this issue by reconnecting people to green spaces across the United States (Figure 1). However, three notable issues impede the parks' function. First, the parks are not equally accessible to all Americans, especially racial and ethnic minorities and people with disabilities (Xiao et al., 2018), (Wolter, 2021). Second, many visitors to National Parks are unprepared for the safety hazards they may encounter there (Russel, 2012). Third, in the era of rapid climate change, sudden shifts to the parks' environments often go unrecorded (NPS, Climate Change). In Acadia National Park, this project has the potential to ameliorate all these issues, and facilitate the park's key function of connecting people to the natural world.

Since 2012, Worcester Polytechnic Institute (WPI) has been working with Acadia National Park to document hiking trails throughout the park (WPI, 2012). The concept was simple, though technologically challenging at the time: to collect 360° images of the trails and stitch them together into interactive tours, now called TrailViews. By 2016, the vast majority of the trails in Acadia had been fully photographed, comprising the first complete visual record of trail conditions in the park (WPI, 2016). Later, in 2020 and 2021, teams started development in earnest for a public website to host the TrailViews and make them accessible to anyone in the world (WPI, 2020), (WPI, 2021). They also expanded the website to include information about hiking safety and the park in general, as well as recaptured TrailViews of poor quality. As our team continued the project, we built on this substantial body of work from past groups which enabled us to bring their vision to new heights.

Figure 1
Students from the 2023 Acadia National Park cohort walking along the Jordan Pond Path.

Because of this rich history, the *Acadia Trails* website was well prepared to address the accessibility, safety, and preservation issues described above. First, digitizing the trails made them available to anyone with an internet connection, not just people who have the means and ability to visit in person. Second, allowing visitors to preview trails will help them assess trail difficulty as compared to their personal skill, facilitating informed decisions and planning. Third, the iterative nature of the project lends itself well to an archive system of TrailViews over time, which can be essential when recovering from disasters like 2021's massive rainstorm (Figure 2). In this way, the *Acadia Trails* website will support Acadia's mission and connect people to the park in many ways.

Figure 2
2021 erosion of Maple Spring Trail; photo taken by Stephanie Clement (Friends of Acadia, 2022).

Note. After this devastating event, only WPI had images of the original state of Maple Spring Trail thanks to the TrailView project.

Goals, Objectives, & Methodology

The goal of this project was to redevelop the *Acadia Trails* website to transform it into a valuable resource for visitors of Acadia National Park. To achieve this goal, we identified the following objectives:

1. Redesign the *Acadia Trails* website in order for it to be more functional and accessible.

2. Construct and reconstruct panoramic trail tours that were either missing or of poor quality on the website.

3. Evaluate the website's effectiveness in meeting the above project goal.

Each of the above objectives was achieved through various methods. For our first objective, we conceptualized the goals that various visitors of Acadia would be using our website to achieve through a Persona and Empathy Map exercise, prototyped an effective website design, and implemented the design using *WordPress*. Our second

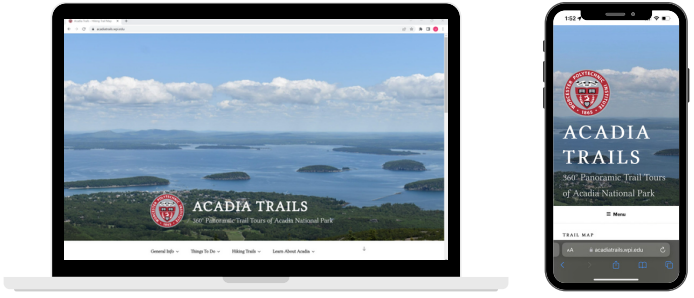
objective was addressed through capturing 360° photos of Acadia's hiking trails using a GoPro Max 360° panoramic 16.6-megapixel camera on a tripod, processing them using the Pano2VR software, and archiving them for future teams' use in the WPI server. Lastly, our third objective was completed through the accomplishment of a heuristic evaluation, a think-aloud user study, an analysis using Google Analytics, and a public survey (Nielsen & Molich, 1990), (Kim et al., 2018), (Sharma et al., 2022).

Deliverables & Results

Acadia Trails Website

While other resources exist for visitors of Acadia to learn about its beautiful hiking trails, none other than the *Acadia Trails* website provides an interactive online experience for the user to fully immerse themself in a trail. When a user arrives at acadiatrails.wpi.edu, the beautiful view from the top of Cadillac Mountain greets them (Figure 15). From here, users scroll down to four main menu options with various submenus that direct users to informational pages on topics such as hidden gems, a new page created for users wanting to avoid crowds while still experiencing worthwhile attractions in Acadia. These pages include relevant visitor knowledge as well as external links to important resources such as the National Park Service website.

Figure 15
Homepage of the *Acadia Trails* website.



The true treasure of the *Acadia Trails* website, however, are the 41 new and improved TrailViews. These TrailViews, created using *Pano2VR*, feature an interactive skin that enhances user engagement using several navigation options (Figure 17). Included are options such as a primary navigation menu, a scrollbar of nodes along the trail, and a directional map. Basic functionality such as clicking and dragging to rotate the view and zooming in are also included, creating a fully functional and easily navigable tour of each trail.

Figure 17
Annotated TrailView with all major navigational features labeled.

Finding these TrailViews can be accomplished by using either the Trail Finder or Trail Map features. The Trail Map is an interactive map with icons pinned at the location of every trailhead, hidden gem, and popular attraction location. Clicking on any of these icons opens a sidebar with a brief description of the trail or attraction and a link to its page on the website. The Trail Finder page includes a variety of ways to search for a trail. These include featured trails, a geographic location dropdown, options such as length or elevation gain, and a full alphabetical list of trails.

Website Effectiveness

Our evaluative methods revealed four main findings:

1. The website reached a wide audience. *Google Analytics* revealed over two thousand lifetime users of the website with an increasing trendline, and the public survey showed no correlation between demographic groups and their ability to use the website.

2. The website was easy to navigate. The heuristic evaluation score increased by 108%, and participants in the think-aloud study consistently navigated the website successfully.

3. The website was useful. *Google Analytics* shows that most users find the website through organic search, indicating that it was able to answer their specific questions, and public survey participants reported a 65% increase in knowledge of Acadia after using the website.

4. The incomplete processing of TrailViews caused problems. Note that the team was only able to

reprocess approximately one-third of the library of TrailViews due to time constraints. This caused confusion in four out of seven think-aloud studies, and was commented on multiple times in the public survey.

Recommendations

Our recommendations for project continuation focus primarily on TrailViews. Many of these still have poor quality images, or are nearing a decade old, and need to be updated. There is also a small number of trails which are still lacking images altogether due to the seasonal trail closures protecting the peregrine falcons. Upkeeping and updating the TrailView collection is therefore the highest priority for future teams. Additionally, adding cross-filtering options to the Trail Finder feature and building the Trail Map in *Pano2VR* would both improve website navigation significantly.

Beyond the focus of TrailViews, other areas for future development should be considered. Firstly, capturing images of the carriage roads and adding them to the TrailView collection could be completed easily. Secondly, the implementation of live data streams could be used to inform website users of how busy different areas in the park are. During the time of this project, two other Acadia research groups were working to monitor traffic at popular locations such as Cadillac Mountain and the Hulls Cove Visitor Center using license plate readers and other techniques. Combining these projects could provide real-time data about park locations to visitors and park rangers alike. Finally, TrailViews built using *Pano2VR* can be made to support virtual reality (VR). Adding VR compatibility would be a complex task, but would vastly improve user immersion into Acadia's beautiful hiking trails.

Conclusions

Overall, by rebuilding the website's structure and aesthetics with a usability focus, redesigning old TrailViews, and assessing the website's success with a variety of tools and methods, the *Acadia Trails* website has been transformed into a valuable resource for visitors of Acadia. We have found the website has effective navigation and is capable of providing useful information to vast audiences. However, its incomplete and dated TrailView library leaves the door open for future development and the implementation of new features. In closing, we have made great strides in advancing the *Acadia Trails* website, providing an interactive experience of the park now and into the future.

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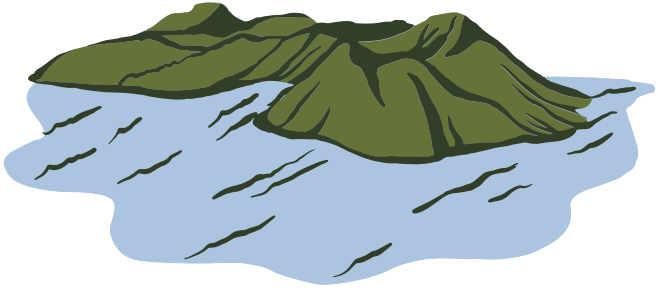

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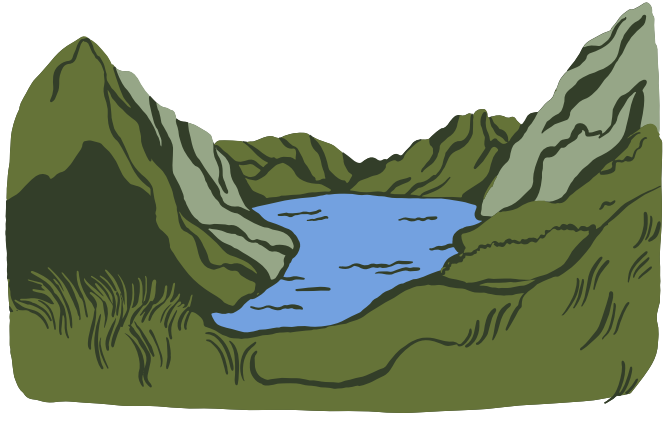

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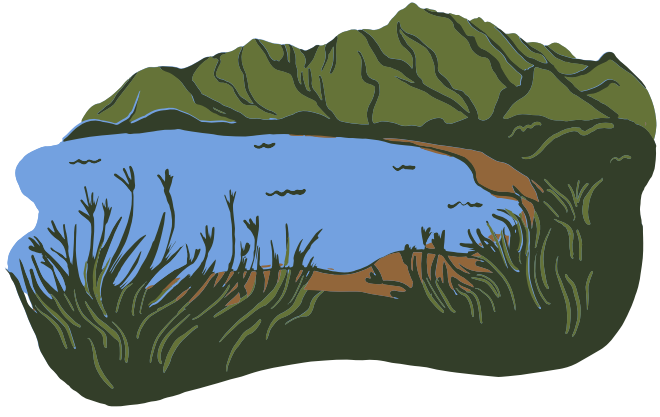
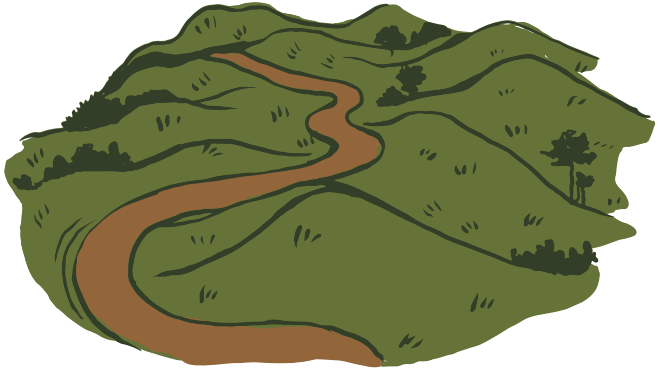


1 Introduction

Imagine a virtual simulation of a hiking trail. What would this look like? To see towering trees, babbling brooks, and ocean cliffs from the comfort of an office; to explore unfamiliar paths of rock, dirt, gravel, and grass; to immerse oneself in a stunning natural landscape without leaving home. This is the vision our project seeks to realize, and the experience we strive to create. In allusion to the *Google Maps* feature known as *Google StreetView*, we call this a 'TrailView.'



Over the last decade, Worcester Polytechnic Institute (WPI) project groups have been working to make this vision a reality. The path to get there, however, has been wending and arduous. Successive groups have fought through technical and methodological challenges to create ever-improving versions of the TrailViews. During the summer of 2023, those challenges fell to us. In this project, we redeveloped the *Acadia Trails* website to transform it into a valuable resource for visitors of Acadia. To achieve this, we identified three key objectives: (1) to redesign the *Acadia Trails* website with the goal of functionality and accessibility, (2) to construct and reconstruct panoramic trail tours that were either missing or of poor quality on the website, and (3) to evaluate the website's effectiveness in meeting the above project goal.

2 Background

In this section we provide background information on the motivating issues behind this year's update of the *Acadia Trails* website, including the project's history and relevance. For this purpose, we first discuss the importance of National Parks as well as the accessibility, safety, and preservation of Acadia National Park specifically. Secondly, we present the project's history since 2012 and why it is properly equipped to address our motivating issues.

2.1 Project Motivation

In order to understand the social and scientific impetus for our project, we must discuss the function of National Parks. To do so, we address three key issues which threaten that functionality, specifically in Acadia National Park.

2.1.1 National Parks' Modern Importance

In today's society, most people are disconnected from the natural world. The United States Environmental Protection Agency (EPA) estimates that the average American citizen spends 90% of their time indoors (US EPA, 2017). This is detrimental to peoples' health and wellbeing for several reasons, including poor air quality, insufficient exposure to sunlight, isolation from nature, and lack of physical activity.

While many people may intuit that their homes are cleaner than outside, this is not true for air quality. Many cleaning products, furnishings, cooking oils, and building materials actively pollute the air inside peoples' homes. Due to the poor ventilation of enclosed spaces as compared to open air, studies have found that the atmosphere inside of a home generally contains two to five times as many pollutants as the air outside (US EPA, 2017). This can aggravate an individual's respiratory system, irritate their eyes and airways, and trigger asthma attacks in susceptible individuals. Spending more time outside is one beneficial way to decrease exposure to those pollutants.

Another benefit of time spent outdoors is the exposure to sunlight. Spending time in the sun increases vitamin D production in the body; this is a vital regulatory agent in the body which directly impacts the operation of more than one thousand genes. Its influence affects systems all throughout the body, from the immune system, to the neuromuscular system, to metabolism (Mead, 2008).

Given its beneficial effects on respiratory health and vitamin D levels, it is clear that time spent outdoors is essential to human health. However, the specific outdoor

environment also plays a key role: time spent in nature—that is, green spaces filled with life and beauty—has the most significant positive effect on mental health and wellbeing.

Human beings' mental health benefits from spending time in more natural environments, whether cultivated or wild (Douglas et al., 2017), (Mantler & Logan, 2015). Studies have long since established that sights of trees, flowers, and other plants can reduce stress and depression. Additionally, Mantler & Logan find that alongside the commonly lauded sense of sight, immersing your other senses in nature is equally beneficial to mental health and wellbeing. They find that natural soundscapes, aromas, and tactile sensations, such as a breeze or the warmth of sunlight, can all have positive impacts on the human mind. While a walk down the street may be a source of fresh air and sunlight, only green spaces, parks, and other natural environments can provide the sights, sounds, and smells that benefit the psychological as well as the physiological.

Lastly, spending time in green spaces and nature also promotes physical activity. It is well-established that physical activity is beneficial to both your physical and mental health, but in today's society, many Americans do not regularly or effectively exercise. Green spaces, especially parks, are built around activities such as hiking, biking, swimming, running, and backpacking, which combat both of those issues (Figure 1). In terms of regularity of exercise, having access to green spaces is shown to increase the likelihood of performing physical activities (CDC, 2022). With regards to effectiveness of exercise, Lawton et al. show that physical activity in nature is even more effective in stress and anxiety reduction than exercise alone indoors (Lawton et al., 2017). Since these activities are not only physical in nature, but also take place in a natural environment, they promote a healthy lifestyle that would be beneficial to many Americans.

Figure 1
Students from the 2023 Acadia National Park cohort walking along the Jordan Pond Path.

Green spaces, parks, and other natural settings can provide definitive benefits to both physical health and mental wellbeing. The increased vitamin D production from spending time in the sunlight, the reduced exposure to pollution, and the general increase in exercise associated with spending time in nature all provide valuable improvements to your health. The exposure to the sights, smells, sounds, and tactile sensations of nature also has a remarkable effect on reducing anxiety and stress, ultimately improving your mental state. All in all, the importance of spending time in natural environments cannot be understated, and therefore the preservation and accessibility of these locations is of paramount importance. Luckily, we find a tremendous provider and protector of such environments in the National Park Service (NPS).

The NPS' publicly advertised goal is to promote green spaces to the public. Their mission statement affirms their commitment to "[preserve] the natural and cultural resources and values of the NPS for the enjoyment, education, and inspiration of this and future generations." They also state their desire to "[cooperate] with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world" (National Park Service [NPS], 2023).

The NPS' mission aligns with their practical work of opening green spaces to the public. In providing access to nature, they positively impact their visitors' health and well-being which serves their stated purpose to provide access to and extend the benefits of the green spaces they upkeep. They accomplish this goal in several manners. First, well-designed parks and trails offer people a safe space to be physically active (CDC, 2022). Many of the park's visitors are from an urban setting, lack access to green areas or hiking trails, and are inexperienced in doing activities in nature. The park system provides them a safe space to experience and explore the outdoors. Additionally, parks are an attempt to give all Americans equitable access to nature. Many people from urban areas also lack equitable access to green spaces; the NPS tries to bridge this gap by providing every person access to the health benefits of nature. The parks are in the unique position to "transcend age, ethnicity, race, income, politics and geography" and improve the physical and mental health of all their visitors (Mozur, 2016).

2.1.2 Accessibility in Acadia

Acadia National Park, which will be henceforth referred to as 'Acadia,' saw more than four million visitors in 2021, and almost as many in 2022 (NPS, 2022), (NPS, 2023). Public appreciation for time spent in nature has increased

significantly in the past decade, especially in the past two years, and the benefits of the parks are reaching an increasing number of people. However, with public awareness of equity issues continuing to grow, we wondered whether all factions of the American public are experiencing this auspicious spike in National Park visitorship equally.

To evaluate this issue, we will consider park accessibility from the perspective of several underprivileged groups. First, Xiao et al. find that racial and ethnic minorities have always been "consistently underrepresented among national park visitors compared to Whites" (Xiao et al., 2018). Additionally, a 2021 survey of the park found that many of its attractions were not sufficiently accessible to people with physical disabilities (Wolter, 2021). These results represent a theme of privilege in which only some people are able to experience the park's attractions, despite the fact that no one faction is more worthy of exposure to our nation's shared natural history and environment than others. It is antithetical to the mission statement of the National Park Service discussed above: how can people be educated and inspired by National Parks if the Parks do not reach all members of the American public equally? Moreover, it is the communities with limited access to the outdoors who most need to understand its importance. This is because, as discussed above, spending time in nature is beneficial to all peoples' physical, mental, and emotional health. These disadvantaged communities are therefore at higher risk for a variety of serious health issues because of their unfairly limited access to natural spaces. Though the park's continued attention will be necessary to address these issues of equity, it can benefit from our concern and efforts as well.

2.1.3 Safety in Acadia

Additionally, when people visit Acadia, they may be unaware of serious safety precautions and accidentally put themselves in a dangerous situation. This concern is demonstrated by the case of a Portland man falling off Precipice Trail on a foggy evening in July of 2018 (Trotter, 2018). To frequent visitors and staff of Acadia, it is well-known that Precipice Trail is the "most difficult, dangerous trail in the park," but to visitors from the other side of the country, it stands out as a fun and challenging hike to a peak of immense beauty. Though the man survived, he experienced significant personal injury due to his lack of understanding of park hazards. Indeed, though it is hardly the deadliest National Park, Acadia sees its fair share of injury and averages one to two deaths every year (Russel, 2012). We must bear in mind that as the park becomes more popular and accessible, so too are more people exposed to

its dangers. All these new visitors will not be adequately prepared for the hazards of the park if they do not fully understand the risks, physical requirements, and appropriate preparations for the activities they set out to do.

2.1.4 Preservation in Acadia

Furthermore, from an ecological perspective, note that Acadia is in a constant state of flux. With Maine's already-variable climate in combination with recent human-caused climate change, the park's environment has shown to be unpredictable. For instance, in 2021, a severe rainstorm heavily damaged the Maple Spring trail and the park's historic carriage roads (Friends of Acadia, 2022), (Hoey, 2021), (Figure 2 & Figure 3). Now, these kinds of shifts are not atypical for any natural environment, but in an era of changing climate it is important to track them with the goal of avoiding future disasters. Indeed, park management is very interested in tracking these changes to decide what changes to "resist, accept, or direct" (NPS, Acadia is Changing). They keep tabs on factors such as sea level, ocean acidity, temperature, and rainfall, as these factors can be early warning signs for larger environmental patterns (NPS, Climate Change). However, the park struggles to maintain an accurate record of visual changes to trails over time. Due to the vast network of over 125 miles of trails, it is not feasible for park rangers to regularly take note of their evolving features. Because of this, if they are heavily affected by disaster, as the Maple Spring trail was in 2021, there exists no record of their previous state. For such an integral part of Acadia's appeal, we wonder if something could be done to preserve the history, and thereby inform the future, of the hiking trails.

Figure 2
2021 erosion of Maple Spring Trail; photo taken by Stephanie Clement (Friends of Acadia, 2022).

significantly in the past decade, especially in the past two years, and the benefits of the parks are reaching an increasing number of people. However, with public awareness of equity issues continuing to grow, we wondered whether all factions of the American public are experiencing this auspicious spike in National Park visitorship equally.

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Figure 3
Erosion of Carriage Roads from June 2021 storm (NPSPhoto).

2.2 Website Project Conceptualization

We now consider the potential role of the *Acadia Trails* website in addressing these concerns. This includes the project history and how its current features can be

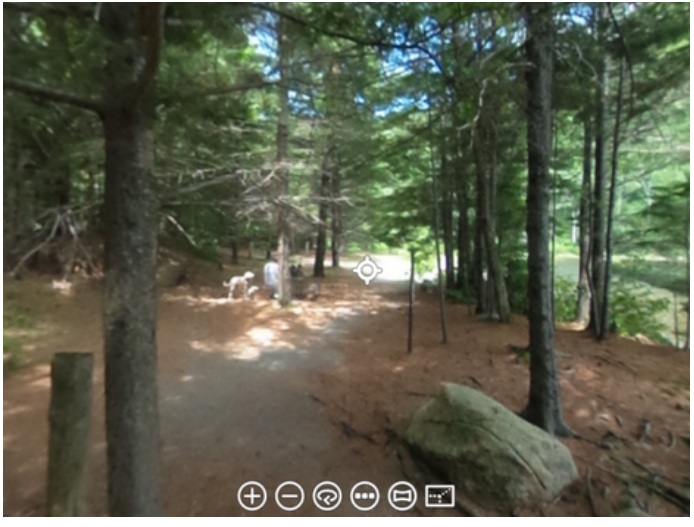
expanded upon to alleviate these motivating issues.

2.2.1 Project History

The TrailView project at WPI has a rich legacy. It began in 2012 with the idea of capturing 360° panoramic trail tours of the hiking trails in Acadia National Park with the goal of spreading environmental awareness (Worcester Polytechnic Institute [WPI], 2012). In this era, 360° camera technology was still new, so the first several groups had to capture these images by taking many still images and stitching them together using photo processing tools. Due to these technological limitations, the earliest groups from 2012 and 2013 were only able to capture short segments of trails over their entire project spans (WPI, 2012), (WPI, 2013).

In 2014, the group improved their photography methods and began development of a website to host their processed trail tours (WPI, 2014), (Figure 4). This paved the way for the 2015 and 2016 teams to greatly ramp up trail photography (WPI, 2015), (WPI, 2016). By the end of the 2016 team's project, nearly every trail in Acadia had been photographed at least once (WPI, 2016). In light of this accomplishment, these TrailViews were stored and no more progress on the project was made for several years.

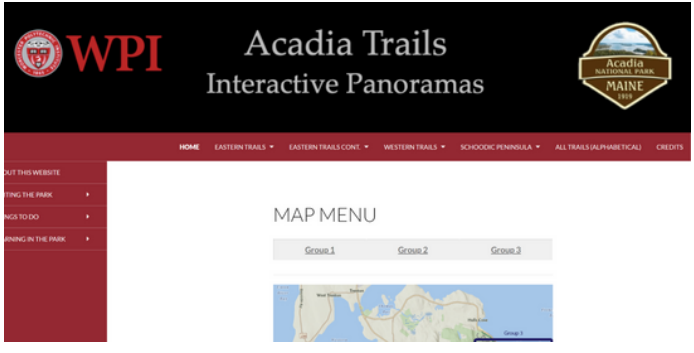
Figure 4
TrailView of the Cadillac West Face Trail taken by the 2016 team (WPI, 2016).



The project was revived in 2020 with a focus on finishing the website initiative the 2014 team had begun (WPI, 2020). They named this website *Acadia Trails*. The team uncovered a lot of bookkeeping issues, particularly trails that had not yet been photographed, and made progress in developing the

website. They also developed a more efficient method of photo processing using a panoramic tour software called *Pano2VR*. Subsequently, the 2021 team worked to fill the holes in the library of trails, recaptured old trails of poor quality, and further developed the website, adding informational pages based on visitor surveys (WPI, 2021), (Figure 5). As our team continued the project, we built on this substantial body of work from past groups which enabled us to bring their vision to new heights.

Figure 5
Homepage of *Acadia Trails* website made by the 2021 team (WPI, 2021).



2.2.2 Project Relevance

Because of this rich history, the *Acadia Trails* website is well prepared to address the accessibility, safety, and preservation issues described above. By re-designing the *Acadia Trails* website and continuing the development of its associated resources, we strive to:

1. Lower the barrier of entry for people to experience Acadia's offerings.

   The *Acadia Trails* website's utility in broadening access to Acadia is twofold. First, note that far more people are able to connect to the internet than are able to visit Acadia. The natural attractions depicted in the website will help motivate people to visit Acadia who would not have known to come otherwise. Alternatively, if such people are still unable to visit Acadia, due to financial barriers, distance, physical ability, or otherwise, the immersive TrailViews give a taste of the park's offerings and act as a way to interact with the park without the commitment of a full visit.

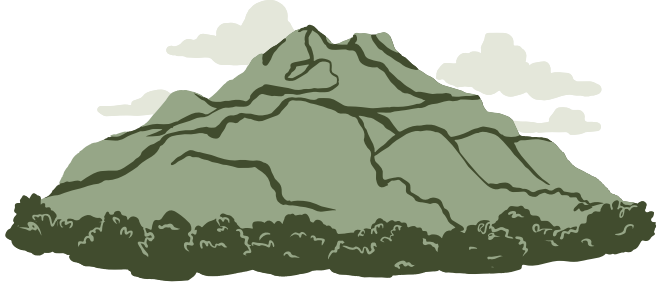
2. Prepare people for their visit to Acadia by informing them of attractions and safety precautions.

An informational website has the ability and responsibility to affect its visitors' perceptions of the attractions it describes. By being judicious with the attractions we choose to include on the website and writing detailed instructions and warnings for best practices in the park, we can encourage visitors of our website to make safe decisions in Acadia. Furthermore, our website's TrailViews offer the unique ability for visitors to scope out the difficulty of trails before visiting them. This allows each visitor to individually determine whether a trail is a good fit for their particular skill-set before embarking upon it.

3. Record the development of trails over time for future study.

   The iterative nature of the project recapturing TrailViews as technology evolves lends itself very well to an archive system. When the Maple Spring trail was destroyed in 2021, it was only WPI that had records of the trail's former state (Friends of Acadia, 2022). With the increasing rate of climate change, it is unknown how many more such events will occur in the future. We want to be prepared for Acadia's emerging future by recording and sharing its past.

In conclusion, the development of the *Acadia Trails* website will build upon the past work of WPI students to benefit the future of the park and its visitors.



3 Goal, Objectives, & Methodology

In this section we explain the various methods used to complete our goal of redeveloping the *Acadia Trails* website to transform it into a valuable resource for visitors of Acadia National Park. To achieve this goal, we identified the following objectives:

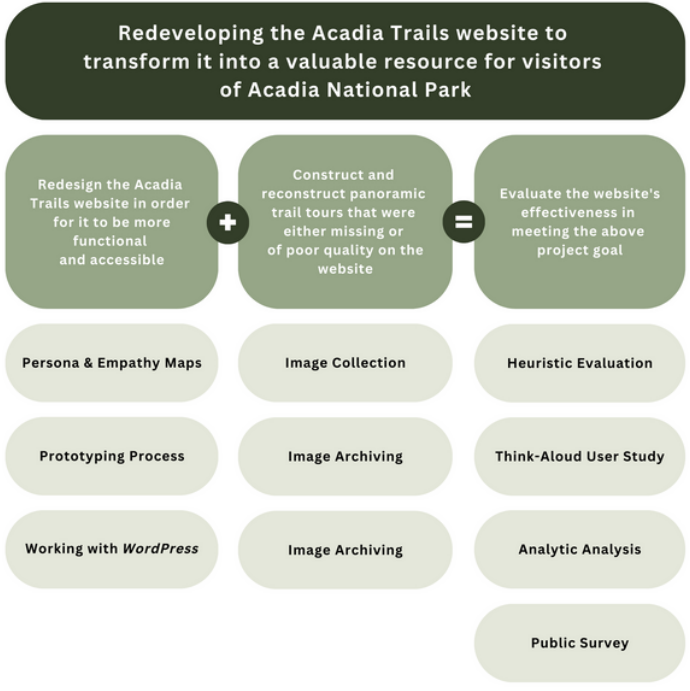
1. Redesign the *Acadia Trails* website in order for it to be more functional and accessible.

2. Construct and reconstruct panoramic trail tours that were either missing or of poor quality on the website.

3. Evaluate the website's effectiveness in meeting the above project goal.

The flowchart to the right outlines our goals that are broken down into objectives and the methods used to achieve them (Figure 6).

Figure 6
Flowchart of goals, objectives, and methods. Generated in *Canva*.



3.1 Website Redesign Process

To achieve our first objective of redesigning the *Acadia Trails* website in order for it to be more functional and accessible, we (1) conceptualized the goals that various visitors of Acadia would be using our website to achieve, (2) prototyped an effective website design that achieved those goals, and (3) implemented the design using the tools made available to us.

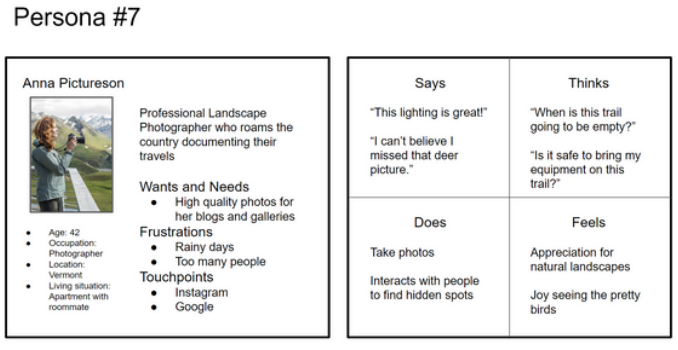
3.1.1 Persona and Empathy Maps

In order to effectively reconstruct the website during our project, we developed a clear set of priorities and a robust plan for the website's design. This creative process occurred before going on-site in Acadia wherein we iteratively constructed a website prototype to guide the project going forward.

In order to better understand our target audience and their needs, we conducted a Persona & Empathy Map exercise (Ferreira et al., 2015). In this exercise, several types of Acadia visitors were brainstormed, each with diverse backgrounds, income levels, ages, motivations, and priorities (Figure 7). Then, we inferred each hypothetical persona's specific wants and needs during their visit to Acadia. Finally, for each persona, we answered four questions: (1) What does this persona *say*? (2) What does this persona *do*? (3) What does this persona *think*? (4) What does this persona *feel*? This exercise gave us a working understanding of what information and website features would be most useful to a broad audience of users.

Figure 7

Persona & Empathy Map example of a photographer looking to visit Acadia. Generated in *Google Slides*.



We identified several commonalities between our seven personas. First, safety information was found to be an important feature for two main reasons. For one, people who

have not spent a lot of time in nature may feel intimidated by their visit to Acadia. We wanted to provide an effective safety resource that makes visitors feel prepared for whatever they may encounter in the park, which both increased their enjoyment of their time in Acadia, as well as allowed them to traverse the park more safely. Conversely, visitors who have spent a lot of time in National Parks may come into Acadia brimming with confidence, thinking themselves above safety protocols due to their experience. Our website endeavored to remind experienced visitors of the risks of each activity they may participate in, and how to mitigate those risks, in a simple way that will not be ignored.

Additionally, traffic around the trails and main attractions of Acadia were of interest to many of the visitors who came to Acadia in search of a quiet, peaceful getaway. To provide for this, we used other online resources, such as AllTrails.com, as well as conversations with park administration and the Friends of Acadia organization, to assign each trail and feature a busyness score of some variety. We also added warnings and additional information to features that have special or particularly notable patterns of visitation (e.g. tends to be highly trafficked in early morning as a sunrise hike, is closed due to falcon nesting season over the summer, etc.). While we were not able to update this with any degree of regularity, it will provide some amount of context to new visitors of the park, helping them make educated decisions about which activities to participate in and when.

Lastly, people who are elderly, ill, or disabled have a shared interest in the physical accessibility of the various attractions around the park. These people would want to know how difficult each trail is, including technical descriptors such as trail length and elevation gain, as well as a simplified interpretation of those factors if they are not familiar with that terminology. They would also be interested in whether they could drive to any given attraction, and what kind of parking to expect.

3.1.2 Prototyping Process

To develop our vision for the website, we constructed two design prototypes using the Figma tool. First, we developed a low-fidelity prototype, which served to roughly test our proposed website structure and navigation with minimal time investment in aesthetic design. Once we were satisfied with the low-fidelity prototype's functionality, we proceeded to a high-fidelity prototype, which was designed to be an approximate model for the final design of the website. As a team, we were very satisfied with the appearance and functionality of the high-fidelity prototype,

and we felt prepared to replicate it in the actual website.

3.1.3 Working with *WordPress*

To put our high-fidelity prototype into practice, we used *WordPress*. *WordPress* is a web content management system which has hosted the *Acadia Trails* website since its creation in 2020. Due to its approachability to non-computer science experts, we elected to continue using it to facilitate future teams' progress on the website. As we began work on the website, our team quickly realized both the benefits and limitations of *WordPress*.

One important benefit of *WordPress* is that it allows for real-time updates and effective collaboration. This enabled our team to quickly start implementing our new design into the actual website. Another benefit of using *WordPress* is its plugin feature. Since the system is widely used, many other companies have created software plugins to help create or enhance website functionality. For example, the software used to create the panoramic tours, *Pano2VR*, has a *WordPress* plugin that allowed us to easily import the tours onto the website pages.

Though there were benefits to using *WordPress*, there were also several limitations. The main concept of *WordPress* is for the developer to choose one of *WordPress's* various themes and fill in the information for his or her company, blog, etc. This allows for the quick creation of high-quality cookie-cutter websites. The problem occurs when you want to personalize these themes. Minimal editing can be completed through various customization options and html code snippets, however, certain options are locked by *WordPress* and cannot be edited. Because of this, as well as time constraints, our end result website did not aesthetically line up with our high-fidelity prototype, but the overall user functionality was the same.

3.2 TrailView Collection

To achieve our second objective to construct and reconstruct panoramic trail tours that were missing from the website or of poor quality, we (1) captured 360° photos along miles of Acadia hiking trails, (2) processed them using the *Pano2VR* software, and (3) archived them using proper file management and nomenclature systems.

3.2.1 Image Collection

The bulk of the physical labor in this project came from the task of manually hiking trails while capturing 360° photos. However, the mindful selection of equipment for this task

and the strategy involved in enacting it efficiently were necessary to collect good quality images in a time-effective manner.

When considering cameras to collect the panoramic images, we focused on three criteria: image quality, affordability, and ease of use. We wanted to improve upon the image quality of the current TrailViews and identified that over half were susceptible to poor image quality. The camera also had to be within a reasonable price range as many high quality panoramic cameras are far too expensive for a project of this magnitude. Lastly, the camera had to be easy to use so every member on the team could use it with minimal training.

Based on these specifications, our team chose to use the GoPro Max. This camera is a GoPro variation that has a 16.6 megapixel camera on both the front and back face so it is capable of taking high quality 360° photos (Figure 8). For camera stabilization, our team used the National Geographic Travel Photo tripod. This tripod had the capability to stand at average chest height and included various leveling options, improving the visual aesthetic of the images.

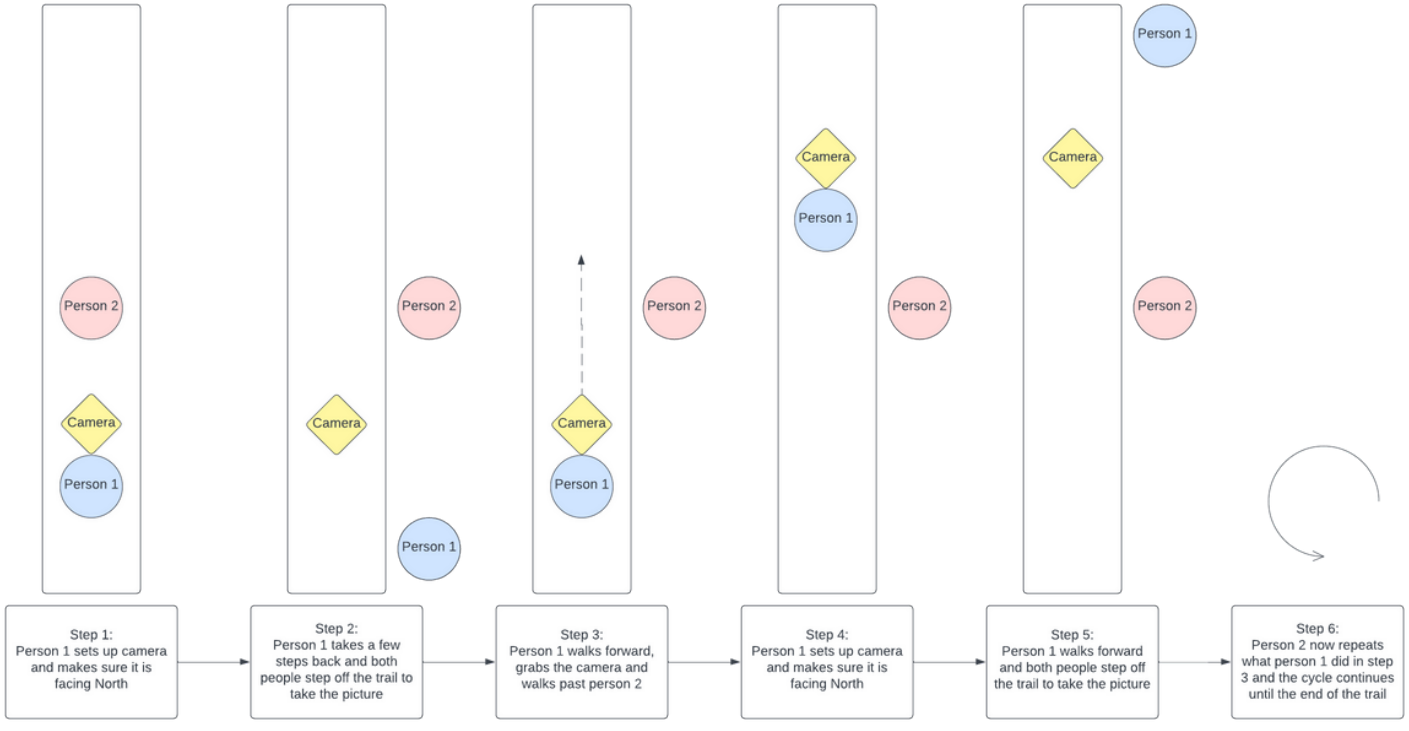
We developed a standardized approach to collecting trail images to ensure consistency. When collecting trail images, a team of at least two people was required. Once on the trail, the team found the desired trailhead and set up the camera. At the trailhead, the team took a preliminary photo with the name of the trailhead written on a notebook, signifying the start of the TrailView. This step was repeated at the end of every TrailView, making it easy for post-image processing and proper archiving.

Figure 8
Team member Nicholas Prayner setting up our equipment during trail collection.

Once the trailhead was marked, we began to collect TrailView photos. The primary method used was termed the “leapfrog method” and is visually depicted in Figure 9. This two-person method limited unnecessary movement along

Figure 9

Diagram of Leapfrog Trail Capture Method. Generated in *LucidChart*.



the trail and divided the work more evenly amongst group members. When approaching sharp turns, very rocky areas, or the beginning and end of the trail, the leapfrog method becomes difficult to manage and one group member often has to walk back to collect the camera. Overall, the strategy greatly improved efficiency of photo collection.

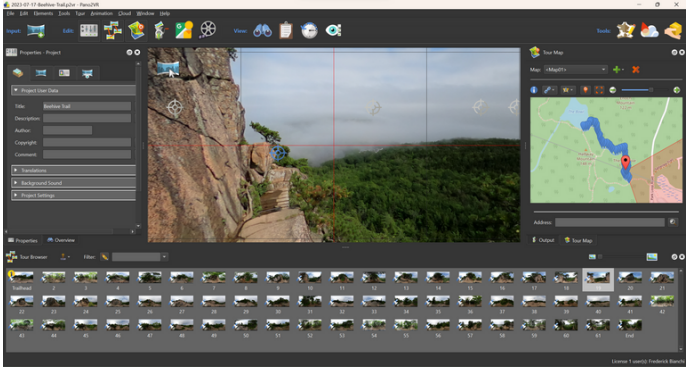
For the distance between photos, we used our best judgment based on the trail terrain and visibility. Generally, photos were spaced approximately 100 to 150 feet apart on straightaways or open areas. For bends and turns, we prioritized taking photos at the apex of the turn to limit redundancy. We also captured lookout spots and other exceptional scenery whenever possible.

Lastly, several setup procedures were enacted to ensure smooth and easy post-production. First, the camera was leveled to limit perspective edits. This was achieved by adapting the legs of the tripod to suit the prevailing landscape. We also used a compass to point the front of the camera towards the north direction. This allowed images to properly line up in relation to each other in post-production, and, once again, limited perspective edits.

3.2.2 Image Processing

Once the 360° images had been obtained, they were processed and stored in a logical and effective manner. These tasks proved to be less than trivial.

Figure 10
Example of a working TrailView in *Pano2VR*.



Pano2VR, our chosen panoramic tour software, was used to stitch together each of the collected 360° trail images into a single virtual tour (Figure 10). All interactive features that allowed the tour to be usable, however, required the addition of a skin to the tour. To reduce the difficulty of

designing a skin, one of the default skins included in *Pano2VR* was modified. This greatly simplified the skin development process, as most of the desired features were already included. The end product of our skin included features such as navigation buttons between images (termed 'nodes'), the addition of full-screen viewing, a menu allowing for faster navigation to intended nodes, and other features such as a map of all nodes. Once our skin was fully developed, it was easy to apply to all trail tours and allowed for intuitive navigation and a cohesive TrailView experience.

After a tour was completed and the skin applied, the next step was to effectively save the tour. This was done so that if the folder containing the project is moved from its original location (including being uploaded to the WPI server and downloaded to a new location), that all images, skins, and other associated files move with the tour and allow for easy tour archiving.

The overall time required to complete a one mile, 100-picture tour using legacy images was roughly 2 hours, while a tour with our new images required roughly 45 minutes. These time estimates provided us a baseline for setting expectations and scheduling.

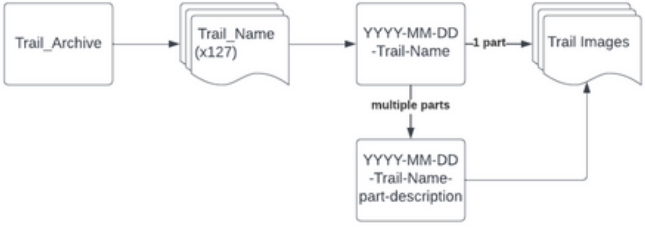
3.2.3 Image Archiving

Another important factor to the longevity of the project was the effective archiving of the 360° pictures and TrailViews from this and previous years. Due to the high quality of the pictures, these files were too large to be stored on a personal computer and other methodologies were needed. Historically, a *Dropbox* folder had been used to store these files, which was managed by our advisor, Prof. Bianchi. However, issues with *Dropbox* permissions and accounts meant that this directory could not be edited by anyone except Prof. Bianchi. As a workaround, files from the *Dropbox* were downloaded onto a 1TB *WD-brand My Passport* hard drive and managed therein until uploaded to the WPI server. On this server there was plenty of storage for the files from our team, as well as the files from past and future teams.

The file management and nomenclature systems from past groups that were left in the *Dropbox* were inconsistent and largely ineffective. In order to develop a workable understanding of the state of the TrailViews, we needed to standardize the storage of the 360° pictures from past years. This involved going through past folders and interpreting their documentation as well as the trail name used for each set of pictures. A new organization scheme,

seen in Figure 11, was developed and allowed for effective inventorying of trail images.

Figure 11
Diagram of Trail Archive organization scheme. Generated in *LucidChart*.



Once this inventorying was performed, several problems became evident. Most notably, the set of trails in the hard drive was inconsistent with the set of trails on the website, which was, itself, inconsistent with the set of trails in the published 2019 National Park Trail Map and website. This, we decided, needed to be corrected according to the Acadia National Park documentation. Additionally, some of the trails were processed into TrailViews on the website without their pictures being archived on the Dropbox. Unfortunately, the tour generation process is irreversible, so we were unable to edit or improve this set of tours without retaking the trail images ourselves. Overall, we spent a lot of time standardizing the archive of previous work so that future teams can proceed forward with a clear understanding of the body of work they are building upon.

3.3 Website Effectiveness

To evaluate the website's effectiveness at satisfying our project objectives, a combination of research methods were employed including (1) a heuristic evaluation, (2) a think-aloud user study, (3) an analytic analysis, and (4) a public survey. Through the use of these research methods, we were able to gain a comprehensive understanding of the website's effectiveness and identify areas for improvement.

3.3.1 Heuristic Evaluation

Our first strategy used to test the website's usability and effectiveness was a heuristic evaluation. A heuristic evaluation is "done by looking at an interface and trying to come up with an opinion about what is good and bad about the interface" (Nielsen & Molich, 1990). The first step in performing this evaluation is coming up with a list of heuristics to use. These typically include concepts such as flexibility, consistency, and aesthetic design. Zhao Huang

and Liu Yuan reworked Nielsen's nine usability heuristics into a list of twelve empirical criteria that we employed in our evaluation (Huang & Yuan, 2017), (Appendix B).

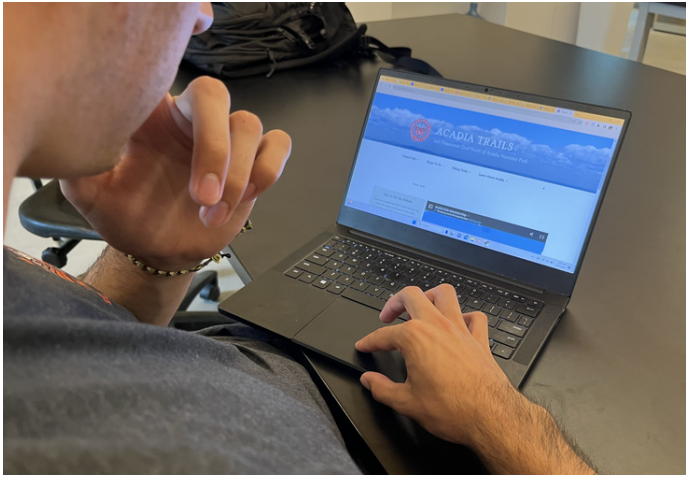
Using these principles to evaluate the original website, we were able to identify its key issues and quantify its overall success. Additionally, a secondary heuristic evaluation was completed after our redesign to measure its overall improvement.

3.3.2 Think-Aloud User Study

Another method used to test the usability and effectiveness of the website was a think-aloud study. In this type of study, participants are asked to verbalize their thoughts and actions as they attempt to complete tasks given to them, allowing us to gain insight into their thought processes and identify potential usability issues (Appendix D). As explained by researchers at the Korea Institute of Science and Technology Information in their study done to improve an online mentoring website, a think-aloud study is a "one-on-one, face-to-face interview between the tester and the testee" in which the testee "express[es] what [they] have in mind," specifically "the reasons for a particular act" (Kim et al., 201), (Figure 12).

For our study, a variety of tasks were given such as finding information on a specific topic or navigating through a trail to find a body of water. Overall, a total of seven users participated in the study.

Figure 12
Example of a user during a think-aloud user study.



This method was particularly useful for assessing whether the TrailView navigational features, the Trail Map and Trail Finder, were effectively implemented and where any

confusion occurred. The insights gained from the think-aloud user study helped create recommendations for future teams to improve the website's navigational experience.

3.3.3 Analytic Analysis

Furthermore, an analysis of the website's analytic data, provided through *Google Analytics*, was used to improve the effectiveness of the website, particularly in regards to search engine optimization (SEO). Using these statistics, we gained insight into our website's target audience and learned about "numerous actions that occur throughout a visit to the website, such as the length of the session, [and] the pages visited during each session" (Sharma et al., 2022).

This information was used to identify the types of users who used the website as well as the usability issues that they encountered. By using this data, we were able to gain a comprehensive understanding of the website's effectiveness and identify areas for improvement in relation to the website's structure, content, and functionality.

3.3.4 Public Survey

Upon completion of the website, a final survey was implemented to evaluate the website's accessibility, breadth of content, and quality of content (Appendix F). The survey contained 3 sections: demographic questions, pre-website questions, and post-website questions.

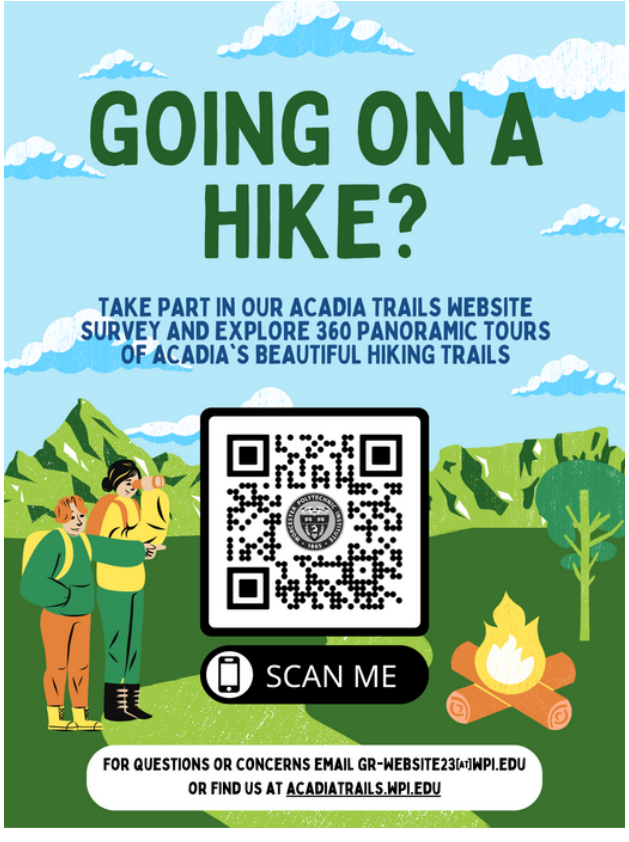
The demographic and pre-website questions were used to determine the website's accessibility to people of different backgrounds. This included not only age, race, and gender, but also general locational information, experience with National Parks, and proficiency with technology.

After using the website, quality and breadth of content was evaluated through the post-website questions. These asked specifically about the quality of informational pages, features such as the Trail Map and the Trail Finder, and TrailViews. Additionally, some open ended questions allowed surveyees to provide specific feedback on website features they found particularly useful (or useless), features or information they believe are missing, and the quality of the website as a whole. These results ultimately provided both qualitative and quantitative feedback with which the overall success of the website was evaluated.

Three methods were used to draw survey users. Firstly, a poster, shown in Figure 13, was prominently displayed at locations throughout Acadia National Park. These locations

included the Hulls Cove Visitor Center, Cadillac Mountain summit, and Wild Gardens of Acadia Nature Center. This poster contained a QR code which linked people to the survey. Secondly, the same poster was digitally distributed amongst various Facebook, LinkedIn, Instagram pages. Lastly, small handouts with links to both the survey and the website were distributed directly to individuals that interacted with team members when conducting field work, primarily during TrailView collection. Combining these methods helped provide exposure to the survey and allow it to reach as many people as possible. Overall, we had 35 survey responses from a diverse group of users.

Figure 13
Acadia Trails survey poster (right). Created in *Canva*.



4 Deliverables & Results

In this section we describe how we utilized the above methodology to complete our goal of redeveloping the *Acadia Trails* website to transform it into a valuable resource for visitors of Acadia National Park. To do so, we present our website redesign, as well as our effectiveness results.

4.1 *Acadia Trails* Website

To demonstrate the accomplishment of the above goal, we direct your attention back to our first two objectives: (1) redesigning the *Acadia Trails* website in order for it to be more functional and accessible, and (2) constructing and reconstructing panoramic trail tours that were either missing or of poor quality on the website. Herein we explain various website components that have been improved, including the website structure, TrailView interface, and navigational features.

4.1.1 Website Structure

When a user arrives at acadiatrails.wpi.edu and is directed to the *Acadia Trails* homepage, either on a mobile device or on a desktop, the beautiful view from the top of Cadillac Mountain greets them (Figure 15). From here, users scroll down to four main menu options: General Info, Things To Do, Hiking Trails, and Learn About Acadia. Each main menu option has various submenus which direct users to informational pages with topics such as safety, recreation, hiking info, and history (Figure 14).

Figure 14
Main menu structure of the *Acadia Trails* website.

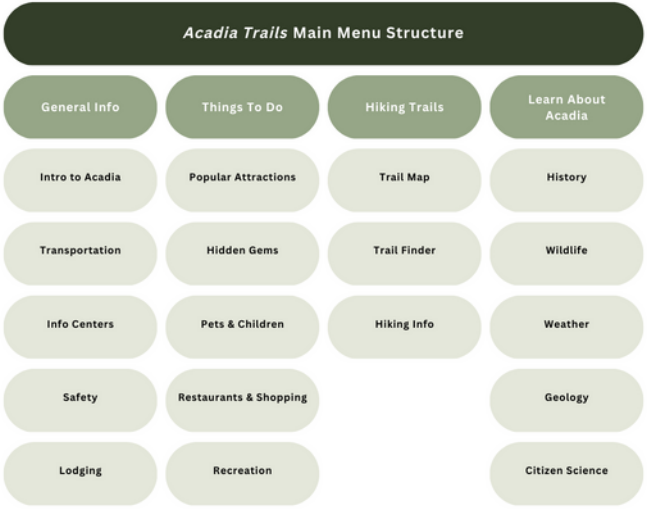
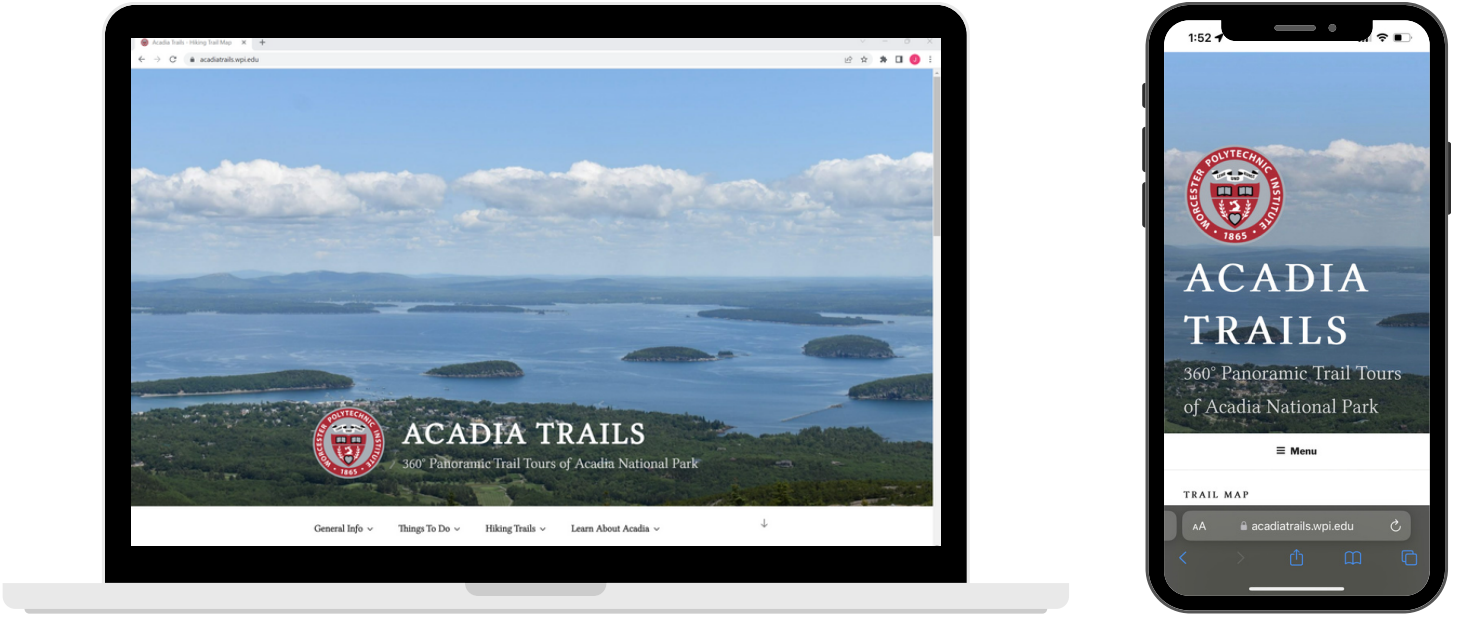
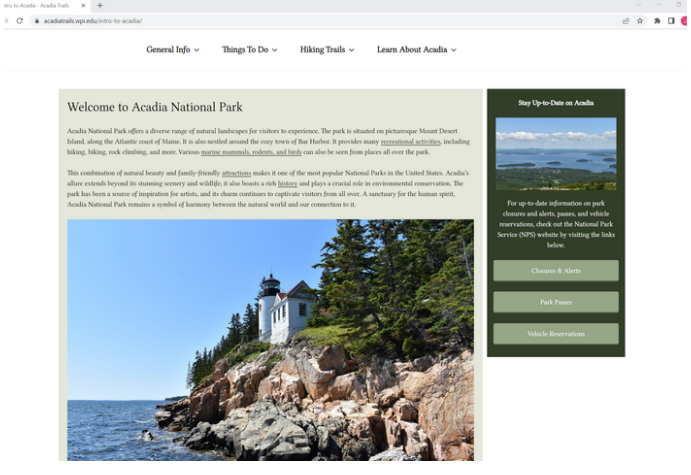


Figure 15
Homepage of the *Acadia Trails* website.



All informational pages contain detailed descriptions of relevant topics for any visitor of the park. Pages also include a dark green sidebar on the right with light green buttons that direct the user to external links with additional information. An example of this can be seen on our Intro to Acadia page that has a link to the NPS website page with the most up-to-date information on park closures and alerts (Figure 16).

Figure 16
Intro to Acadia page of the *Acadia Trails* website.



Of these informational pages, the new *Popular Attractions* and *Hidden Gems* features are some of the most useful. The *Popular Attractions* page gives visitors information about the most beloved attractions in Acadia, such as Cadillac Mountain and the Jordan Pond House. Unfortunately, because of their popularity, these attractions are often crowded and heavily congested. To combat this congestion issue, we created a list of less busy, but still beautiful, attractions that we term 'hidden gems.' Some examples of locations on the *Hidden Gems* page include Dorr Point and Seal Harbor Beach.

Another key feature of the website are the archive pages. The archive pages give users the ability to visualize how the trails have evolved over the years. Each trail page has a dedicated archive button that, when clicked, directs them to an archive page in which every TrailView created for that trail is stored. This allows website users to view the trail over the course of several years and observe how the trail has evolved in that timeframe. It also enables the teams to demonstrate how the TrailView quality and usability has improved over the course of this project's history.

4.1.2 TrailView Interface

Though the informational pages include a variety of hidden

gems, the true treasures of the *Acadia Trails* website lie in the new and improved TrailViews. These TrailViews, created using *Pano2VR*, feature an interactive skin overlying each node. This skin enhances user engagement and is demonstrated in Figure 17.

Figure 17
Annotated TrailView with all major navigational features labeled.

For all new and updated TrailViews, the skin features the name of the trail, a menu, a navigation scrollbar, a directional map, and navigation hotspots. On the menu there is an 'X' icon, a four corners symbol, a globe icon, and an eye icon. These icons and symbols perform the following actions, respectively: closes the menu and navigation scrollbar, toggles fullscreen, toggles perspective mode (allows mobile users to tilt their device to change the view), and hides the navigational hotspots. When the menu is closed, a small icon of 3 horizontal lines appears to allow the user to reopen the menu at any time. The navigation scrollbar on the bottom of the screen allows users to scroll along the trail, previewing thumbnails of nodes. Clicking on any of these images jumps the user directly to that node. When the screen is too small for the scrollbar, a three dot icon appears in its place. This icon toggles a full screen scrolling menu which also shows the nodes, making it more friendly for mobile users. The directional map has GPS data for all of the nodes, shows the user where the current node is, and displays where the user is facing in relation to the rest of the nodes. Clicking on any of the node icons will navigate the user to that node. The 'X' icon in the corner of the map will hide it from view. Finally, the navigation hotspots are aligned with the trail itself and can be clicked to move to the next node in sequence along the trail.

Within each node, *Pano2VR* provides the base functionality to view the full images. Clicking and dragging on an image rotates the view, allowing users to see all 360° of the

image. Additionally, users can zoom into the images. When combining these basic features with the three navigational methods provided by the skin (the scrollbar, map, and hotspots) the result is a fully functional and easily navigable tour of each trail. In total, 41 TrailViews have been remade or retaken with these features.

4.1.3 Navigational Features

To aid users in navigating the TrailViews, two new features have been implemented. One is the Trail Map and the other is the Trail Finder. Each has their own page on the website and can be found in the 'Hiking Trail' menu dropdown.

The first way to navigate our TrailViews is by using the Trail Map (Figure 18). The Trail Map is an interactive map that gives users an intuitive geographic understanding of where points of interest are in Acadia National Park. These points are categorized by color and symbol, as seen within the legend in Figure 18. There are hiking trailheads (blue), significant geographic locations (green), popular attractions (pink), and hidden gems (yellow). As the user clicks on a specific point, a description bar appears. This description directs the user to that location's website page and includes any other necessary safety information, such as a tide chart for Bar Island Trail. This map also features our website's newly added locations, known as popular attractions and hidden gems. It can also be downloaded on mobile devices for offline use when visitors are in the park without internet service.

The second way to navigate our TrailViews is by using the Trail Finder (Figure 19). The Trail Finder allows users to look through our featured trails, sort based on a specific geographic location or options such as difficulty, elevation gain, length, etc., and lastly, find a trail by name in the alphabetical list. Furthermore, the Trail Finder allows users to find a trail fit to their skillset and interest.

Overall, both the Trail Map and Trail Finder are useful features to navigate the TrailViews. You can also be directed to a specific trail by looking it up by name in the search bar, located in the footer of every page.

4.2 Website Effectiveness

To quantify this accomplishment, we will now focus on our third objective: evaluating the website's effectiveness. In this section, we discuss the conclusions drawn from the results of our evaluation methods. To do so, we discuss the website's audience, assess the usability of navigation features, evaluate the value of website information, and

Figure 18
Trail Map from *Acadia Trails* website with major features labeled.

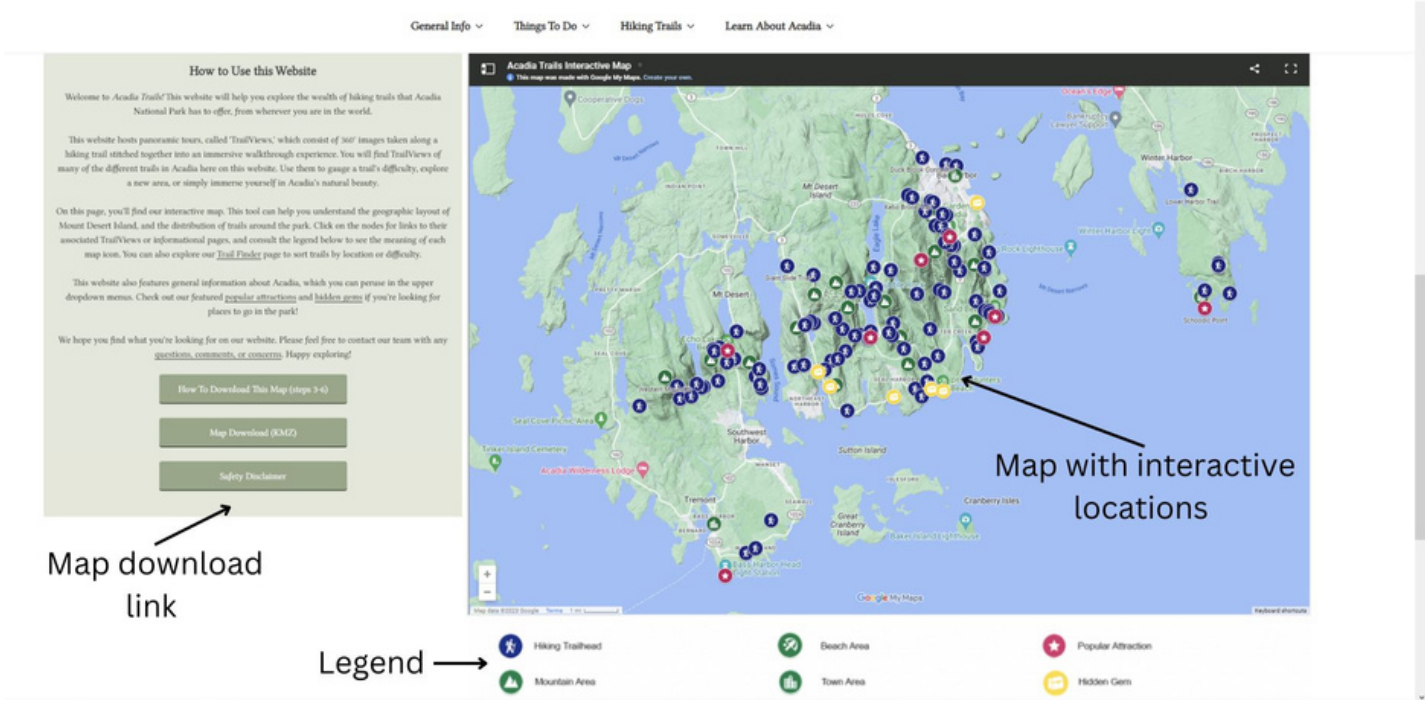
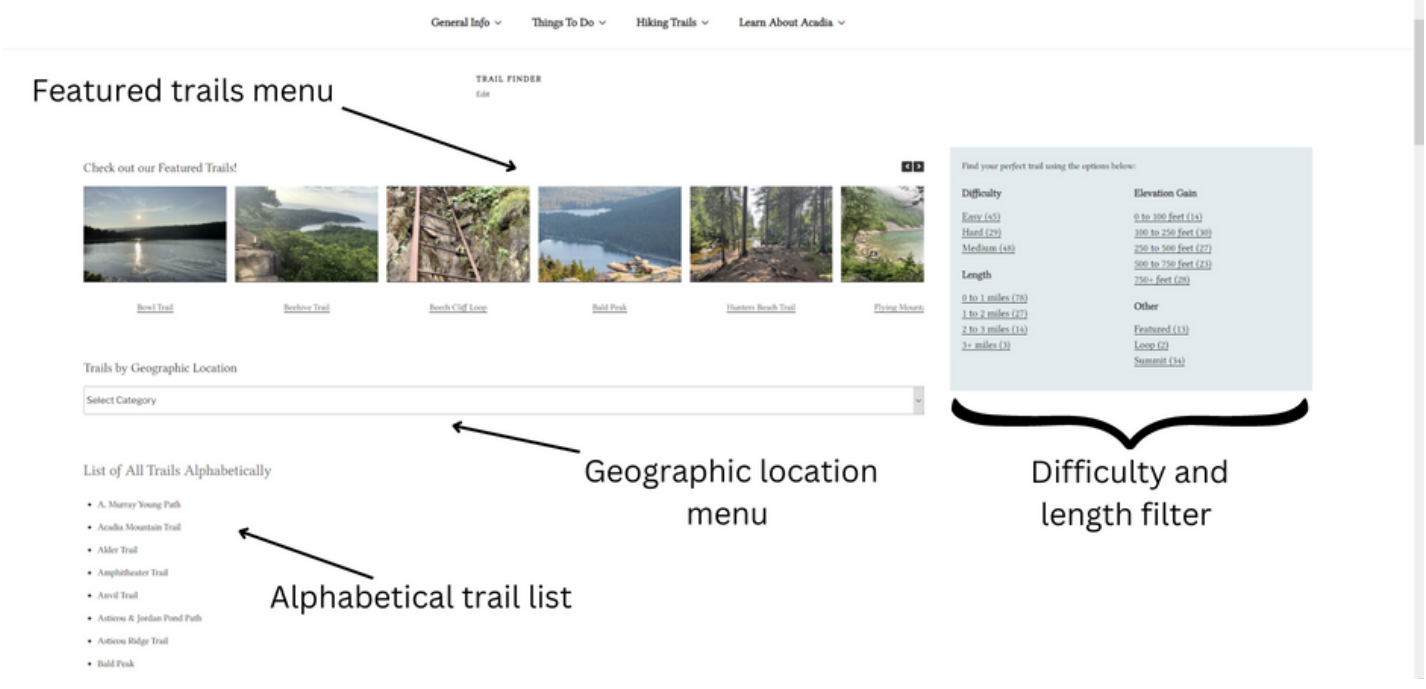


Figure 19
Trail Finder from *Acadia Trails* website with major features labeled.



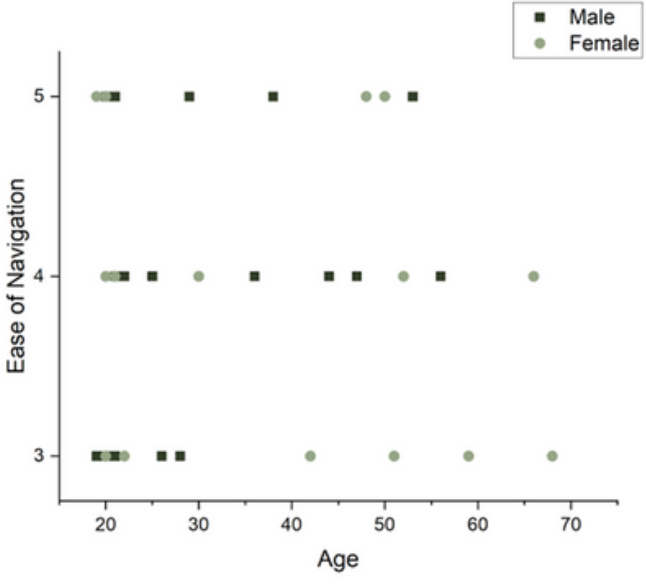
address issues that may have weakened the website's overall effectiveness.

4.2.1 Audience

First, we found that the website was accessible to a broad range of users. Over the past three months using *Google Analytics*, we saw a 240.9% increase in website usership, totaling to 2,000 unique lifetime users. Additionally, in the last month, the website's average search engine position was found to be 13.4. This measure represented the typical position of different website pages on Google in response to various user queries. This was a reasonably good statistic for a small website such as ours, given that we were competing with professional-quality websites like the National Park Service and Friends of Acadia. Overall, this suggested that our implementation of SEO was effective in making our website available to a larger audience.

With regards to different demographic groups, we found that neither age nor gender had a statistically significant correlation with the user's reported ease of navigation around the website (Figure 20). This indicated that the website was equally navigable for people of all ages and genders, which aligned with our project goal.

Figure 20
Graph of responses to ease of navigation plotted against age (x-axis) and gender.



Note. Male is depicted with dark green squares, female is depicted with light green circles Visually, we see no correlation in either of these statistics, which is supported by their R-squared values of 0.0005 and 0.0024 respectively.

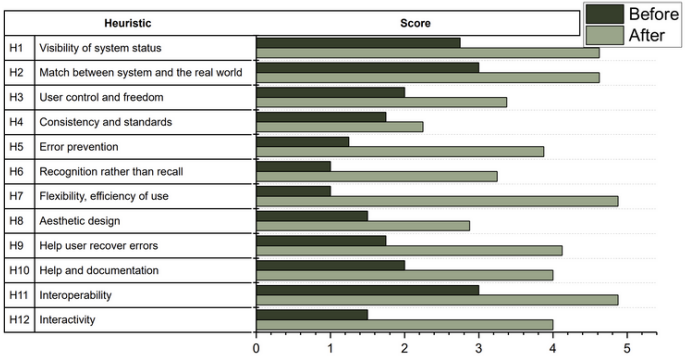
Since our survey respondents were overwhelmingly white, we were not able to determine if a racial correlation with ability to use the website does or does not exist. This could be an area of further study for future groups.

4.2.2 Navigation

Next, we found that the website was intuitive to navigate. This was evidenced by the results of the heuristic evaluation (Figure 21), (Appendix C). Recall that the heuristic evaluation investigated the quality of the user interface that the website created using established categories related to user interaction. Over the course of the website redesign, the average heuristic score increased from 1.88 to 3.90 out of 5, which represented a 108% increase. This shows that overall, the website was significantly more navigable and user-friendly than it was previously. In terms of specific heuristics of note, we remarked that H2 (match between system and real world) and H6 (recognition rather than recall) had the highest new heuristic scores at 4.875 out of 5 respectively. These results reflected the visual power of the website. Through its high-quality photography, both in informational pages and as a part of the TrailViews, users were able to gain an intuitive understanding of real-world locations and various demonstrated concepts. Conversely, H9 (help user recover errors) had the lowest new heuristic score, at 2.25 out of 5. This indicated a need for more redundant features to aid users in avoiding and reacting to getting lost when they encountered an error; for instance, implementation of misspelling support in the search bar.

Figure 21

Heuristic evaluation results before and after 2023 website redesign.



This conclusion is also supported by the results of the think-aloud user study, wherein four participants used both the Trail Map and Trail Finder to navigate the website, and three used only the Trail Finder (Appendix E). Notably, everyone used either one or the other, meaning all

participants were able to navigate between trails successfully. This did indicate that the Trail Finder was more intuitive to use, and supported the idea that the Trail Map could use additional development to fully achieve its potential.

The responses to the public survey are also in line with this result. Participants rated the ease of navigation around the website as a 3.91 out of 5, and the visual design as a 3.82 out of 5. This was very in line with the overall results of the heuristic evaluation (3.88 out of 5), lending validity to both results. Seeing that the theoretical and practical results were consistent indicated that we effectively adhered to website best practices in order to improve website usability.

4.2.3 Information

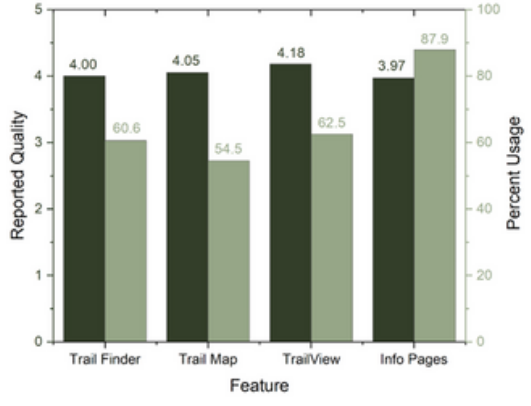
Furthermore, we found that the information presented in the website was useful and comprehensible to users. To demonstrate this, Google Analytics analysis revealed several relevant factors about how and why users visited our website. First, 78.8% of users found our website through organic search, meaning it came up as a result through a search engine, and they clicked on it there. This meant that our website was serving as a way to answer people's direct questions. Next, 70.7% of users accessed the website on a mobile device. This validated the work we did to make the website layout mobile-compatible. It also suggested that users were interacting with the website on the go, as they explored Acadia and thought up questions. However, this result might have been partly due to our distribution of QR codes of the website and survey, which were easier to scan with a mobile device. Most interestingly, our most popular pages tended to be minimally trafficked trails, such as Hadlock Brook Trail, Cadillac Cliffs Trail, and Lower Harbor Trail (Table 1).

Table 1
Statistics for popular trails on the website. Gathered using *Google Analytics*.

Trail	Clicks (past month)	Position (past month)
Hadlock Brook	53	8.8
Cadillac Cliffs	27	6.9
Lower Harbor	24	7.4
Website Average (page-wise)	2.4	16.4

All of these trails tended to be somewhat off the beaten path, meaning that other informational websites were less likely to have detailed information about them. This indicated that the completeness of the trail library afforded it a niche in the realm of informational Acadia websites, to help users find and understand the merits of less popular trails in the park. Overall, our website provided users with information about the park that was comprehensible, and in some cases, totally unique to what they could find from other sources.

Figure 22
Website feature survey responses.



This assertion was supported by the public survey, when the participants were asked to rank their knowledge of Acadia out of five before and after using the website. These scores were on average 2.3 and 3.8 respectively, which represented a 65% increase after viewing the website. However, do note that this metric was a self-evaluation of knowledge, meaning it was partial to the participants' biases about their own intelligence. More so, this demonstrated an improvement in participants' confidence about the park.

Moreover, the survey also demonstrated how participants interacted with specific features of the website. Of the Trail Finder, Trail Map, TrailViews, and informational pages, the survey inquired whether participants were able to find these features, and if so, how they rated their quality. These results, depicted in Figure 22, showed that website feature quality was very consistent, both between the features themselves and the results of the heuristic evaluation (3.88 out of 5). This indicated a cohesiveness and overall quality of all parts of the website. Encouragingly, the TrailViews were the highest-ranked feature, which validated our efforts in improving their quality. Conversely, the informational pages were ranked the lowest, which implied that they could be expanded upon by future teams. With regards to participants' ability to find and use each

feature, the results were less encouraging. Since the informational pages were organized in a similar way to many other websites, it made sense that users were able to navigate the submenus effectively and achieved a high usage rate. For the navigational features, their lower usage rates indicated a need for additional instruction, or development, to make them more intuitive. However, the lower rates may also have been due to poor wording in the survey, with users not realizing they were employing these features to move around the website. Lastly, the low usage rates of the TrailViews was likely due to the overall lack of updated TrailViews on the website, which will be further discussed below.

4.2.4 Lack of TrailViews

Finally, we identified several outstanding issues with the website. Most severely, only one-third of the trails on the website had updated TrailViews, due to time constraints. Although the old TrailViews were stored in archive pages which were publicly accessible, this meant that two-thirds of the trail pages had no TrailView on them. This consistently caused user confusion and frustration. For instance, in the think-aloud user study, four of the seven participants clicked on a trail without a TrailView, causing confusion and often requiring moderator intervention (Appendix E: U2-701, U3-701, U4-701, U6-701). This indicated that actual website users were confused when they inevitably encountered a trail without a TrailView. This issue was rated a severity level of 4, so it should be ameliorated by future teams as soon as possible.

Additionally, in the public survey, we received several written responses criticizing the lack of consistent TrailViews around the website. For example, one participant stated “Many of the trails are missing the 360[°] images.” Another noted that “3D tour[s] [are] a good idea but could be more easily navigable. Not all photos load facing forward along the trail path.” This commentary showed that the old trails in the archive pages were not easy for users to find, and when they did find them (as in the second comment, since all updated TrailViews have properly oriented nodes), their poor quality hampered the user experience. Furthermore, this might have been the reason that 37.5%, a notably high proportion, of survey participants were unable to find a TrailView to interact with. In order to ensure that the core feature of the website is made available to all website users, the remaining TrailViews must be updated and reposted in future years.

5 Recommendations

Our evaluative methods demonstrate that we affected positive change on the website. However, there is still ample space for our work to be revised and built upon in the future. To this end, we now discuss areas for further development and features to future implementation.

5.1 Areas for Further Development

We first discuss the current features of the website which would benefit from further development by future groups. These pertain to the advancement of the Trail Finder, the Trail Map, and general TrailViews.

With regards to the website design itself, we were forced to make several concessions in our design due to time and software constraints. For one, the filtering system in the Trail Finder feature is less robust than we would have liked, as it does not allow for cross-filtering (e.g. searching for a trail by length and geographic location at the same time). Additionally, we believe that with sufficient development time, an interactive map could be constructed within the *Pano2VR* software. Although the current interactive map is sufficient, creating it in *Pano2VR* could visually show the paths of trails, provide a more visually appealing and and customizable layout, and allow users to drop directly into a trail from the interactive map, affording the website more interconnectivity.

With regards to the upkeep of TrailViews, much work remains to be done. Most notably, several TrailViews were found on the website whose images had not been preserved from previous years (Appendix G). These TrailViews were saved privately for archiving purposes, but we determined that they should not be put up on the website because the old TrailView format slows down its processing speed significantly. Therefore, these trails need to be rephotographed and reprocessed so that the website collection of TrailViews is complete and no damage is done to the processing speed of the website. Additionally, many TrailViews still exist that have been reprocessed but have poor-quality images. Although these aren't as pressing of an issue since they don't affect website performance, it would still be prudent to recollect these images with a more modern camera to unify the quality of the trials on the website and continue preservation of the trails over time. Lastly, there still exist some trails which have not been photographed at all. This is primarily due to the trail closures associated with the nesting season of peregrine falcons and the inconsistent naming schemes of the various lists of trails in Acadia. Since the trail closures always occur

at the same time, it will never be possible for a summer IQP team to obtain TrailViews for these trails. Additionally, it would be prudent to communicate with National Park administration to obtain a definitive list of trails and their names as to eliminate confusion between different sources, and ensure that our website contains the complete and accurate set of trails in Acadia.

5.2 Features for Future Implementation

We now discuss features beyond the scope of this year's project which we believe would improve the website. These include concepts such as TrailViews of the carriage roads, utilization of virtual reality, and implementation of large-scale data.

First, though at this point, TrailViews have been collected for most hiking trails, we have not started recording the network of carriage roads that stretches throughout the park. These longer, wider paths would provide different logistical challenges for collecting 360° images which would need to be solved by future teams, but much of the same equipment, strategy, and existing technological infrastructure would be transferable to the new endeavor. Having these roads recorded would help more people understand their function and appeal, thereby making them more accessible to visitors of the park.

Next, we wonder if it would be possible for the TrailViews to be experienced in virtual reality (VR) (Figure 23). Significant research would be required on the process of preparing VR tours and embedding them in the website, but if feasible, this would create a much more immersive experience for users with the proper equipment.

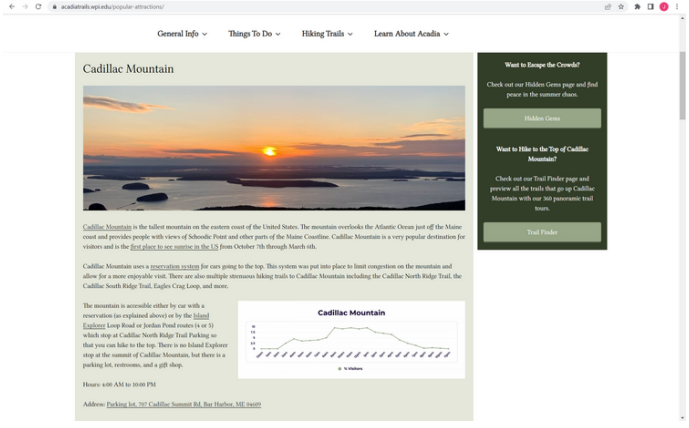
Figure 23
Conceptualization of TrailViews being designed for VR capability.

Lastly, from our Persona and Empathy Map exercise, we hypothesized that many users may be interested in the traffic patterns of the various attractions in Acadia, as this would inform the best times for them to visit these locations. We attempted to fulfill this desire with generic busyness information on the *Popular Attractions* and *Hidden Gems* pages, but this could not be catered to specific times of day, week, or year. An example of this concept can be seen in Figure 24. If it were possible to collect consistent information on these patterns as a live-collected metric, this would be a fantastic tool for visitors of Acadia to make use of.

During the time of this project, two other Acadia research groups were working to collect potential real-time data for this concept. One group was collecting interior movement data in the Hulls Cove Visitor Center and the other group was collecting exterior movement data of cars around the park using License Plate Readers. As these groups have proven the collection of real-time visitor and traffic data possible, future groups will be able to collaborate to make this vision a reality.

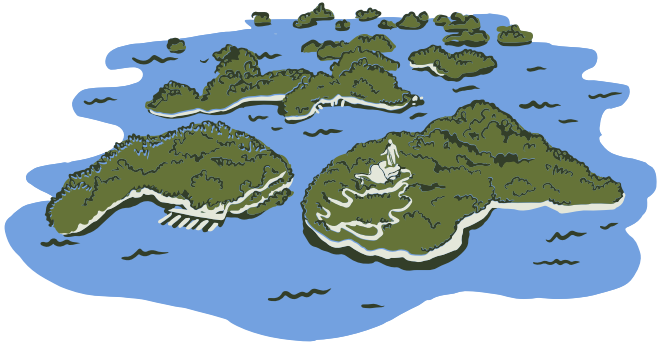
Figure 24

Conceptualization of how to implement traffic pattern data on the *Popular Attractions* page for Cadillac Mountain.



6 Conclusions

Overall, we have transformed the *Acadia Trails* website into a valuable resource for visitors of Acadia. This was accomplished by revising old TrailViews, redesigning the website with a focus on usability, and finally assessing our website's success using several evaluative methods. We have found that the website is capable of reaching a vast audience, has effective navigation, and provides useful information. However, its incomplete TrailView library leaves the door open for future development and the implementation of new features. In closing, we have made great strides in advancing the *Acadia Trails* website, providing an interactive experience of the park now and into the future.



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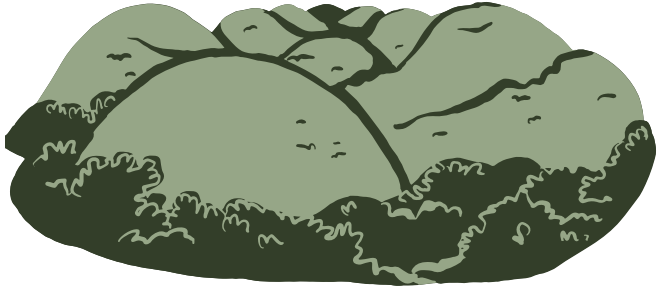
This report was generated in *Canva*; all graphics were created by @sketchifyphilipines and accessed through *Canva*. All photos not explicitly credited elsewhere were captured by the 2023 project team.

Appendices

Appendix A: Note to Future Teams

We have created a hand-off document containing detailed instructions and advice on all the constituent parts of this project, as well as important links and passwords for the various applications involved in the work that we did. There is one hard copy in the GoPro Max case, a link in an unpublished page on the website, and Professors Bianchi and McCauley should each have the document saved on their computers. We may also be able to provide you with this document via email if you really can't find it. We strongly encourage you to find this document so you don't have to re-learn all the project procedures the way we did.



Appendix B: Usability Heuristics

Table 2

Usability Heuristics

No.	Usability Heuristic	Interpretation
H1	Visibility of system status	To keep users informed about their progress
H2	Match between system and the real world	To use the user' language, follow real-world conventions, make information appear in a natural and logical order
H3	User control and freedom	To make undo, redo functions available during interaction
H4	Consistency and standards	To keep the same design features, follow platform conventions
H5	Error prevention	To support users overcome errors, prevent same problem occurrence
H6	Recognition rather than recall	To make information easily remembered
H7	Flexibility, efficiency of use	To consider usage for both novice and experienced users
H8	Aesthetic design	To make minimalist design
H9	Help user recover errors	To precisely indicate the problem, constructively suggest a solution
H10	Help and documentation	To provide help to support user's task completion
H11	Interoperability	To ensure exchanged information, services work together via different systems
H12	Interactivity	To provide rich interactive and social experience

Note. From "Gender differences in tourism website usability: an empirical study," by Huang, Z., & Yuan, L., 2017, *Design, User Experience, and Usability: Understanding Users and Contexts*, (Vol. 10290, pp. 453–461). Copyright 2017 by Springer International Publishing. Note that H13 (security and privacy) was omitted for this study as the website does not store personal information, so it was not considered relevant.

Appendix C: Heuristic Evaluation Results

Table 3

Heuristic Evaluation Results

No.	Usability Heuristic	Score Before Redesign	Score After Redesign	Change
H1	Visibility of system status	1.5	4	+2.5
H2	Match between system and the real world	3	4.875	+1.875
H3	User control and freedom	2	4	+2
H4	Consistency and standards	1.75	4.125	+2.375
H5	Error prevention	1.5	2.875	+1.375
H6	Recognition rather than recall	1	4.875	+3.875
H7	Flexibility, efficiency of use	1	3.25	+2.25
H8	Aesthetic design	1.25	3.875	+2.625
H9	Help user recover errors	1.75	2.25	+0.5
H10	Help and documentation	2	3.375	+1.375
H11	Interoperability	3	4.625	+1.625
H12	Interactivity	2.75	4.625	+1.875
Average		**1.875**	**3.896**	**+2.078**

Note. Above is a table of the results from two heuristic evaluations. The first was completed before the website redesign and the second was completed after. Heuristics highlighted in gray are those limited by the use of WordPress.

Appendix D: Think-Aloud Study

Introduction Script

"Today we will be doing a think-aloud study. What I mean by 'think aloud' is that I want you to tell me everything that you are thinking from the time that you hear the statement of the task until you finish the task. Please don't try to explain to me what you are doing. Just act as if you are alone, speaking to yourself as you solve the problem. I won't be able to answer your questions, but if a question crosses your mind, say it out loud. If you forget to think aloud, I'll say please keep talking. Lastly, remember that *I* am testing the software, not you. If anything is confusing or unclear it is due to poor design and please feel free to say them out loud during your think-aloud. My associate will be taking notes as you do so, but do not let my writing affect your talking, just go at your own pace. This study has minimal to no risks and you are allowed to withdraw from the survey at any time. First we will have you answer a short 2-question consent questionnaire, then we will proceed with the think-aloud."

Note. Questions in red are required, questions in black are optional.

Consent Questions

1. Are you 18 years old or more? (if yes, then 2; if no, then leave)
   a. Yes
   b. No
2. Do you consent to participate? (If yes, then continue to practice task; if no, then leave)
   a. Yes
   b. No

Study Description

We are evaluating the usability and technical efficacy of our newly redesigned website in providing useful information to visitors of Acadia.

Practice Task

Walk us through how many windows are in your house or apartment?

Main Tasks

1. Find the FAQ page
2. Find information about safety

3. Find information about horseback riding
4. Find a trail with a length less than 1 mile with an easy difficulty
5. Find a trail on the Schoodic Peninsula
6. Navigate to live alerts on the official Acadia National Park website
7. Navigate to a 360° interactive trail tour and find a body of water
8. Find and rate a hiking trail you have done

Debrief & Wrap Up Script

"We are now done with our study. Thank you for participating in this think-aloud. Your help is greatly appreciated. Do you have any questions?"

"Thank you and have a good day."

Usability Aspect Reports (UARs) to analyze findings

ID:
Name:
Evidence:
Explanation:
Severity:
Solution:

Appendix E: UAR Chart

Table 4
UAR Chart

ID	Name	Evidence	Explanation	Severity Rating	Solution
U1-001	Domain name issue	User stated “I don’t like the http thing.”	Domain name includes *.wpi.edu* as it is hosted through the WPI server instead of using the more natural *acadiatrails.com* format that users are used to.	1	No action should be taken at this time as this website is hosted through the WPI server and all WPI links have the .wpi.edu structure.
U1-002	Font dislike	User stated “I hate this font.”	User disliked the font choice of the overall website.	1	Potentially change font.
U1-003	Title dislike	User stated “I do not like how this title is small and so in the middle.”	User disliked the formatting of the title on informational website pages.	1	Potentially change title style.
U1-101	Confusion locating FAQ page	User moused over menu options including General Info and Learn About Acadia to find the FAQ page.	User first explored menu options to find the FAQ page instead of instantly looking in the footer.	2	Potentially relocate the FAQ page into General Info or Learn About Acadia menu.
U1-102	Scroll to bottom to find FAQ	User stated “I am going to scroll to the bottom because it wasn’t in any of the obvious menu options.”	User used background knowledge of other websites to navigate to the footer for the FAQ page.	0	N/A

U1-201	Easy navigation to Safety page	User clicked the General Info menu and Safety page.	User easily navigated to the Safety page by going through the General Info menu.	0	N/A
U1-401	Easy navigation to Trail difficulty options	User clicked Hiking Trails, Trail Finder, and Easy difficulty.	User easily navigated to the list of easy trails using the Trail Finder.	0	N/A
U1-402	Easy scroll though easy trails to find < 1 mile	User scrolled through a list of easy trails and located the Jesup Path which was less than a mile.	User easily navigated through the list of easy trails to find one that was also less than a mile in length.	0	N/A
U1-501	Preferred Trail Finder over Trail Map for location task	User clicked on Trail Finder instead of Trail Map.	User preferred to use the Trail Finder and the geographic location dropdown instead of the Trail Map.	0	N/A
U1-502	Schoodic Head Trail length issue	User found trail length in description and length in statistics did not match.	Length in description was trail out in back (double) as compared to length in statistics.	3	Go through trail descriptions and stats to ensure consistency as they are often pulled from different sources.
U1-503	Archive button dislike	User stated “I don’t like the blue archive button.”	User disliked the color choice of the archive button.	1	Potentially change the color of the archive button.
U1-601	Preference of Google for NPS Alerts link	User stated “I can’t just use Google?”	User found the task unnecessary with the existence of the Google search engine.	0	N/A

U1-602	Difficult navigation to NPS Alerts link	User clicked Info Center page and Safety page and states it is an “impossible task” and that the link is “really hidden.”	User was confused about the location of the NPS Alerts link and navigated to many incorrect pages before eventually finding it.	2	Potentially relocate the NPS Alerts link to another page such as Info Centers or Safety.
U1-701	Issue with link opening in new tab	User stated “If I was a grandma I’d be stuck” when being unable to click the back button because the internal link opened in a new tab.	User disliked that the Trail Map link opened in a new tab.	2	Make selected trail links open in the same tab instead of a different one as to aid in back button navigation.
U1-702	Tagline confusion	User clicked the tagline and was confused to be directed to the homepage.	User clicked the tagline and expected to be navigated to a page with the 360-degree panoramic tours.	1	Potentially change tagline to limit confusion.
U1-703	Fast featured trail movement	User states that the featured trails move “way too fast to read.”	Sliding transitions between featured trails are too fast.	3	Slow down sliding transitions.
U1-801	Successful star rating	User clicked the appropriate star rating.	User was able to easily interpret and use the star rating system.	0	N/A
U2-001	Visually appealing homepage	User states “I like this picture and the menu along the bottom.”	User found the homepage visually appealing.	0	N/A
U2-101	Confusion locating FAQ page	User moused over menu options including General Info and Learn About Acadia to find the FAQ page.	User first explored menu options to find the FAQ page instead of instantly looking in the footer.	2	Potentially relocate the FAQ page into General Info or Learn About Acadia menu.

U2-102	Scroll to bottom to find FAQ	User stated “Sometimes FAQ pages are at the bottom, let me look there.”	User used background knowledge of other websites to navigate to the footer for the FAQ page.	0	N/A
U2-201	Easy navigation to Safety page	User clicked the General Info menu and Safety page.	User easily navigated to the Safety page by going through the General Info menu.	0	N/A
U2-401	Easy navigation to Trail difficulty options	User clicked Hiking Trails, Trail Finder, and Easy difficulty.	User easily navigated to the list of easy trails using the Trail Finder.	0	N/A
U2-402	Easy scroll though easy trails to find < 1 mile	User scrolled through a list of easy trails and located the Hemlock Trail which was less than a mile.	User easily navigated through the list of easy trails to find one that was also less than a mile in length.	0	N/A
U2-501	Easy use of Trail Map	User clicked, Hiking Trails, Trail Map, and quickly navigated to the Schoodic Peninsula to click on Lower Harbor Trail.	User easily navigated to a TrailView using the Trail Map.	0	N/A
U2-601	Easy navigation to NPS Alerts link	User clicked on General Info, Intro to Acadia, and found the Closures and Alerts button on the right sidebar.	User easily found the NPS alerts link through recognizing that the dark green sidebar of each informational page held important external links such as the NPS alerts.	0	N/A

U2-701	Lack of updated TrailViews	User clicked on Eagle Lake Trail and Bubbles Trail before finding an updated TrailView on Bar Island Trail.	There are many trails missing updated TrailViews and causing user confusion.	4	Need to continue adding updated TrailViews to improve user experience.
U2-801	Successful star rating	User clicked the appropriate star rating.	User was able to easily interpret and use the star rating system.	0	N/A
U3-101	Confusion locating FAQ page	User moused over menu options including General Info and Learn About Acadia to find the FAQ page.	User first explored menu options to find the FAQ page instead of instantly looking in the footer.	2	Potentially relocate the FAQ page into General Info or Learn About Acadia menu.
U3-102	Scroll to bottom to find FAQ	User stated “Sometimes FAQ pages are at the bottom, let me look there.”	User used background knowledge of other websites to navigate to the footer for the FAQ page.	0	N/A
U3-201	Easy navigation to Safety page	User clicked the General Info menu and Safety page.	User easily navigated to the Safety page by going through the General Info menu.	0	N/A
U3-301	Easy navigation to information about horseback riding	User clicked the Things To Do menu and Recreation page, then scrolled down until they found horseback riding.	User easily navigated to horseback riding information by going through the Things To Do menu and Recreation page.	0	N/A
U3-401	Difficulty order issue	User stated “I don’t like how difficulty goes easy, hard, then medium.”	User disliked how difficult was now in the usually easy, medium, hard order.	1	Create specific tag order instead of default alphabetical order.

U3-402	Easy navigation to Trail difficulty options	User clicked Hiking Trails, Trail Finder, and Easy difficulty.	User easily navigated to the list of easy trails using the Trail Finder.	0	N/A
U3-403	Easy scroll though easy trails to find < 1 mile	User scrolled through a list of easy trails and located the Hemlock Trail which was less than a mile.	User easily navigated through the list of easy trails to find one that was also less than a mile in length.	0	N/A
U3-501	Easy use of Trail Map	User clicked, Hiking Trails, Trail Map, and quickly navigated to the Schoodic Peninsula to click on Schoodic Head Trail.	User easily navigated to a TrailView using the Trail Map.	0	N/A
U3-601	Failed navigation to NPS Alerts link	User clicked on many different pages without finding Alerts link. States they are “confused” multiple times.	User was confused about the location of the NPS Alerts link and navigated to many incorrect pages, ultimately being unable to find it.	2	Potentially relocate the NPS Alerts link to another page such as Info Centers, Safety, or Hiking Info.
U3-701	Lack of updated TrailViews	User clicked on Jordan Pond Path before finding an updated TrailView on Cadillac West Face Trail.	There are many trails missing updated TrailViews and causing user confusion.	4	Need to continue adding updated TrailViews to improve user experience.
U3-801	Successful star rating	User clicked the appropriate star rating.	User was able to easily interpret and use the star rating system.	0	N/A
U4-101	Easily located FAQ page	User stated “The FAQ page is usually at the bottom, let me look there.”	User used background knowledge of other websites to navigate to the footer for the FAQ page.	0	N/A

U4-201	Easy navigation to Safety page	User clicked the General Info menu and Safety page.	User easily navigated to the Safety page by going through the General Info menu.	0	N/A
U4-301	Easy navigation to information about horseback riding	User clicked the Things To Do menu and Recreation page, then scrolled down until they found horseback riding.	User easily navigated to horseback riding information by going through the Things To Do menu and Recreation page.	0	N/A
U4-401	Easy navigation to Trail difficulty options	User clicked Hiking Trails, Trail Finder, and Easy difficulty.	User easily navigated to the list of easy trails using the Trail Finder.	0	N/A
U4-402	Easy scroll though easy trails to find < 1 mile	User scrolled through a list of easy trails and located the Hemlock Trail which was less than a mile.	User easily navigated through the list of easy trails to find one that was also less than a mile in length.	0	N/A
U4-501	Easy use of Trail FInder with geographic location dropdown	User clicked, Hiking Trails, Trail Finder, and quickly navigated to the Schoodic Peninsula using the geographic location dropdown to get to Lower Harbor Trail.	User easily navigated to a TrailView using the Trail Finder.	0	N/A
U4-601	Difficult navigation to NPS Alerts link	User looked through General Info and Learn About Acadia menus, then looked in About This Website and eventually found the link in Intro to Acadia.	User was confused about the location of the NPS Alerts link and navigated to many incorrect pages before eventually finding it.	2	Potentially relocate the NPS Alerts link to another page.

U4-701	Lack of updated TrailViews	User clicked on two different trails before finding an updated TrailView on Cadillac West Face Trail.	There are many trails missing updated TrailViews and causing user confusion.	4	Need to continue adding updated TrailViews to improve user experience.
U4-702	Category list confusion when clicking on trail	User clicked on the description box of the trail instead of the name of the trail while in the Cadillac category list and stated confusion.	User thought they should be able to click any part of the trail preview to access the post, as seen in many other websites with this style of filtering system.	2	Add functionality to click any part of the trail preview to access specific trail instead of just the title.
U4-801	Successful star rating	User clicked the appropriate star rating.	User was able to easily interpret and use the star rating system.	0	N/A
U5-101	Easily located FAQ page	User stated “Let me scroll down and see if it’s at the bottom.”	User used background knowledge of other websites to navigate to the footer for the FAQ page.	0	N/A
U5-201	Easy navigation to Safety page	User clicked the General Info menu and Safety page then stated “That was easy.”	User easily navigated to the Safety page by going through the General Info menu.	0	N/A
U5-301	Confusion on navigation to information about horseback riding	User clicked the Things To Do menu and Pets & Children page before the Recreation page. They then scrolled down until they found horseback riding.	User was initially confused, but eventually navigated to horseback riding information by going through the Things To Do menu and Recreation page.	0	N/A
U5-401	Easy navigation to Trail difficulty options	User clicked Hiking Trails, Trail Finder, and Easy difficulty.	User easily navigated to the list of easy trails using the Trail Finder.	0	N/A

U5-402	Easy scroll though easy trails to find < 1 mile	User scrolled through a list of easy trails and located the Hemlock Trail which was less than a mile.	User easily navigated through the list of easy trails to find one that was also less than a mile in length.	0	N/A
U5-501	Easy use of Trail Finder with geographic location dropdown	User clicked, Hiking Trails, Trail Finder, and quickly navigated to the Schoodic Peninsula using the geographic location dropdown to get to Lower Harbor Trail.	User easily navigated to a TrailView using the Trail Finder.	0	N/A
U5-601	Failed navigation to NPS Alerts link	User clicked on many different pages without finding Alerts link.	User was unable to find the location of the NPS Alerts link and navigated to many incorrect pages, ultimately being unable to find it.	2	Potentially relocate the NPS Alerts link to another page such as Weather.
U5-701	Easy use of featured trails on trail finder	User clicked on Bar Island Trail from featured trails on Trail Finder and quickly located a body of water as directed by the task.	User easily located a trail through the featured trails in the Trail Finder.	0	N/A
U5-702	Fast featured trail movement	User states that the featured trails move “a little too fast.”	Sliding transitions between featured trails are too fast.	3	Slow down sliding transitions.
U5-801	Successful star rating	User clicked the appropriate star rating.	User was able to easily interpret and use the star rating system.	0	N/A
U6-101	Easily located FAQ page	User stated “Here it is at the bottom, just where I’d expect.”	User used background knowledge of other websites to navigate to the footer for the FAQ page.	0	N/A

U6-201	Easy navigation to Safety page	User clicked the General Info menu and Safety page.	User easily navigated to the Safety page by going through the General Info menu.	0	N/A
U6-301	Confusion on navigation to information about horseback riding	User clicked the Things To Do menu and Popular Attractions page before the Recreation page. They then scrolled down until they found horseback riding.	User was initially confused, but eventually navigated to horseback riding information by going through the Things To Do menu and Recreation page.	0	N/A
U6-401	Easy navigation to Trail difficulty options	User clicked Hiking Trails, Trail Finder, and Easy difficulty.	User easily navigated to the list of easy trails using the Trail Finder.	0	N/A
U6-402	Easy scroll though easy trails to find < 1 mile	User scrolled through a list of easy trails and located the Hemlock Trail which was less than a mile.	User easily navigated through the list of easy trails to find one that was also less than a mile in length.	0	N/A
U6-501	Easy use of Trail Map	User clicked, Hiking Trails, Trail Map, and eventually navigated to the Schoodic Peninsula to click on Sundew Trail.	User navigated to a TrailView using the Trail Map.	0	N/A
U6-601	Failed navigation to NPS Alerts link	User clicked on many different pages without finding Alerts link.	User was unable to find the location of the NPS Alerts link and navigated to many incorrect pages, ultimately being unable to find it.	2	Potentially relocate the NPS Alerts link to another page such as Weather or Info Centers.

U6-701	Lack of updated TrailViews	User clicked on two different trails before finding an updated TrailView on Bar Island Trail.	There are many trails missing updated TrailViews and causing user confusion.	4	Need to continue adding updated TrailViews to improve user experience.
U6-702	Easy use of featured trails on trail finder	User clicked on Bar Island Trail from featured trails on Trail Finder and quickly located a body of water as directed by the task.	User easily located a trail through the featured trails in the Trail Finder.	0	N/A
U6-801	Confusion when rating trail	Clicked on “Rate this” instead of clicking on the stars.	User was confused of how to rate a trial.	1	Make the star rating bigger to limit initial confusion.
U7-101	Easily located FAQ page	User stated “Right where it usually is.”	User used background knowledge of other websites to navigate to the footer for the FAQ page.	0	N/A
U7-201	Easy navigation to Safety page	User clicked the General Info menu and Safety page.	User easily navigated to the Safety page by going through the General Info menu.	0	N/A
U7-301	Easy navigation to information about horseback riding	User clicked the Things To Do menu and Recreation page, then scrolled down until they found horseback riding.	User easily navigated to horseback riding information by going through the Things To Do menu and Recreation page.	0	N/A
U7-302	Dislike of titles	User stated “I don’t like how the title is sometimes repeated on pages.”	User disliked how some titles appear in the whitespace as well as in the colored box.	1	Potentially remove the second appearance of the title in a colored box.

U7-401	Easy navigation to Trail difficulty options	User clicked Hiking Trails, Trail Finder, and Easy difficulty.	User easily navigated to the list of easy trails using the Trail Finder.	0	N/A
U7-402	Easy scroll though easy trails to find < 1 mile	User scrolled through a list of easy trails and located the Hemlock Trail which was less than a mile.	User easily navigated through the list of easy trails to find one that was also less than a mile in length.	0	N/A
U7-501	Easy use of Trail FInder with geographic location dropdown	User clicked, Hiking Trails, Trail Finder, and quickly navigated to the Schoodic Peninsula using the geographic location dropdown to get to Lower Harbor Trail.	User easily navigated to a TrailView using the Trail Finder.	0	N/A
U7-601	Failed navigation to NPS Alerts link	User clicked on many different pages without finding Alerts link and stated things such as “I have no idea where this is” and “I think I’m missing it.”	User was unable to find the location of the NPS Alerts link and navigated to many incorrect pages, ultimately being unable to find it.	2	Potentially relocate the NPS Alerts link to another page such as Info Centers or Popular Attractions.
U7-701	Easy use of featured trails on trail finder	User clicked on Bar Island Trail from featured trails on Trail Finder and quickly located a body of water as directed by the task.	User easily located a trail through the featured trails in the Trail Finder.	0	N/A
U7-801	Successful star rating	User clicked the appropriate star rating.	User was able to easily interpret and use the star rating system.	0	N/A

Note. Above is a chart of Usability Aspect Reports (UARs) created after conducting the think-aloud user study. Highlighted in red are those with a high severity rating and highlighted in yellow are those with a medium severity rating. Severity was ranked from 0 (low) to 4 (high).

Appendix F: *Acadia Trails* Survey

Consent Script

Why is this study being done? This survey is about the accessibility and content concerns of the *Acadia Trails* website.

Do I have to participate? No, your participation in this study is voluntary.

What is involved in this research study? This study should take 10-15 minutes and we will be asking you general demographic questions along with questions about the quality and accessibility of our website.

What are the risks of participation? The participation risks in this survey are minimal to none. No questions are expected to cause discomfort and nearly all are optional. This set of questions have been approved by the Institutional Review Boards at Worcester Polytechnic Institute.

How will my privacy be protected? All individual responses to this survey will be kept completely anonymous.

Who can participate? This survey is open to anyone above the age of 18 with an interest in visiting or learning about Acadia National Park.

What are the benefits to participating? Your participation in this study will help the functionality, accessibility, and quality of the WPI *Acadia Trails* website.

Note. Questions in red are required, questions in black are optional.

Consent Reminder

Remember, your participation in this study is voluntary so you can exit the survey at any time. Also, the participation risks in this survey are minimal to none. No questions are expected to cause discomfort and nearly all are optional, except for questions related to age and consent. This set of questions have been approved by the Institutional Review Boards at Worcester Polytechnic Institute.

Consent Questions

1. Are you 18 years of age or older? (if yes, then 2; if no, then submit form)

a. Yes
b. No

2. Do you consent to participate? (If yes, then 3; if no, then submit form)
   a. Yes
   b. No

Study Description

Hello! We are a team evaluating the effectiveness of our newly redesigned website in providing useful information to visitors of Acadia National Park. We are interested in determining whether our website is accessible to people of different backgrounds, which is why we are collecting demographic information.

After asking a few questions to learn about your background, we will ask you a series of questions about your familiarity with Acadia National Park. Then, you follow the link to the *Acadia Trails* website and spend some time exploring it. When you are done, we will ask a few more questions about how you perceived the website.

All demographic questions are optional. Please answer questions to the best of your knowledge and comfort level. You do not have to answer anything you do not want to disclose, but remember that this survey is completely anonymous.

Demographic Questions

3. What is your age?
   a. (short answer text)
4. What gender do you identify with?
   a. Male
   b. Female
   c. Do not want to specify
   d. Other (specify):
5. What race(s) do you identify with? (select all that apply)
   a. White
   b. Black or African American
   c. American Indian or Alaska Native
   d. Asian
   e. Native Hawaiian or Other Pacific Islander
   f. Do not want to specify
   g. Other (specify):

Pre-Website Questions

Before looking at the *Acadia Trails* website, please answer the questions below so we can understand your familiarity with Acadia National Park.

6. Where are you coming from to visit Acadia National Park?
    a. Local (within 50 miles of Bar Harbor, Maine)
    b. New England
    c. USA
    d. Canada
    e. International
7. What type of environment do you live in?
    a. Rural
    b. Suburban
    c. Urban/city
8. How many times have you visited Acadia National Park before?
    a. 0
    b. 1-2
    c. 3+
9. How many times have you visited National Parks other than Acadia?
    a. 0
    b. 1-2
    c. 3+
10. On a scale from 1-5, how would you rank your proficiency with technology?
    a. 1 (Very poor)
    b. 2
    c. 3
    a. 4
    b. 5 (Highly proficient)
11. Prior to using the website, on a scale from 1-5, how would you rank your knowledge of Acadia National Park?
    a. 1 (Not knowledgeable at all)
    b. 2
    c. 3
    d. 4
    e. 5 (Extremely knowledgeable)
12. Prior to using the website, on a scale from 1-5, how likely are you to visit Acadia National Park?
    a. 1 (Not likely at all)
    b. 2
    c. 3
    d. 4
    e. 5 (Extremely likely)

Post-Website Questions

Please follow the link below to the *Acadia Trails* website and spend some time exploring it. When you are done, return here to answer a few more questions about how you perceived the website so we can understand how it felt to use.

Acadia Trails Website Link: https://acadiatrails.wpi.edu/

13. On a scale from 1-5, how would you rate your ease of navigation around the website?
    a. 1 (Extremely difficult)
    b. 2
    c. 3
    d. 4
    e. 5 (Extremely easy)
14. On a scale from 1-5, how would you rate the visual design/aesthetic appeal of the website?
    a. 1 (Very unattractive)
    b. 2
    c. 3
    d. 4
    e. 5 (Very attractive)
15. Were you able to find the panoramic trail tours on the website?
    a. Yes
    b. No
16. If you answered yes to question 15 (above): On a scale from 1-5, how would you rank their [the panoramic trail tours'] quality?
    a. 1 (Extremely low)
    b. 2
    c. 3
    d. 4
    e. 5 (Extremely high)
17. Were you able to find any informational pages on the website?
    a. Yes
    b. No
18. If you answered yes to question 17 (above): On a scale from 1-5, how would you rank their [the informational pages'] quality?
    a. 1 (Extremely low)
    b. 2
    c. 3
    d. 4
    e. 5 (Extremely high)
19. Did you try out the Trail Finder feature on the website?
    a. Yes
    b. No
20. If you answered yes to question 19 (above): On a scale from 1-5, how would you rank its [the Trail Finder's] ease of use?
    a. 1 (Extremely difficult)
    b. 2
    c. 3
    d. 4
    e. 5 (Extremely easy)
21. If you answered yes to question 19: Do you have any

comments on the Trail Finder feature? (Missing filter options, ease of use, etc.)
   a. (long answer text)
22. Did you try out the Trail Map feature on the website?
   a. Yes
   b. No
23. If you answered yes to question 22 (above): On a scale from 1-5, how would you rank its [the Trail Map's] ease of use?
   a. 1 (Extremely difficult)
   b. 2
   c. 3
   d. 4
   e. 5 (Extremely easy)
24. If you answered yes to question 22: Do you have any comments on the Trail Map feature? (Missing trailheads, ease of use, etc.)
   a. (long answer text)
25. After using the website, on a scale from 1-5, how would you rank your knowledge of Acadia National Park?
   a. 1 (Not knowledgeable at all)
   b. 2
   c. 3
   d. 4
   e. 5 (Extremely knowledgeable)
26. After using the website, on a scale from 1-5, how likely are you to visit Acadia National Park?
   a. 1 (Not likely at all)
   b. 2
   c. 3
   d. 4
   e. 5 (Extremely likely)
27. Do you have any other observations, recommendations, criticisms, or comments?
   a. (open-ended)

Appendix G: Trail List

Table 5
Comprehensive Trail List

Trail Name	Most Recent TrailView	TrailView Reconstructed in 2023
A. Murray Young Path	2015	Yes
Acadia Mountain Trail	2021	No
Alder Trail	2015	Yes
Amphitheater Trail	2016	Yes
Anvil Trail	2015	No
Asticou & Jordan Pond Path	2015	No
Asticou Ridge Trail	2021	No
Bald Peak	2015	Yes
Bar Island Trail	2023	Yes
Beachcroft Path	2016	Yes
Beech Cliff Loop	2021	No
Beech Mountain Loop	2016	No
Beech Mountain South Ridge Trail	2016	Yes
Beehive Trail	2023	Yes
Bernard Mountain Trail	2016	Yes
Birch Spring Trail	2021	No
Bowl Trail	2015	No
Breakneck Road	2021	No
Bubble & Jordan Pond Path	2015	No
Bubbles Divide	2021	No
Bubbles Trail	2015	No
Buck Cove Mountain Trail	2015	No
Cadillac Cliffs Trail	2015	No
Cadillac North Ridge Trail	2021	Yes

Cadillac South Ridge Trail	2015	Yes
Cadillac West Face Trail	2023	Yes
Canada Cliff Trail	2021	No
Canon Brook Trail	2015	No
Champlain North Ridge Trail	2021	Yes
Champlain South Ridge Trail	2016	Yes
Cold Brook Trail	2016	Yes
Compass Harbor Trail	2021	No
Day Mountain Trail	2016	No
Deer Brook Trail	2016	No
Dorr North Ridge Trail	2015	No
Dorr South Ridge Trail	2015	Yes
Duck Brook Connector	2021	No
Eagle Lake Trail	2015	No

Eagles Crag Loop Trail	2021	Yes
East Trail	2021	Yes
Eliot Mountain Trail	2021	No
Emery Path	2023	Yes
Flying Mountain Trail	2021	No
Friends Path	2021	No
Giant Slide Trail	2015	No
Gilley Trail	2016	No
Goat Trail	2015	No
Golf Course Trail	2021	No
Gorge Path	2015	No
Gorham Mountain Trail	2015	No
Grandgent Trail	2016	No
Great Head Trail	2021	Yes

Great Meadow Loop	2021	No
Great Notch Trail	2016	No
Hadlock Brook Trail	2021	No
Hadlock Ponds Trail	2016	No
Harbor Brook Trail	2021	No
Hemlock Road	2021	No
Hemlock Trail	2021	Yes
Hio Road	None	N/A
Homans Path	2023	Yes
Hunters Beach Trail	2021	Yes
Hunters Brook Trail	2015	No
Hunters Cliff Trail	2021	Yes
Jesup Path	2021	No
Jordan Cliffs Trail	2016	No

Jordan Pond Carry	2015	No
Jordan Pond Nature Trail	2015	No
Jordan Pond Path	2016	No
Jordan Stream Path	2016	No
Kane Path	2023	Yes
Kebo Brook Trail	2015	No
Kebo Mountain Trail	2021	No
Kurt Diederich's Climb	2023	Yes
Ladder Trail	2023	Yes
Ledge Trail	2021	No
Long Pond Trail (Great Pond Trail)	2016	No
Lower Day Mountain Trail	2021	Yes
Lower Harbor Trail	2015	No
Man O' War Brook Fire Road	2021	No

Mansell Mountain Trail	2016	Yes
Murphy Lane	2021	No
Norumbega Connector Trail	2021	No
Norumbega Mountain Trail	2015	No
Ocean Path	2015	No
Orange & Black Path	None	N/A
Otter Cove Trail	2021	No
Parkman Mountain Trail	2015	No
Pemetic East Cliff Trail	2015	No
Pemetic North Ridge Trail	2021	No
Pemetic North West Trail	2015	No
Pemetic South Ridge Trail	2015	No
Penobscot Mountain Trail	2016	No
Perpendicular Trail	2016	No

Precipice Trail	None	N/A
Quarry Trail	2021	No
Razorback Trail	2021	No
Sargent East Cliffs Trail	2016	No
Sargent Northwest Trail	2016	Yes
Sargent South Ridge Trail	2016	No
Satterlee Trail	2021	No
Schiff Path	2023	Yes
Schoodic Head Trail	2015	No
Schooner Head Path	2021	No
Seaside Path	2021	No
Ship Harbor Nature Trail	2021	No
Shore Path	2021	No
Sluiceway Trail	2016	Yes

Spring Trail	2016	No
St. Sauveur Trail	2016	No
Stratheden Trail	2021	No
Sundew Trail	2021	No
Triad Pass Trail	2015	No
Triad Trail	2015	No
Valley Cove Road	2021	No
Valley Cove Trail	None	N/A
Valley Peak Trail	2016	No
Valley Trail	2016	Yes
West Ledge Trail	2016	Yes
West Ridge Trail	2021	Yes
Western Mountain Connector	2023	Yes
Wonderland Trail	2015	No