



WPI

Bar Harbor Project Center

Trail View Hiking: Interactive Panoramas

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Abstract

The National Park Service (NPS) has, in recent years, worked to transition many of its great offerings to be both digital and in-person. To help with this, Acadia National Park teamed up with WPI to create the Trail View Hiking Team in 2012 whose goal was to take panoramic photographs of all the trails in the park. Previous Trail View Hiking Teams photographed most trails in Acadia National Park but hadn't created virtual tours or a website to house the photos. The 2020 Trail View Hiking Team set out with the goal of making the virtual tours accessible to the public on a website by making 92 virtual tours and an informative website. This was done to help to increase Acadia National Park's digital offerings and interest in the trails.

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Executive Summary

The goal of the National Park Service (NPS) is to preserve the land of the park while making it accessible to the public. In 2011, the NPS released *A Call to Action* which called upon all National Parks to complete 4 main objectives before the centennial of the NPS in 2016 (NPS 2014). These 4 objectives were broken down into 36 calls to action which included parks increasing their digital offerings to the public, engaging national park visitors with interpretive media, and enhancing the connection of densely populated, diverse communities to the parks. (NPS 2014).

The Trail View Hiking Project was started in 2012 to bring Acadia National Park into the digital age by taking panoramic images of all the trails in the park and creating virtual tours of those trails that could then be accessed by the public. Each year, a new team took photos of different trails of Acadia National Park until the entire park was mostly documented. The 2012, 2013, and 2014 teams' efforts were severely limited due to the time-consuming nature of the technology. The 2013 team made a proof of concept for the whole project by taking panoramic pictures of an entire trail, creating a virtual tour, and putting the tour onto the website they created (2013 Trail View Team). The 2015 team obtained a Ricoh Theta camera that allowed them to take panoramic pictures (Figure 1). Thus, the 2015 Team was able to take pictures of 64.5 of 130 miles of trails (2015 Trail View Hiking Team). The 2016 team continued taking pictures with the Ricoh Theta and was able to take panoramic pictures of almost all of the remaining trails in Acadia National Park (2016 Trail View Hiking Team).



Figure 1: Panoramic Picture Taken by 2015 Team

The 2020 Trail View Hiking Team's goal was to create virtual tours for the trails in the park using the pictures from previous IQP Teams and build a website to house the tours to make them accessible to the public. All the virtual tours were created using a software called Pano2VR which takes folders of pictures and auto-sequences them to create the tour. During the IQP, 92 virtual tours were completed. These tours were taken and put on a website created by the team, which was hosted on the WPI server (Figure 2). Also, the website contains maps of the trails and their descriptions.



Figure 2: Home Page of Website Created by 2020 Team

Our recommendations for the next Trail View Hiking Team include photographing the remaining trails and creating functioning, interactive maps on the website. Since the 2015 and 2016 Trail View Hiking Teams were unable to photograph all of the trails, the website is not fully complete. Adding in the remaining trails would complete the full database of trails. Also, if possible, we recommend making all trails accessible from an interactive map. Most of the other websites that cover Acadia National Park trails have interactive maps. These interactive maps allow users to easily go through the park and see where all of the trails are located. Thus, the website will be more user-friendly and be able to compete with other Acadia National Park trail websites.

1. Introduction

Since 1916, Acadia National Park has been visited by millions of people from all over the world who come to see its natural beauty. However, some potential visitors can't experience the wonders of Acadia because of disability, distance from the park, or financial reasons. To help increase access to the park's trails, WPI collaborated with Acadia National Park to create comprehensive 360-degree virtual tours of the trails. This collaboration helps people to virtually access the trails of Acadia National Park, regardless of their capability to visit the park.

In preparation for the centennial of the establishment of the National Park Service, *A Call to Action* was originally published in 2011 by the NPS and called upon all National Park Service employees and directors to complete 4 main objectives before 2016 (NPS 2011). *A Call to Action* was re-published in 2014 with updates on the action points that had already been completed. The NPS had 36 action points that would enable the parks to complete these 4 objectives (NPS 2014). Out of these 36 calls to action, there are three that pertain to our Trail View Hiking project. These include parks increasing their digital offerings to the public, engaging national park visitors with interpretive media, and enhancing the connection of densely populated, diverse communities to the parks. (NPS 2014).

To help Acadia National Park increase its digital offerings to the public, the WPI Trail View Hiking team was created in 2012. The team was tasked with photographing all of the trails in the park with 360-degree photos and creating an interactive website where users could "walk" through the trails remotely. Since the Trail View Hiking team was created, most of the recognized trails in Acadia National Park have been photographed with 360-degree imaging, but the photographs weren't yet compiled into an interactive website.

For this year, the 2020 Trail View Team set out to make all the images from the previous teams accessible to the public through online virtual tours hosted by an informative website. To achieve this goal, we identified the following objectives:

1. Create virtual tours for all individual trails in Acadia National Park using panoramic photos collected by previous Trail View IQP Teams.
2. Create a website that houses and showcases the tours and information for all of the trails in Acadia National Park.
3. Collect and apply feedback from different test-users of the website regarding improvements based on their opinions.

2. Background

2.1 National Parks

The United States National Parks are managed by the U.S. Government for conservation, public access, and recreation purposes. According to Lary Dilsaver, a professor of historical geography at the University of South Alabama, the idea of National Parks first came about because of the high presence of fences and trash around Niagara Falls (Dilsaver 2016). This was because Niagara Falls was under landowners' control, who didn't care about the pollution of Niagara Falls. To better protect famous natural features like Niagara Falls, while establishing representatives of American culture, Congress established the first national park, Yellowstone National Park, in 1872. Following the trend of the first national park, more national parks were established.

With the increasing number of national parks, the “fragile and unprofessional management” of the parks became a problem (Everhart 2019). To balance the protection and enjoyment of all National Parks, the National Parks Service (NPS) was established in 1916. The idea of NPS was first raised by President William Howard Taft in 1912. In a letter to Congress, the president said he wanted a “Bureau of National Parks”. However, since some held the opinion that the Forest Service could take on the responsibility of the NPS, the NPS wasn't established until August 25, 1916 (Everhart 2019).

2.2 Acadia National Park

In 1916, Acadia National Park was established with the name "Sieur de Monts National Monument" by President Woodrow Wilson and later renamed to "Lafayette National Park" in 1919. In 1929, the park took its official name of "Acadia National Park".

Currently, Acadia National Park, nicknamed “the Crown Jewel of the North Atlantic Coast,” is the most popular National Park in the Northeastern United States. Its unique and convenient location, astounding natural scenery, and diverse species have gradually made it one of the most popular National Parks in the United States. According to statistics from the NPS, it attracted over 3.5 million people in 2019 alone (NPS 2019). Additionally, on more than 49,000 acres of land, Acadia National Park has many different types of terrain including mountains, ocean coastline, woodlands, lakes, ponds, and wetlands. The park also contains hundreds of miles of trails for public enjoyment (Acadia National Park, 2014).

2.3 Stakeholders

2.3.1 Friends of Acadia National Park

The Friends of Acadia National Park (FOA) is a non-profit organization that was founded in 1986 with a simple mission: "...[to preserve, protect, and promote] stewardship of the outstanding natural beauty, ecological vitality, and distinctive cultural resources of Acadia National Park and surrounding communities for the inspiration and enjoyment of current and future generations". This organization started with just a small group of passionate people and had grown its membership to over 5,000 people across the country. In 2018 alone, the Friends of Acadia funded National Park Service carriage road crews and contractors to open up four historic

vistas, repair joint mortar on four carriage road bridges, and complete overhead cutting on 8.5 miles of carriage roads. Additionally, in 2018, FOA rehabilitated important sections of several trails and provided testimony to Congress in support of legislation that would address the backlog of maintenance projects in the park. In Acadia alone, the backlog in FY2018 was estimated to be at \$65M (Friends of Acadia n.d.).

Since its founding, the Friends of Acadia have sponsored many park rehabilitation and preservation projects. In 1992-1995, FOA completed extensive rehabilitation on the carriage roads in the park. These carriage roads were built by John D. Rockefeller Jr. and were donated to the park in 1960 by the Rockefeller family. Due to NPS staff constraints and the loss of the Rockefeller staff, the carriage roads were under-maintained which caused drainpipes to get clogged, paths to get overgrown, and erosion to increase. Today, these carriage roads are used by a wide variety of park visitors as these roads are accessible for wheelchairs, bikes, and horses. In 1996, the Friends of Acadia set out to restore the Village Connector Trails which had previously run all over the park. These trails allowed people to walk in and out of the park, which in turn reduces congestion at trailheads. In 2000, the Friends of Acadia and Acadia National Park established Acadia Trails Forever to restore and maintain the park's 130-mile historic hiking trail system. This endowment was the first of its kind in the country and today serves as an example for other national parks. The goals of the Acadia Trails Forever endowment include rehabilitating Acadia's historic hiking trail system, reconstructing abandoned or unmaintained trails, and endowing the ongoing maintenance of the trails in the future. The Friends of Acadia used thousands of stewardship volunteers to maintain the trails. Additionally, the endowment fund allows for up to 20 seasonal jobs and funds the Acadia Youth Conservation Corp. and the

Ridge Runners. Overall, the Friends of Acadia put a lot of time and effort into maintaining the park and trails (Friends of Acadia n.d.).

2.3.2 Visitors to the Park

The visitors of the park will also benefit greatly from a virtual trail viewer. The trails in Acadia run through woods, up mountains, beside beaches, and over a variety of other terrains. This terrain can prove to be difficult for an individual with limited mobility. In a survey conducted in 2018 by the U.S. Census Bureau, 30,411 people out of 323,156 were found to be living with a disability (census.gov 2018). Additionally, a 2014 report from the U.S. Census Bureau found that 40% of people aged 65 and over have at least one disability. Out of 15.7 million 65 and over residents surveyed between 2008-2012, $\frac{2}{3}$ of those people, or 10.5 million have difficulty walking and climbing (census.gov 2014). This data alone shows that there are a lot of individuals in the United States living with a disability or limited mobility. If these individuals can view the trails online, especially the more strenuous and non-accessible trails, then the online virtual tour will allow them to still see the views that they would have a hard time seeing otherwise.

As of right now, there are very few trails accessible to those with movement disabilities, including Jesup Path, Ship Harbor, and several in the Jordan Pond area (NPS n.d.). While the Friends of Acadia have strived to make many of the trails accessible, many remain inaccessible to those with physical disabilities (Friends of Acadia 2015). Our website and virtual tours would seek to provide the missing experience to those unable to physically visit the trails that do not accommodate those disabilities.

An additional group of people who can benefit from this trail viewer is those who want to plan their trip to Acadia. Often, people want to view the attractions of the area and the sights that

they could see before actually going on a trip. This allows them to plan out their entire trip and not be left in an unfamiliar area without knowing what to do. A trail viewer can add an interactive method of trip planning. Instead of just looking through the trails on the Acadia website or in a guidebook with vague descriptions, trip planners can get a more comprehensive idea of what all of the trails look like.

2.4 Previous Trail View Projects

2.4.1 The 2013 Trail View Hiking Team

The key objective of the 2013 Trail View Hiking Team was to establish the framework and proof of concept for future Trail View projects with Acadia National Park. The 2013 team used a Nikon camera containing a 360-degree cylinder to take photos (Figure 3). The lens captured about a fifth of the full 360-degree view. The team took multiple photos and stitched them together to achieve a full 360-degree picture (Figure 4). They used a Garmin eTrex to get the GPS coordinates where each photo was taken. After they had the full 360-degree photos with the GPS coordinates, they loaded each image into Google Maps through JavaScript interaction with the Maps API (Trail View Hiking 2013). The 2013 Trail View Hiking Team was able to create a website and was successful in hosting one of the trails using Google's API.



Figure 3: Nikon panoramic camera used by 2013 Trail View Hiking Team



Figure 4: The images the 2013 Team had to stitch together to create one Panoramic picture

2.4.3 The 2014 Trail View Hiking Team

The 2014 Trail View Hiking Team continued the work of the 2013 team by photographing additional trails and creating an interactive platform. They changed the camera to an iPod 5 since it was more convenient, easier to use, and capable of auto-stitching the images. They mounted the camera on a tripod and took multiple photos at each location (Figure 5). To get the GPS coordinates, they used the same system as the 2013 group, that being the Garmin eTrex. To interact with the photos, they used a software called Panotour which loaded each photosphere into a virtual tour creator and created the trail view tour (Trail View Hiking 2014). The 2014 trail view team was close to completing the virtual tours for two of the trails.



Figure 5: Camera and tripod system used by 2014 Trail View Hiking Team



Figure 6: Panoramic picture taken by 2014 Team

2.4.4 The 2015 Trail View Hiking Team

The 2015 Trail View Hiking Team set out to photograph 100 miles of the Acadia National Park trails. Photographing technology had progressed since the 2013 and 2014 teams, and the 2015 team was able to use this new technology. The 2015 team used the Ricoh Theta, a camera with a spherical lens that captures an entire 360-degree panoramic photo with one click of a button (Trail View Hiking 2015) (Figure 7). The Ricoh Theta also had a built-in GPS that

records the GPS coordinates from where the photo was taken. To access these 360-degree photos, they used Panotour 2.3, which put the photosphere together and allowed a user to move around in the photo (Figure 8). During the 2015 trail view team's IQP, they were able to photograph 64.5 miles worth of trails and successfully catalog all of them. This put a huge dent in photographing the 130 miles of trails in Acadia National Park.



Figure 7: Ricoh Theta Camera used by 2015 Trail View Hiking Team

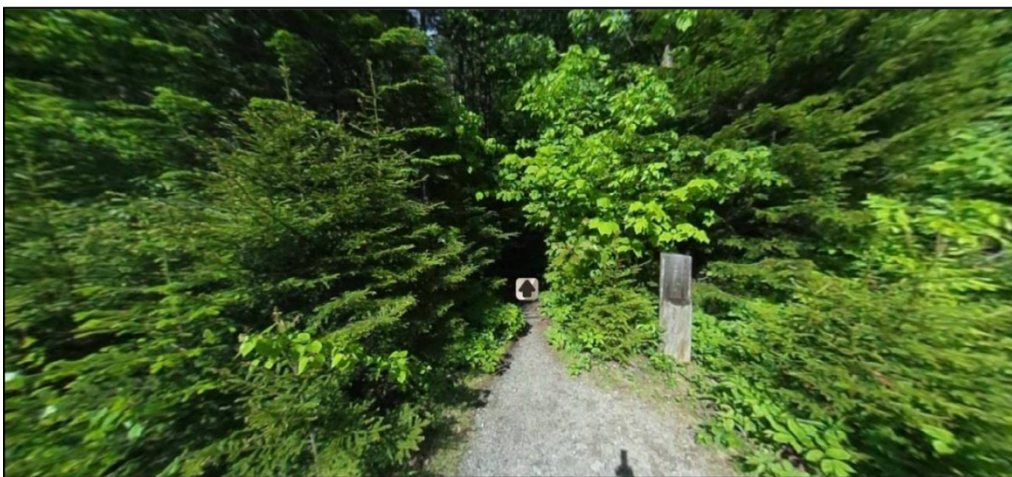


Figure 8: Panoramic picture taken by the Ricoh Theta Camera

2.4.5 The 2016 Trail View Hiking Team

The 2016 Trail View Hiking Team's goal was to finish photographing the trails in Acadia National Park and to make a proof of concept regarding new technologies. Since the 2015 team had success with the Ricoh Theta, the 2016 team used that camera as well (Figure 9). They attached it to a stick and were able to take the photos using their phone from a distance so that only the person holding the camera was in the shot. They spaced these photos every 20 yards throughout the trails. When completed, the 2015 and 2016 teams had amassed 18,348 photos (Figure 10).



Figure 9: Ricoh Theta m15 and Ricoh Theta S used by 2016 Trail View Hiking Team



Figure 10: Panoramic picture taken by 2016 Team

2.5 Cyber Tourism

2.5.1 Definition

According to Bruce Prideaux, cyber tourism is the use of technology to tour environments virtually, regardless of the technological medium used (Prideaux 2005). The overall appeal of cyber tourism is the ability to view locations from the comfort of home. The internet has been especially useful for virtual tours, far outshining both virtual reality and television in practicality and accessibility (Cho, Wang, & Fesenmaier 2002). The internet's cyber tourism capabilities vary drastically depending on the implementation. One example of cyber tourism is Google's Earth and Street View programs, containing a 3D model viewer and panoramic photos of most traversable places around the world. There are also many other virtual tours, where users can look at interactable 360° images or videos.

2.5.2 Panoramic Picture Application

Panoramic virtual tours have become increasingly popular all around the world, with schools, businesses, and tourists alike all taking a keen interest. The kinds of cameras used for taking panoramic photos required for these virtual tours have been around for over a century, dating back 1854 with the Friedrich von Martens Megaskop Panoramic Camera (von Martens Megaskop Panoramic Camera Patent Document) (Figure 11).



Figure 11: A Megaskop Panoramic Camera

Since then, panoramic cameras have only gotten more advanced - even modern smartphones have them by default now. Real estate agencies are heavy users of this technology, and cyber tourism is no exception. Plenty of applications from Photoshop to Pano2VR can easily mesh together panoramic photos taken by the average person (ggnome.com 2020).

2.5.3 Virtual Tours at other National Parks

So far, no national park in the United States has any currently available virtual tours of all its trails on street level. However, there are many examples of VR, 3D, and panoramic tours of attractions in other national parks. Yellowstone has a 3D object viewer of its geysers, and plenty of other parks like Bryce Canyon in Utah, and Dry Tortugas in Florida have panoramic video explanations of their hotspots (Romano 2020).

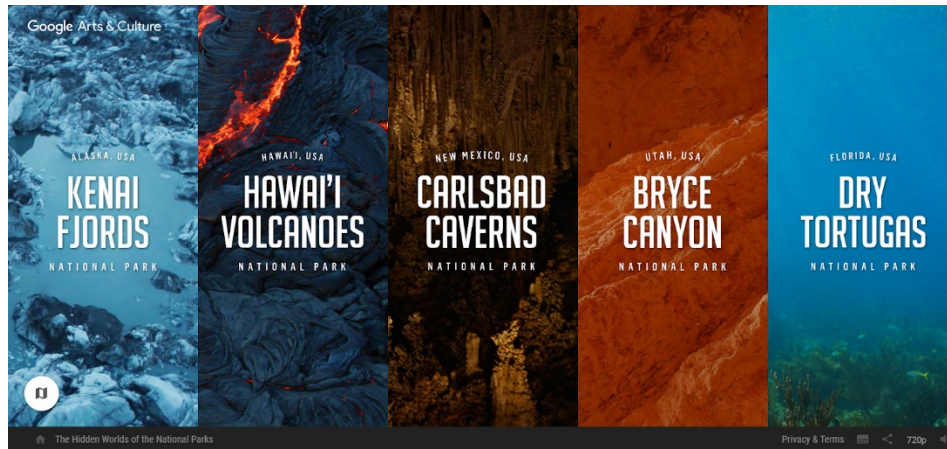


Figure 12: Google's Arts & Culture video tours of various US National Parks

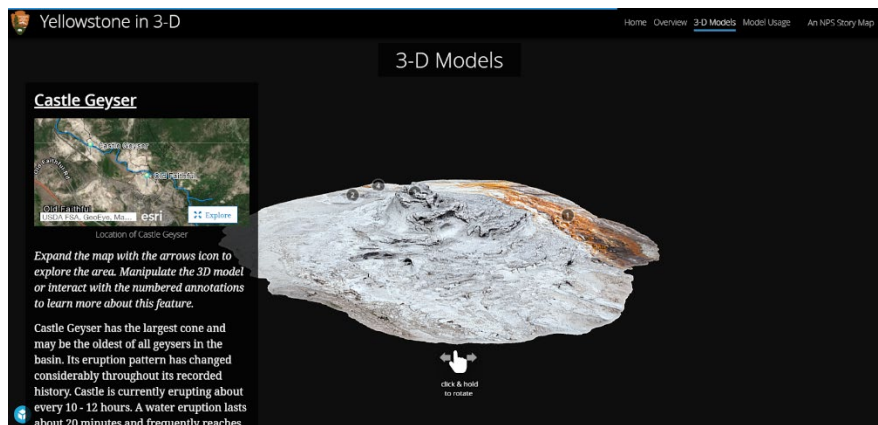


Figure 13: Yellowstone's Castle Geyser as a 3D model

In other countries, there are some national parks and other landmarks that also have 3D and panoramic viewers. Machu Picchu in South America has a 360° image viewer of several high points, with voice narration about the exact spot you are viewing from (Vjestica 2020). None have an interactive trail viewer, where users can freely explore the main trails and paths from the internet.

2.6 Virtual Tour Viewers

2.6.1 Definition

Virtual tours are created by simulating a location to help people visit it through the web by using computers or mobile devices. Usually, virtual tours are based on 360-degree panoramic photos. A panoramic view is a real-scene restoration display method. Virtual tours combine one or more sets of photos taken in 360-degrees from the camera ring into a panoramic image, which is restored and displayed through computer technology. Panoramic shooting can be very clear, eliminating the problem of over-retouching traditional still photos. These visual experiences can help visitors make decisions intuitively and quickly. It has several important advantages such as creating a strong sense of reality, zooming in and out and dragging freely with the mouse, and low computer feature requirement. A virtual tour viewer can be a platform or web service which supports users to achieve the virtual tour by uploading panoramic photos or providing virtual tour services.

2.6.2 Google Street View and Pano2VR

Google Street View and Pano2VR are two high-level virtual tour software packages that have allowed advances in virtual tours to occur rapidly. According to Hirose and Kitamura, Google Street View is a Web service by Google Inc. that provides panoramic images taken at street-level all over the world (2015) (Figure 14).



Figure 14: Example of Google Street View

Pano2VR, another software for virtual tours, helps people to convert their panoramic photos into an interactive virtual tour experience. Pano2VR has features such as: extracting, interface overlays, creating highlights, linking images automatically, and allowing visitors to zoom into a photo (Figure 15).



Figure 15: Example of Pano2VR

3. Methodology

The goal of our project was to make an informative website accessible to the public with interactive panoramas of all the trails in Acadia National Park. To complete this goal, we achieved three objectives. Our objectives were:

- Create virtual tours for all individual trails using panoramic photos collected by previous WPI Trail View Hiking IQP teams.
- Create a website that houses and showcases the tours and information for all the trails in Acadia National Park.
- Collect and apply feedback from test-users regarding website functionality.

3.1 Objective 1

Our first objective was to create virtual tours for all individual trails in Acadia National Park using panoramic photos collected by previous WPI Trail View IQP Teams. The 2013-2016 Trail View Hiking IQP Teams collected over 18,000 panoramic images of the trails in Acadia National Park. These images were organized by trail, sometimes segmented within the trail, and put onto a hard drive for future teams to access. Due to the virtual nature of our project, the hard drive was uploaded onto Dropbox so all team members would be able to access the photos.



Figure 16: Beehive Trail Panoramic Photo



Figure 17: Jordan Pond Path Panoramic Photo

3.1.1 Quality Control of Images

The previous IQP Teams left all of the photos in folders with various sub-folders and lots of photos within. Some of these photos had incorrect geographic coordinates and some of the photos were in the wrong folder as they belonged to a completely different trail. The 2016 team found a website called [gps.photos](#) which takes the internal GPS coordinates from photos and maps them out onto a Google Map (2016 Trail View Hiking IQP). The website proved to be quite useful in quality controlling images. The images could be dragged and dropped from a locally stored folder onto the map. They were then mapped using internal GPS coordinates ([gps.photos](#)). Originally, all of the trails were mapped using [gps.photos](#) to see if any coordinates were tagged incorrectly. These photos were tracked down by dragging each photo individually from the trail folder onto the map until the incorrect photo was found. As a team, we decided that any photo that had bad coordinates should be deleted so future teams could simply fix the coordinates and add it to the tour.

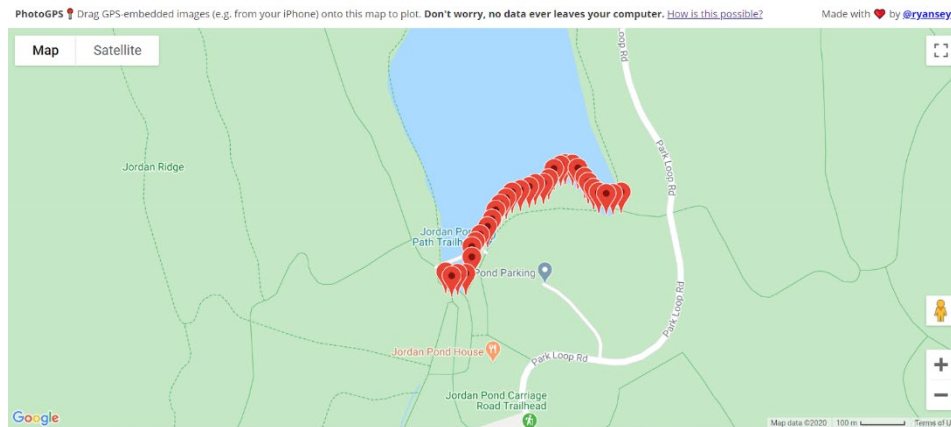


Figure 18: Example of a trail mapped on gps.photos

We compared the original maps of the trails with a paper map called the *Acadia National Park Waterproof Trail Map* by Steve Bushney and Jill Keefe. We found that some of the photos were not placed in the correct trail folder. Again, using gps.photos, we tracked down the incorrect photos comparing the map on the computer with the paper map that we had obtained. For example, one of the previous teams had photographed Jordan Stream Trail and Asticou & Jordan Pond Path together (Figure 19). These trails are two separate trails. To separate them, we dragged each photo individually from the "Jordan Stream Trail and Asticou" folder from the previous team and put it on the gps.photos map (Figures 20-21). As we dragged each photo on, we compared where the photo was on the electronic map compared to the paper map. Depending on which trail the photo fell along, either Jordan Stream Trail or Asticou & Jordan Pond Path, we put it in the proper folder. All of this was done to ensure that the user was viewing the most accurate trails.



Figure 19: Map of “Asticou & Jordan Stream Trail” with Incorrect Coordinate

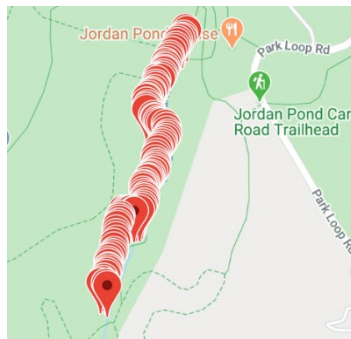


Figure 20: Corrected Jordan Stream Trail

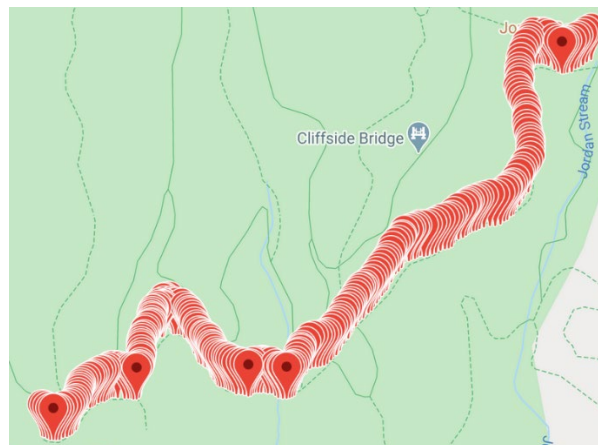


Figure 21: Corrected Asticou & Jordan Pond Path

The team members responsible for inputting all of the images into Pano2VR to create the virtual tours were also responsible for checking the quality of the images. While the photos were straightened out by the software, some photos were washed out or too dark due to sunlight or lack thereof, respectively. These photos were deleted, as decided by the full team, and marked

down in a master spreadsheet for future teams to work on retaking. The photos with incorrect geo-coordinates were also marked in a spreadsheet so future teams could retake the photos to create better tours.



Figure 22: Example of 360° photo from a previous team

3.1.2 Software Selection

To further complete the objective, we found software that would allow us to process all of the panoramic photos into complete tours. We looked at using multiple different software packages, including Google API, Mapillary, Host360, among others. Google API, at 252 USD per month, was going to be too expensive for WPI to maintain (Google Maps Billing Platform). Additionally, if the project gets turned over to Acadia National Park to maintain, the park might have to take on the cost of using the Google API. After extensive searching, we found a software called Pano2VR from Garden Gnome. Pano2VR was the best option due to its usability, cost, and features. Unlike Google API and other software options, Pano2VR requires a license that, when purchased at 400 USD or 349 Euro (Garden Gnome 2020), allows for two downloads on different computers. This allowed for two team members to work on putting the tours together.

Additional licenses could be purchased for Pano2VR if deemed necessary. However, it was determined that only one license with two downloads would be necessary to complete the tours by the end of the project term.

3.1.3 Using the Software

Pano2VR can mass-input and sequence any number of photos, using internal GPS coordinates, into a virtual tour project. The software also created nodes, which are markers on the screen that the user could click on to view the next photo or the previous photo when embedded into the website via an HTML5 output. The nodes, which were also auto-sequenced based on GPS coordinates or input order could be moved if they ended up not making complete sense.

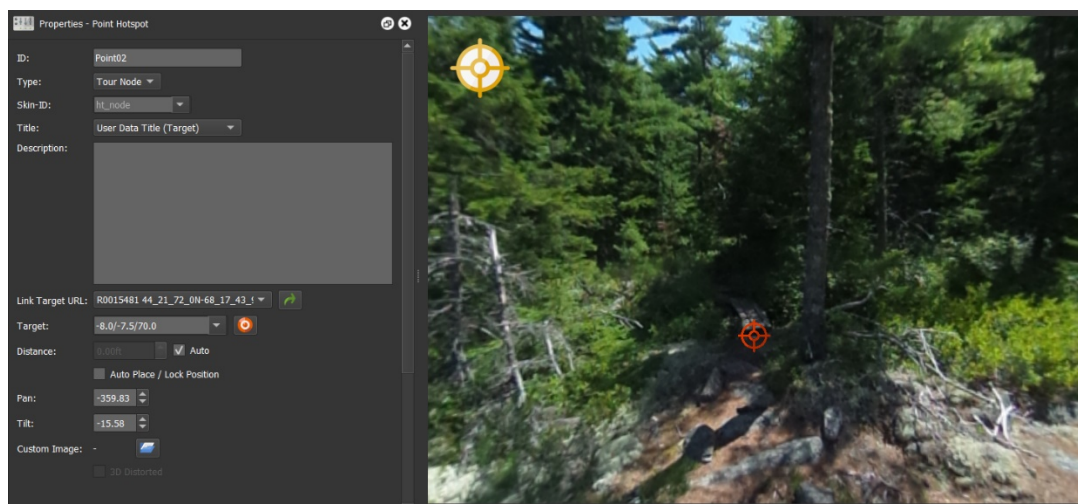


Figure 23: The red crosshair represents a node, which connects one photo to another. All of the options on the left (including name, description, URL, target direction, and auto-positioning/lock-positioning) are all visible on the left side of the editor.

For example, if the node was auto sequenced to be slightly off the trail, we moved it to be on the trail. Also, we picked the direction that the nodes transitioned into another photo. For example, if the preview direction was facing the side of the trail, we moved the direction of

transition back onto the trail. The same could be done with the node positions on each of the photos. All of these tools were essential in creating as many tours as fast and as best as we could.

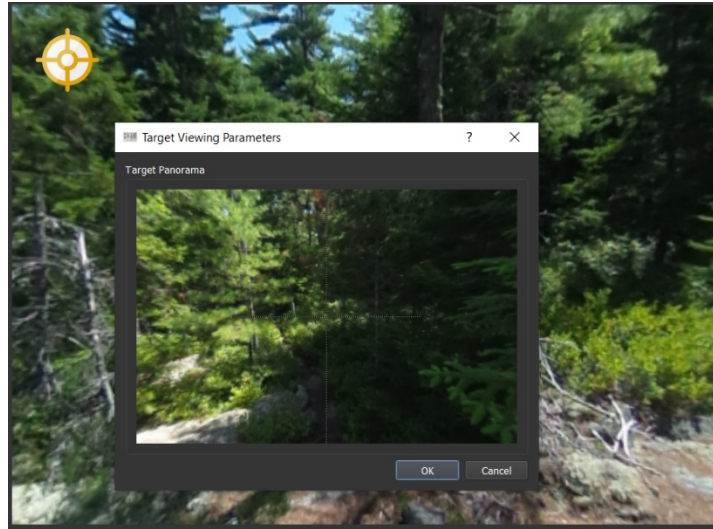


Figure 24: The Target Viewing Parameters window allows the editor to choose which direction the preview and the camera face when hovering over and moving to the photo contained in each node.

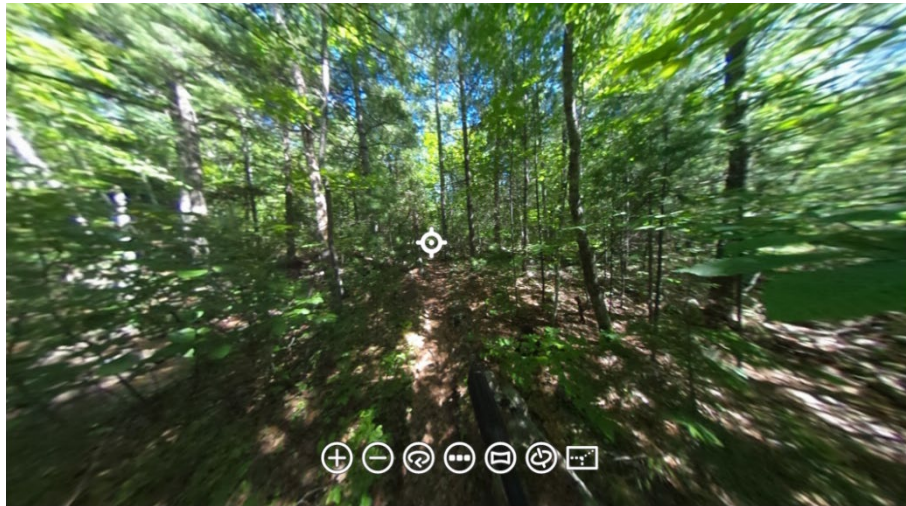


Figure 25: Example of a finished Pano2VR tour as uploaded onto the website. The white crosshair represents a node.

3.2 Objective 2

Our second objective was to create a website that houses and showcases the tours and information for all of the trails in Acadia National Park. The 2013 Trail View Hiking team made a proof of concept website design using various tools, including Google sites and Google API (Trail View Hiking 2013). However, our team needed to make a website that could host all of the trails in Acadia.

3.2.1 Setting Up a Server

To host all of the trails and have future teams able to access them, our team needed to set up a server with Worcester Polytechnic Institute. A server had been previously set up for past Trail View Hiking Teams. Our team's IT Services Tech, Ermal Toto, met with the team and added us all as users and moved the previous work done into a separate directory so it wouldn't conflict with our current work. Additionally, Toto installed WordPress onto our server.

3.2.2 Creating the Website

We decided to use WordPress because it is very user-friendly and open-source, meaning anyone can download and use it on any website. Instead of having to code everything, WordPress takes text and images and changes it to HTML code, which is commonly used for websites. Thus, the software was easy to learn when first using it.

The second objective of our project, as mentioned previously, was to make an informative website. To achieve this objective, we needed to first create individual landing pages for each trail. These pages served as the information space where all of the information about the trail was contained. For example, how the trail connects to other trails, how to access the trail,

the terrain of the trail, and more. Additionally, the page also featured a map of the trail that would be linked to the trail's 360° tour.

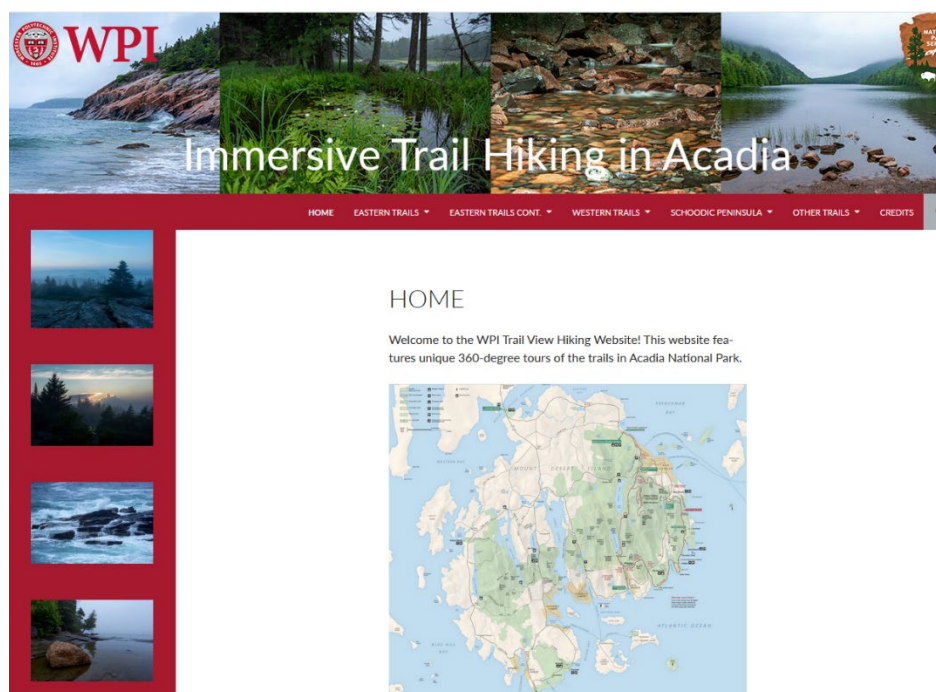


Figure 26: Home Page of Website Created by 2020 Team

3.2.2.1 Creating Maps

To intensify the user experience on the website, we created maps with the trails. To keep the maps looking consistent, we used a website called GmapGIS (gmapgis.com 2020). The website used Google Maps as a map basis and allowed the user to draw on the map to clearly show the location of the trails. Google had mapped out all the trails in Acadia for its maps at some point. The maps that Google made were compared to the maps that Acadia recognizes as its official trail maps to trace the trail path as accurately as possible. These maps were then screenshots as zoomed-in photos and as zoomed-out photos with a view of the whole park. These screenshots were uploaded and embedded into the website page. The zoomed-in photos were then linked to the corresponding tour page for ease of access (Figure 27).

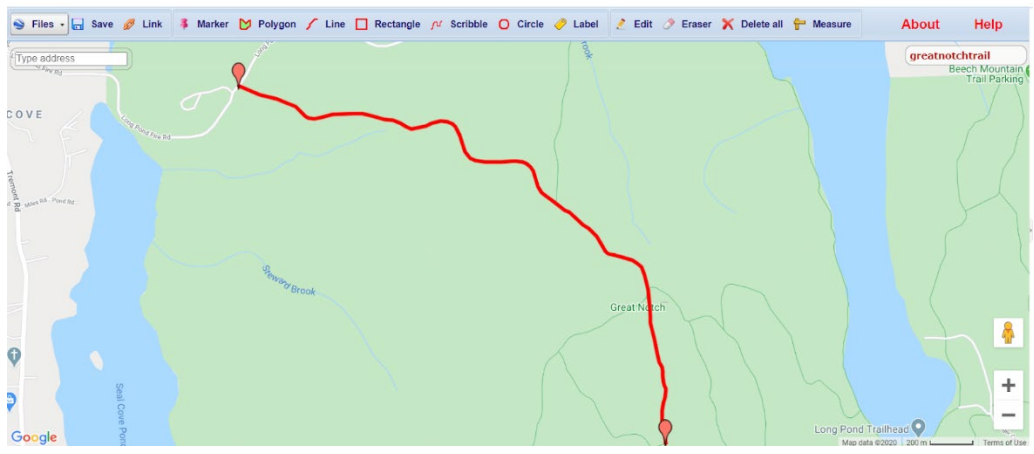


Figure 27: GmapGIS Website Example



Figure 28: Zoomed-out GmapGIS map example

3.2.2.2 Trail Descriptions

The trail descriptions were a key part of the website. When a user accesses any trail's page, along with the virtual tour of the trail, they get an overview of the trail from the description. This additional information would be useful for anyone who is planning on going to

Acadia National Park. Information such as where the trail is in the park and where to park to access the trail are important to know if visiting the park. The descriptions allow the website to compete with other Acadia National Park trail websites. Below is the information that was displayed for every trail:

- Location of the park
- Parking
- What to expect on the trail
- The difficulty of the trail
- What other trails could be accessed from the trail
- The length of the trail
- The elevation of the trail
- The type of trail it is
- If dogs are allowed.

This information was obtained from various websites that have databases of the trails in Acadia National Park, which include Alltrails.com, Hikingproject.com, and Mainetrailfinder.com. All these websites provided key information from maps of the trails to descriptions about the different trails. They all have similar information about each trail, such as distance, difficulty, and elevation. In gathering all of the information, these sites were cross-checked to have accurate descriptions. From the information provided by these websites, we determined the most useful elements that we should have on our website. Below is an example of one of the trail descriptions from one of Acadia's famous trails: The Beehive Trail.

Beehive Trail is one of the most beautiful and one of the top trails that Acadia National Park has to offer. Located near Seal Harbor this trail is 1.4 miles long.

Beehive Trail is an exposed iron rung climb. The Beehive Trail connects to Bowl Trail, Champlain South Ridge Trail, and Gorham Mountain Loop. The Beehive Trail is rated as advanced and is not recommended for small kids or people with a fear of heights.

- How to access: Parking is at Beehive Trailhead Parking Area little down the road on Park Loop Road
- Type of trail: Loop
- Distance: 1.4 Miles
- Elevations: 488 feet
- Are dogs allowed: No

3.3 Objective 3

For our third objective, we collected and applied feedback from different test-users of the website regarding improvements based on their opinions.

3.3.1 First Survey of Project

The first survey was conducted halfway through the IQP. The reason behind surveying was to get feedback about the design of the site, the maps, description, and virtual tours. After the test-users worked with the website and hiked a virtual trail, they took a 20-question survey (Appendix 2). The questions ranged from how the trails looked, the trail maps, the organization of the website, and the descriptions of the trails. From this survey, we hoped to get third-party opinions about the website.

3.3.2 Exit Survey

To collect feedback from the public, a survey was created to ask visitors about their experience with the website. The survey asked questions such as the user's overall experience and suggestions for improvement (Appendix 3). This exit survey will continue to collect survey data that can be utilized by future Trail View Hiking IQP teams.

4. Results

4.1 Pano2VR

Pano2VR was the backbone of our entire project. Without it, the virtual tours couldn't have been made as efficiently and as well as they were. The software was just the right pick in terms of cost and effectiveness and helped us to become the second website that offers interactive virtual tours for an entire National Park, after Yellowstone National Park's now-defunct website.



Figure 29: Example of a virtual tour

The figure above is what visitors see when they use our virtual tour. The white point in the image will lead people to the next image and will show a small preview of the next photo when users hover over it (Figure 29). The toolbar at the bottom of the screen contains various tools that enhance the user experience, such as zooming and auto-rotating the panoramic picture. Users could also skip to any photo they want via the thumbnail menu.



Figure 30: The Thumbnail Menu tool

The fourth button provides users the power to show the Thumbnail Menu as shown in Figure 30. When opening this menu, it will show all images in the trail. This is good for users who want to jump to another part of the trail or scan trails faster. This is very helpful and convenient for people who jump away and want to go back and continue their journey.



Figure 31: Normal View Mode



Figure 32: Stereoscopic View Mode



Figure 33: Fisheye View Mode

Figures 31, 32, and 33 above show how the fifth button works. This tool allows users to change the view of the image. Figure 31 is the original view. If visitors click that button, the photo will become more stereoscopic, like a convex lens (Figure 32). If people click that again, the stereoscopic mode will be enhanced into what is called fisheye mode. In this mode, visitors

can see the image like the surface of a sphere (Figure 33). Clicking the button again returns the view to the original view. In both stereographic and fisheye mode, the node will be hidden to allow the user to look through the other view modes without distractions. In other words, if users want to go to the next image, they either have to return to the original view or use the Thumbnail Menu. The last button is easy to understand, which allows users to enter full screen.

4.2 Website

The website design was one of the most critical aspects of tying everything together into a visually appealing outcome. For our project, we used WordPress's built-in 2014 theme (Figure 34) and customized it to make it a bit more our own. The 2014 theme was chosen because of its simplicity as well as its design. As a team, we liked the way that it presented the menu spread out at the top of the page rather than condensed as some other themes did. Additionally, we liked the flexibility it gave us in many aspects. It allowed us to have menus on both the sidebar and the top, but based on feedback, decided to just have a top menu. The header image was custom-made by the team with images of Acadia National Park taken by one of our team members. We changed the color scheme from the default scheme to one that featured WPI's colors.

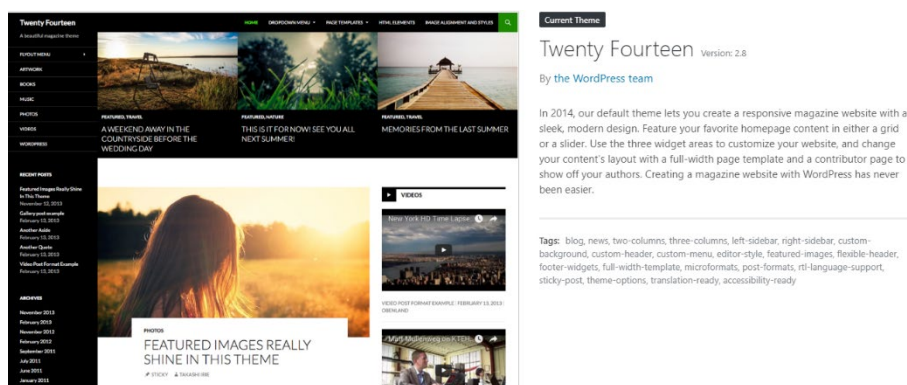


Figure 34: WordPress 2014 Theme

We also took advantage of some of the plugins available on WordPress from various developers. The main plugin that we used was the Garden Gnome Package plugin by Garden Gnome Software (Figure 35). This plugin allowed us to upload our Pano2VR packages as Garden Gnome Packages (file extension .ggpkg) and embed them without hassle. This cut a lot of time out of our work because without using the Packages, we would've had to upload each tile and photo for each tour. The embedding process was also made easier as there was no need for using a short code, WordPress's easy way of embedding links since you uploaded the tour as you would an image.

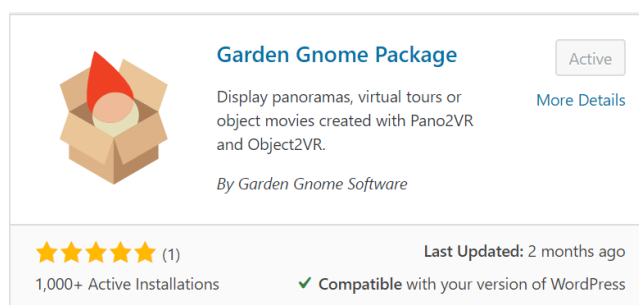


Figure 35: Garden Gnome Package Plugin Information

Another very helpful plugin for the website was the Yoast Duplicate Post plugin by Enrico Battocchi & Team Yoast (Figure 36). This plugin allowed us to make a page template for both the tour pages and the intro pages for each of our tours and duplicate it. Not only did this ensure that we didn't have any discrepancies between pages, but it also cut down on the time that we would need to design each of the pages.

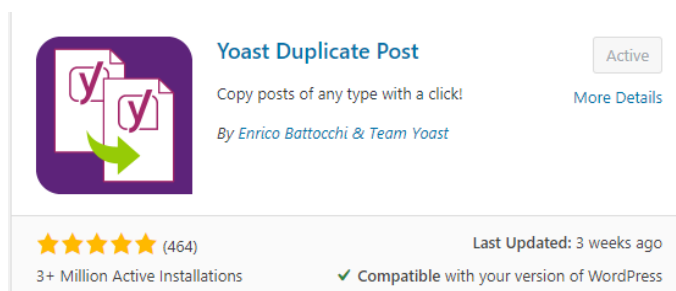


Figure 36: Yoast Duplicate Post Plugin Information

4.2.1 Quality Control

While completing quality control for the trails, it was noticed that quite a bit of the trails were missing parts or missing completely. This was verified by comparing the trails on the *Acadia National Park Waterproof Trail Map* by Steve Bushney and Jill Keefe to the photos of the trails that we had (Figure 37). As mentioned previously, we used gps.photos to see which trails were photographed correctly by previous teams. Additionally, any blurry photos had to be removed. Altogether, 12 trails were missing significant sections, 19 trails had at least one photo removed due to an incorrect coordinate, 11 trails had at least one photo removed due to bad photos, and at least 20 trails were missing completely (Appendix 1). Pano2VR used both the order that the photos were taken in as well as the internal GPS coordinates to put the photos in order. If the photo has bad GPS coordinates, then it will be out of order within the virtual tour. Additionally, bad photos don't give an accurate representation of how the trail looks. We removed most of the blurry or washed out photos from the trails and marked them down. However, some of the photos were taken in unfavorable conditions such as cloudy or foggy weather, the sun was too bright or went behind a cloud or other conditions that didn't lend to good photos (Figure 38).



Figure 37: Map from Map Adventures



Figure 38: “Bad Photo”

4.2.2 Maps

As mentioned above, every individual trail page has a map of the trail. During selecting maps, we originally used the Windows snipping tool to take screenshots of maps from trail websites, Maine Trail Finder (Figure 39), Hiking Project (Figure 40), and AllTrails (Figure 41). However, there were a few problems with just taking screenshots. The first problem was that not every website had every trail, so the screenshots weren't consistent. Additionally, the screenshots weren't able to clearly show nearby trails. After researching GIS mapping and communicating as a group, we decided to make the map for each trail ourselves. We scanned through several trail websites like Hiking Project, Maine Trail Finder and AllTrails, and a map called *Acadia National Park Waterproof Trail Map* by Steve Bushney from Map Adventures to collect information about trail locations and how they connect. Based on our research, we then made each map through a website called GmapGIS, which allowed us to draw red lines and put markers based on the trail lines already on Google Maps. With the GIS map, it made it easier for viewers to tell which line the trail was compared to surrounding trails. Additionally, we used Adobe Photoshop to add the names of connecting trails and trails around the target trail on some of the trail maps (Figure 42).

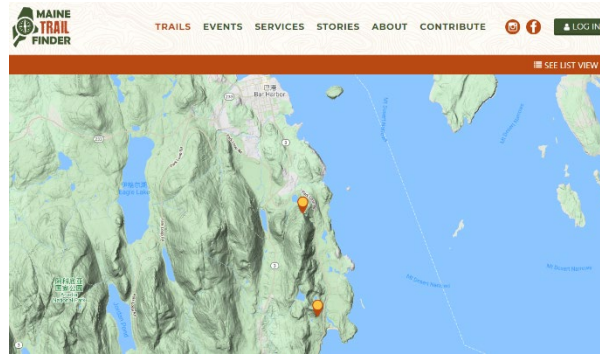


Figure 39: Maine Trail Finder

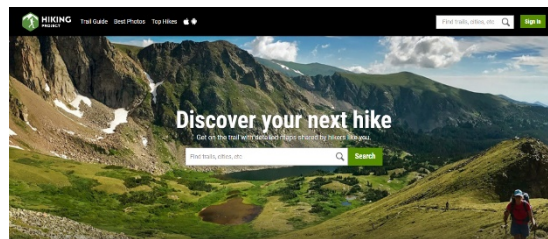


Figure 40: Hiking Project

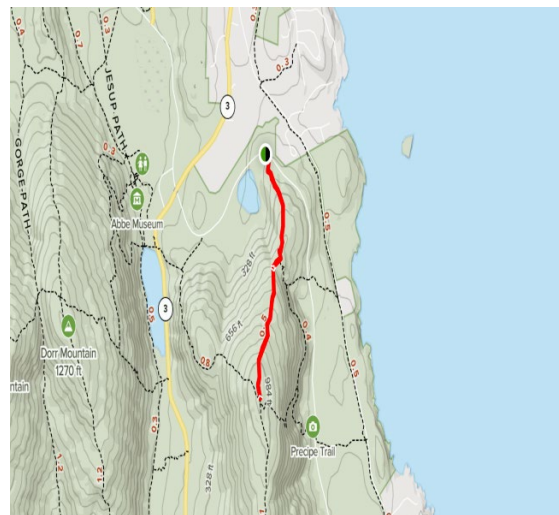


Figure 41: Champlain North Ridge Trail (prev. map) from AllTrails

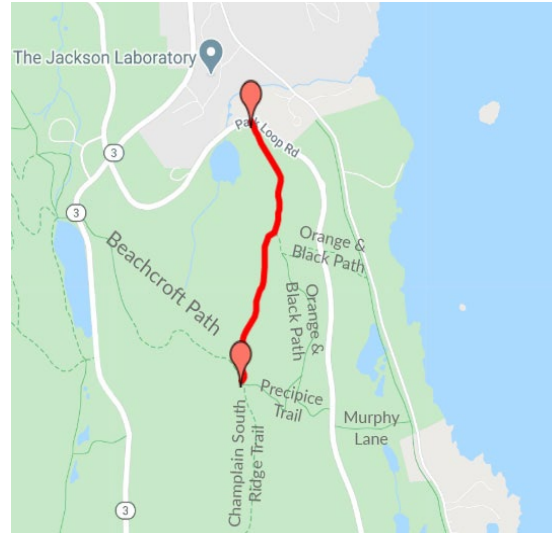


Figure 42: Updated Trail Map

4.3 Survey

As mentioned previously in the methodology chapter, we had friends and family look at the website and give us feedback. At this time in the project, only a couple of trails were fully complete with descriptions, the full trail map, and the tour. In general, the survey respondents liked the website's design and were able to navigate to the different trails in the park.

One of the questions was what you would like to see on our website. One of the responses was to reduce the number of links on the home page. Originally the website had the top menu and the entire sidebar had drop-down menus that had links to the trails. With the feedback, we changed the organization of the links and made a better organizational system for the drop-down menus. We broke the park into Eastern and Western Trails, based on their location relative to Somes Sound. These sections were broken down further into subsections of mountain areas or other landmarks, such as Jordan Pond. Under these subsections were all the trails in that area.

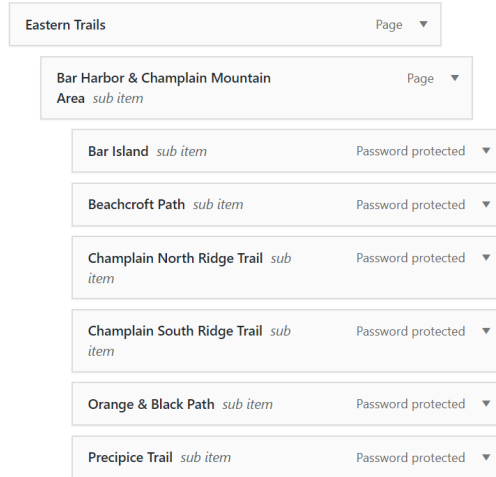


Figure 43: Eastern Trails Menu Organization Example

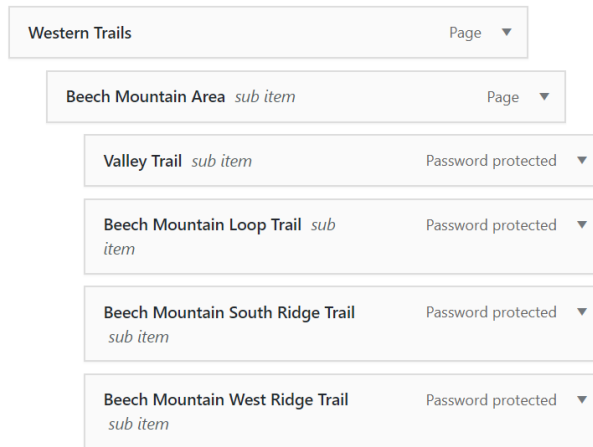


Figure 44: Western Trails Menu Organization Example

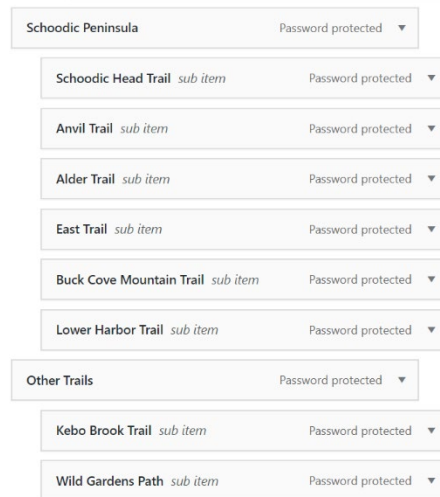


Figure 45: Schoodic Peninsula & Other Trails Menu Organization Example

Other changes that were requested by survey users was to make the header more interesting and to have a map where you can see where each trail is in the park. The original header was a black background with the title of our project (Figure 46). We created a new header that includes pictures of the park, WPI's logo, and the National Parks Service logo (Figure 47).



Figure 46: Original Website Header



Figure 47: Finalized Website Header

Originally, the trail maps were taken from either Alltrails.com, hikingproject.com, or maintrailfinder.com. All of these maps were different and had no uniformity. We decided to create all of the trail maps using GmapGIS. We took two screenshots of the GIS trail map. One of the pictures was zoomed into the trail to show the trail and surrounding trails. The second screenshot was an overview of the park with the trail, so users could see where the trail is in the park.

5. Recommendations

Although our Trail View team has successfully achieved the goal of making a 360-degree virtual tour website with trail information, some parts of our project can be enhanced. Therefore, we had some helpful recommendations for future Trail View teams to have a starting point to work off.

5.1 Website Design

The first recommendation is on website design. Because of time limits, the website constructed only has a simple layout, and hopefully, future teams can help make the website better designed. A well-designed website will not only help users find the information they want easily but also attract them to use the website again.

To design a better layout for the website, future teams should first take a look at other trail websites like Maine Trail Finder (Figure 48) to see how they are designed. After that, future teams should make a prototype website for testers with better-organized tour maps and trail information. Also, they can enhance the website appearance through the utilization of a WordPress plugin like SiteOrigin Page Builder (Figure 49) or other software like Adobe Photoshop or InDesign. Finally, with the feedback collected from testers of the prototype, they can edit the website design accordingly.

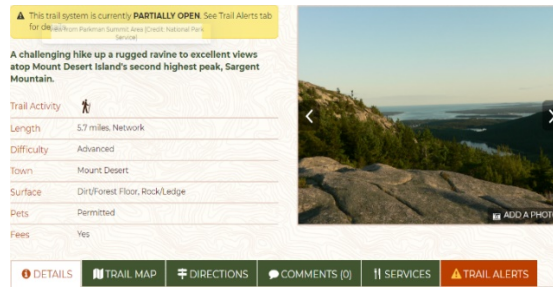


Figure 48: Maine Trail Finder

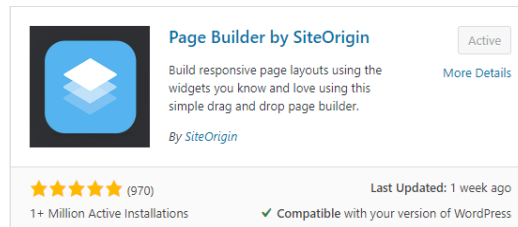


Figure 49: Site Origin Page Builder Plugin

5.2 Maps

Another significant recommendation is about the interactive maps and virtual tour maps. Future teams can enhance the user experience by adding them to part of the trail view website.

5.2.1 Interactive Maps

To help users better understand the distribution of trails, we recommend that future Trail View teams should consider using interactive maps on both the website home page and trail pages. The screenshots of Google Maps that our group used has drawbacks -- it is not interactive. There's no doubt that an interactive map is the most effective and the best choice for the website because it can show clearly where the trail is in the Acadia National Park, and users can zoom in and out to see nearby trails. The website that does interactive maps the best is Hiking Project. Their interactive maps clearly show all of the trails, which trail you are on, where the parking areas are, and a user can go from one trail page to the next by clicking on the trail on the map.

We were unable to use interactive maps due to time constraints, although we did look into it. Thus, we leave this to the next group to consider.

5.2.2 Maps on Virtual Tours

To provide a better virtual tour experience, we highly recommend adding a small interactive map to each tour. With this map, visitors will know where they are on the trail as they go through the tour. However, it is not easy to add a map to a virtual tour. If future groups are still using Pano2VR, which we used to create virtual tours, they need to create a new skin within Pano2VR to display the map. Moreover, Google APIs are also required to achieve this goal. Future teams may need to create a project on Google Cloud Platform to create API services and use API keys, like Geocoding API, Map JavaScript API, and Place API, and link these API keys with Pano2VR to get the support of displaying a google map. Geocoding API can provide geocoding and reverse geocoding of address. It can convert addresses into geographic coordinates and also convert geographic coordinates into addresses. Place API provides information about the place. Map JavaScript API allows users to display a map on the web and mobile devices. Additionally, using Google API service requires a credit card to ensure that users don't go over their monthly limit.

5.3 More Trails and Trail Photos

Our third recommendation is about picture retaking. While going through the panoramic photos that previous teams had taken, it was noticed that there were a lot of errors with the photos. Some of the trails were incomplete, had bad photos, bad GPS coordinates, or were missing altogether. Our team was unable to fix the photos due to the COVID-19 pandemic and

the virtual nature of the project. We recommend that future teams either retake or take photos that have issues with them. Some of these trails weren't photographed due to peregrine falcons nesting during the summer months. When taking the new photos, we also recommend that the photos are taken in the direction that the trail should go. Previous Trail View teams took some of the trail photos from the middle of the trail or the opposite direction. This led to issues with the thumbnails not being in order. Additionally, any historic trails that aren't typically accessible to the public would be worthwhile to photograph. Having them as panoramic tours will give people the ability to experience the trails while respecting the preservation efforts that Acadia National Park wishes to continue.

5.4 Survey

The website is equipped with an exit survey for visitors to take. This survey will hopefully collect at least one year's worth of data to provide some feedback as a starting point for some adjustments that future teams can make to the website. These feedback points include how the website is designed, how well it works, and any bugs that are encountered.

6. Conclusion

The goal of the Trail View Hiking project was to create an informative website accessible to the public with interactive panoramic tours of the trails in Acadia National Park. This project helps to complete the National Park Service's *A Call to Action*, which touches upon increasing digital offerings to the public, engaging national park visitors with interpretive media, and enhancing the connection of densely populated, diverse communities to the parks (NPS 2014).

We created 92 virtual tours and a website to house these tours. The website includes the virtual tour, a map of the trail, and the trail description for each of these 92 trails. Additionally, we gathered feedback from family and friends to get the best product possible. We recommend that future teams consider taking the rest of the trail photos and putting interactive maps on the website. These two points will allow for the website to become more comprehensive and allow people to experience the entire park virtually.

Bibliography

- 10Web Form Builder Team. Form Maker (Version 1.13.40) [Software]. (2020, July). Retrieved July 25, 2020, from https://10web.io/plugins/wordpress-form-maker/?utm_expid=.Weevlv9rRO6s1JDYpclVMg.0&utm_referrer=https%3A%2F%2F10web.io%2Fwordpress-plugins%2F
- AllTrails. (2020). Retrieved July 25, 2020, from <https://www.alltrails.com/explore/parks/us/maine/acadia-national-park>
- Battocchi, E. (2020, July 07). Yoast Duplicate Post (Version 3.2.5) [Software]. Retrieved July 25, 2020, from <https://yoast.com/wordpress/plugins/duplicate-post/>
- Bushney, S. (2019). Acadia National Park Waterproof Trail Map [Map]. In J. Keefe (Ed.), *Map Adventures Maps & Guides* (4th ed.). Portland, ME: Map Adventures.
- Census Bureau, U. S. (2018). Current Population Survey (CPS), CPS Table Creator. Retrieved April 24, 2020, from <https://www.census.gov/cps/data/cpstablecreator.html>
- Census Bureau, U. S. (2014, December 2). Mobility is Most Common Disability Among Older Americans. Retrieved April 24, 2020, from <https://www.census.gov/newsroom/press-releases/2014/cb14-218.html>
- Center for Community GIS. (2020). Search, Discover, Go. Retrieved July 25, 2020, from <https://www.mainetrailfinder.com/>
- Cho, Y. H., Wang, Y., & Fesenmaier, D. R. (2002). Searching for experiences: The web-based virtual tour in tourism marketing. *Journal of Travel & Tourism Marketing*, 12(4), 1-17.

- Christopher, J. (2019, November 19). Duplicate Menu (Version 0.2.2) [Software]. Retrieved July 25, 2020, from <https://github.com/jchristopher/duplicate-menu>
- Dilsaver, L. M. (Ed.). (2016). *America's National Park System: The Critical Documents* (2nd ed.). Lanham, MD: Rowman & Littlefield.
- Draw on Google maps; label, save & share maps. (2010). Retrieved July 25, 2020, from <https://gmapgis.com/>
- E. D'Annibale, A. N. Tassetti, & E. S. Malinverni. (2013). From Panoramic Photos To A Low-cost Photogrammetric Workflow For Cultural Heritage 3d Documentation. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XL-5/W2*, 213–218. <https://doi.org/10.5194/isprsarchives-XL-5-W2-213-2013>
- Everhart, W. C. (2019). *The National Park Service*. New York, NY: Routledge.
- Fariello, S., Gonzalez, F., Marcoux, C., Pantuosco, L. (2014) Bar Harbor Project Center Trail View: Acadia National Park [Undergraduate Interactive Qualifying Project, Worcester Polytechnic Institute], Digital WPI. https://web.wpi.edu/Pubs/E-project/Available/E-project-073114-092251/unrestricted/IQP_Paper.pdf
- Friends of Acadia National Park. (n.d.). Retrieved from <https://friendsofacadia.org/>
- Friends of Acadia. (2015, June 26). Wheelchair Access. Retrieved July 28, 2020, from <https://friendsofacadia.org/what-we-do/trails-and-carriage-roads/wheelchair-access/>
- Gnome, C. (2020, May). Garden Gnome Package (Version 2.2.1) [Software]. Retrieved July 25, 2020, from <https://ggnome.com/ggpkg/>

Google Maps Platform Billing. (2020, July 09). Retrieved July 13, 2020, from

https://developers.google.com/maps/billing/gmp-billing?hl=en_US#dynamic-street-view

Halsey, N. (2020, March). Fourteen Colors (Version 1.6) [Software]. Retrieved July 25, 2020,

from <https://celloexpressions.com/plugins/fourteen-colors/>

Hiking Trails near Acadia National Park. (2020). Retrieved July 25, 2020, from

<https://www.hikingproject.com/directory/8008454/acadia-national-park>

Hirose, S., & Kitamura, Y. (2015). Preliminary evaluation of virtual cycling system using google street view. *Lecture Notes in Computer Science (including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 9072, 65–70.

https://doi.org/10.1007/978-3-319-20306-5_6

Hulse, D. (2018). Add From Server (Version 3.3.3) [Software]. Retrieved July 25, 2020, from

<https://dd32.id.au/wordpress-plugins/add-from-server/>

National Park Service. *A Call to Action: Preparing for a Second Century of Stewardship and Engagement*. (2014, August 25). Retrieved from

https://www.nps.gov/calltoaction/PDF/C2A_2014.pdf.

National Park Service. (n.d.). Virtual Tours. Retrieved July 28, 2020, from

<https://www.nps.gov/yell/learn/photosmultimedia/virtualtours.htm>

National Park Service. (n.d.). Physical / Mobility. Retrieved July 28, 2020, from

<https://www.nps.gov/acad/planyourvisit/physical-mobility.htm>

- Pano2VR (Version 6.1.8) [Computer software]. (2020, May 25). Retrieved July 25, 2020, from <https://ggnome.com/pano2vr/>
- Pano2VR - Virtual Tour Software. (2020, May 25). Retrieved July 13, 2020, from <https://ggnome.com/pano2vr/>
- Friday, G. (2020, July 17). Page Builder Plugin (Version 2.11.1) [Software]. Retrieved July 25, 2020, from <https://siteorigin.com/page-builder/>
- Friday, G. (2020, July 23). SiteOrigin Widgets Bundle (Version 1.17.3) [Software]. Retrieved July 25, 2020, from <https://siteorigin.com/widgets-bundle/>
- Prideaux, B. (2005). Cyber-tourism: A New Form of Tourism Experience. *Tourism Recreation Research*, 30(3), 5–6. <https://doi.org/10.1080/02508281.2005.11081481>
- Romano, A. (2020, March 17). Need to Get Outside? These 5 National Parks Offer Virtual Tours You Can Take From the Comfort of Home. Retrieved April 15, 2020, from <https://www.msn.com/en-us/travel/travel-trivia/need-to-get-outside-these-5-national-parks-offer-virtual-tours-you-can-take-from-the-comfort-of-home/ar-BB11iIuj>
- Vjestica, A. (2020, March 27). Top 10 virtual tours: see museums and the world without leaving home. Retrieved April 24, 2020, from <https://www.techradar.com/best/virtual-tours-museums-national-parks-around-the-world>
- Von Martens Megaskop Panoramic Camera Patent Document. (n.d.). Retrieved May 09, 2020, from https://americanhistory.si.edu/collections/search/object/nmah_1030573
- Wheelchair Access. (2015, June 26). Retrieved July 28, 2020, from <https://friendsofacadia.org/what-we-do/trails-and-carriage-roads/wheelchair-access/>

Yellowstone in 3-D. (n.d.). Retrieved July 28, 2020, from

<https://www.nps.gov/gis/storymaps/cascade/v1/index.html?appid=ee0b10d44b6843b18cc>

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Appendix 1:

Trail	Issue:
Valley Peak Trail	Missing North of St. Sauveur Intersection
Jesup Path	Missing Section from Emery Path to Great Meadow Loop
Giant Slide Trail	Missing section from Parkman Connector/Grandgent Intersection to Parkman Mountain Intersection
Jordan Cliffs Trail	Missing section from Penobscot East intersection to Spring Trail intersection; incorrect coordinate; bad photos
Schoodic Head Trail	Missing section
Anvil Trail	Missing section; incorrect coordinate
Kebo Brook Trail	Missing section; incorrect coordinate
Norumbega Connector Trail	Missing section
Pemetic NW Trail	Missing section; incorrect coordinates
Perpendicular Trail	Missing section
Schiff Path	Missing section
Orange & Black Path	Missing section
Bald Peak Trail	Incorrect coordinate
Beehive Trail	Incorrect coordinate
Bubble & Jordan Ponds Path	Incorrect coordinates
Cadillac North Ridge Trail	Incorrect coordinate
Cadillac South Ridge Trail	Incorrect coordinate
Champlain North Ridge Trail	Incorrect coordinate
Eagle Lake Trail	Incorrect coordinate

Emery Path	Incorrect coordinate
Hadlock Ponds Trail	Incorrect coordinate
Jordan Pond Path	Incorrect coordinate
Jordan Stream Trail	Incorrect coordinate
Sargent South Ridge Trail	Incorrect coordinate
St. Sauveur Mountain Trail	Incorrect coordinate
Triad Trail	Incorrect coordinate
Wonderland Trail	Incorrect coordinate
Alder Trail	Bad photos
Beech West Ridge Trail	Bad photos
Buck Cove Mountain Trail	Bad photos
Gorham Mountain Trail	Bad photos
Great Notch Trail	Bad photos
Hadlock Ponds Trail	Bad photos
Jordan Pond Path	Bad photos
Lower Harbor Trail	Bad photos
Ocean Path	Bad photos
South Bubbles Trail	Bad photos
Ship Harbor Trail	Completely missing
Acadia Mountain Trail	Completely missing
Flying Mountain Trail	Completely missing
East Trail	Completely missing
Canada Cliffs Trail	Completely missing

Great Meadow Loop	Completely missing
Beech Cliff Trail	Completely missing
Stratheden Trail	Completely missing
Precipice Trail	Completely missing
Satterlee Trail	Completely missing
Otter Cove Trail	Completely missing
Lower Day Mountain Trail	Completely missing
Hunters Cliffs Trail	Completely missing
Hunters Beach Trail	Completely missing
Man O'War Brook Fire Rd	Completely missing
Valley Cove Trail	Completely missing
Valley Cove Rd	Completely missing
Beech Cliff Loop Trail	Completely missing
Golf Course Trail	Completely missing
Ledge Trail to St. Sauveur	Completely missing

Appendix 2:

Survey Questions for Survey Halfway Through Project:

1. Did you like the design of the website? Yes or No
2. Did you like the organization of the website? Yes or No
3. Were you able to differentiate links easily? Yes or No
4. On a scale of 1-10, how would you rate the usability of our website?
1: Not at all usable
10: Very user-friendly
5. What is working well on our existing website?
6. What's not working well on our website?
7. What would you like to see on the website?
8. Were you able to find links and trails easily?
9. Did you find the information on the pages meaningful?
10. Could you search for the trails you were looking for?
11. On a scale of 1-10, how would you rate the clarity of the content?
1: Not clear at all
10: Very clear
12. Was the content presented in the right format?
13. Do you think there is a better way to present the same content?
14. Did it take too long to load the website? Yes or No
15. Did it take too long to fetch the trails on your website? Yes or No
16. On a scale of 1-10, how would you rate the performance of our website?

1: Loads slowly, low performance, etc.

10: Quick loading speeds, high-level performance, etc.

17. What do you like most about our website?

18. What would you like to change on the website?

19. Did you face any challenges while using our website?

20. Do you have any suggestions or comments?

Appendix 3:

Exit Survey Questions:

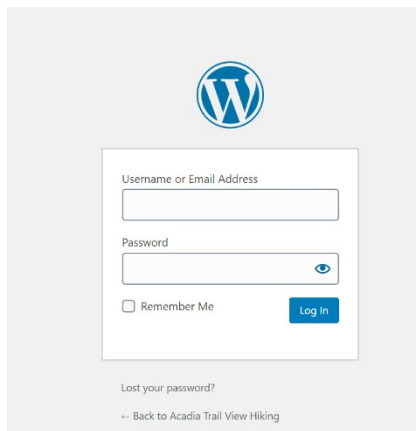
1. What was your purpose for using the site?
2. How did you feel about the design of the website (scaled rating)?
 - 1: Definitely didn't like it
 - 5: Loved it
3. On a scale of 1-10, how would you rate the performance of our website?
 - 1: Loads slowly, low performance, etc.
 - 10: Fast loading speeds, quick performance, etc.
4. Please list any challenges you faced while using our website.
5. Please list any suggestions or comments you have for our website.

Appendix 4

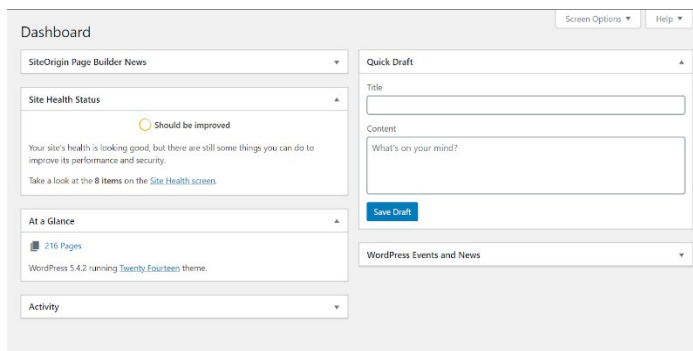
How-To Guide For Future Teams:

How to Access the WordPress site:

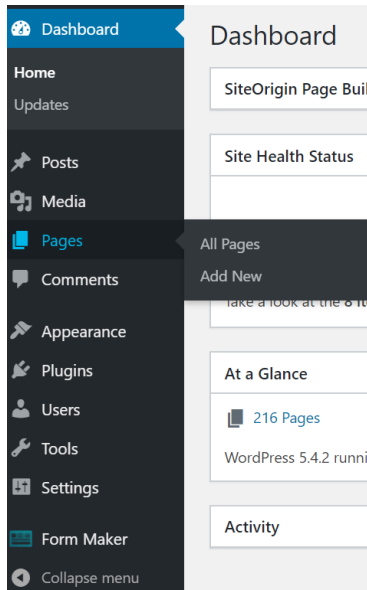
1. Go to acadiatrails.wpi.edu/wp-admin to access the backend of the website (main website is acadiatrails.wpi.edu)



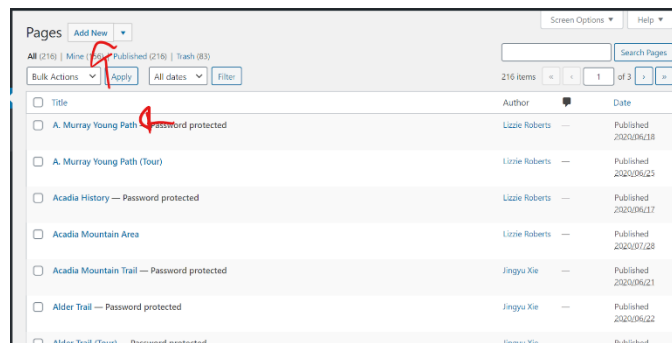
2. Put in supplied username and password - Ermal Toto from IT Services originally set up the website and the server and should be able to help get you set up on the website.
 - a. The page will load and bring you to the WordPress dashboard



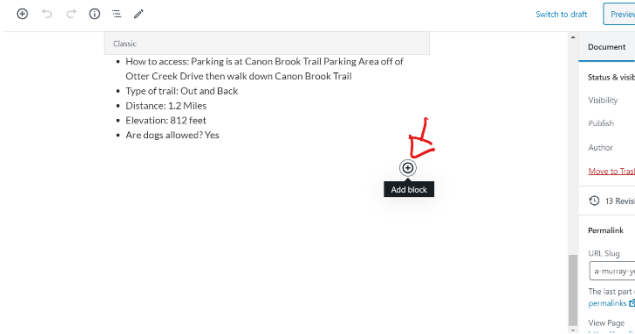
3. To access the pages either to edit them, add new pages, etc., navigate to "pages" on the left sidebar.



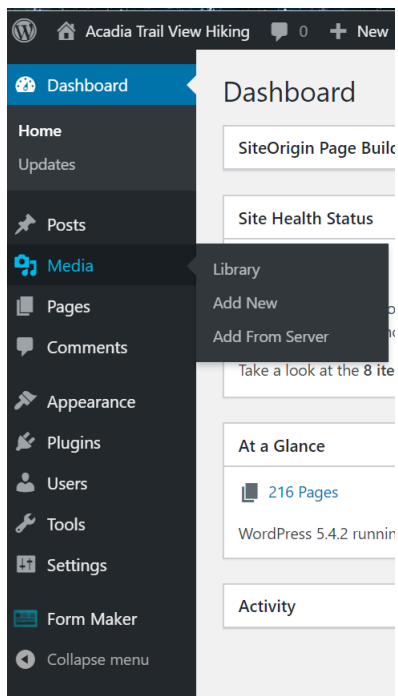
- a. Once there, navigate to the page you wish to edit or click on "add new"



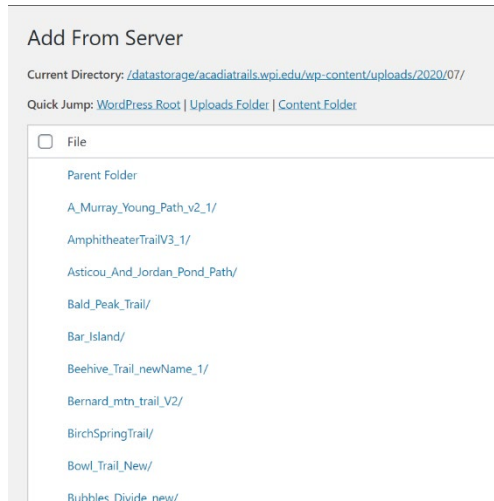
- b. Currently, WordPress uses a block editor which allows you to use pre-programmed blocks such as "image," "paragraph," and more. To add one, click on the plus button at the bottom of the page.
 - i. The Garden Gnome Package plugin that we used also added a block to the block menu - the GGPKG block. This was very helpful in creating our virtual tour pages



4. To add new media, navigate to "media" on the left sidebar.



- a. To add any files from the server, especially files that are above 8MB or the GGPKGs, use the "add from server" option which connects to the server and allows easy uploads directly from the server, bypassing the upload limit.



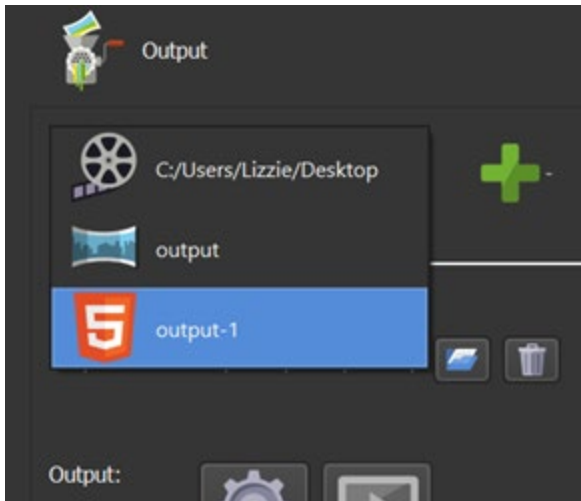
- b. Any media file that is deleted from this area is deleted from the server as well, so use caution when deleting media files.

How to Access Pano2VR:

1. Download Pano2VR Pro from the Garden Gnome website (<https://ggnome.com/pano2vr/>).
2. Once it is downloaded, you'll need to enter in a license key
3. The ggnome will send you an email that contains the License key after purchasing the Pano2VR. Copy the key you received and paste it into the license key field which will show up when you first open Pano2VR.

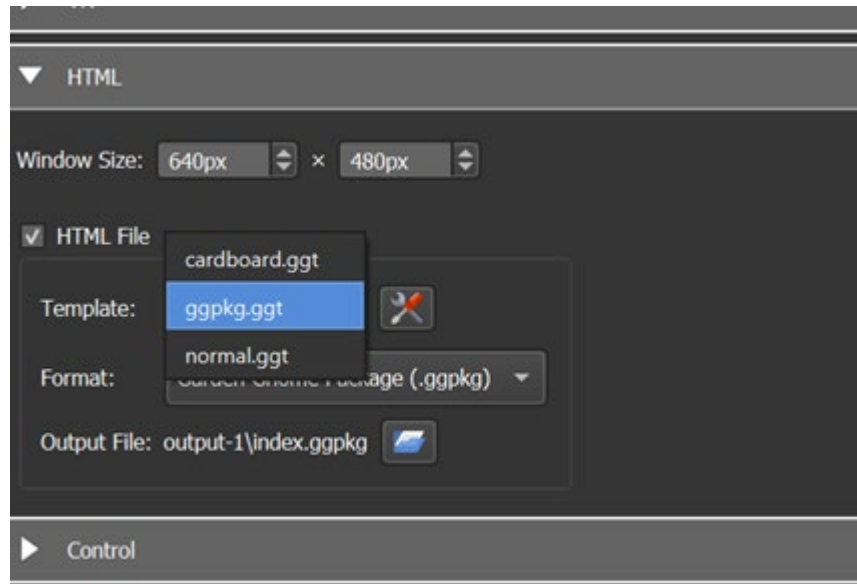
How to Get GGPKGs for the Website:

1. When outputting on Pano2VR, choose the HTML5 output option

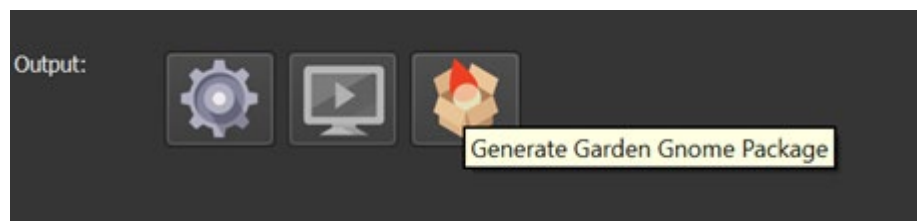


- a. We used the simplex skin for all of our tours, but making a custom skin to have more/different options is a possibility to explore
- b. Scroll down in the menu to the HTML option and select the ggpkg.ggt file template





- c. Click on the gnome in a box symbol to output as a ggpkg file



- i. When saving, don't use spaces or weird symbols (full list of accepted symbols is on the Garden Gnome website)
2. Upload the file to WinSCP or by using the terminal on the Mac.
 - c. Ensure that the file is in the `.../wp-content/uploads/YEAR/MONTH` for proper WordPress uploading to occur
 - d. Before uploading to WordPress, ensure that the file owner is `www-data`
 - i. To change it, insert the following two lines of commands into Putty on Windows or Terminal on Mac. It will ask for your password before running the second command. Depending on file size, changing the file permissions can take quite a while.


```
cd /var/www/acadiatrails [ENTER]
```



```
sudo chown -R www-data:acadiatrails * [ENTER]
```

3. To upload files to WordPress, use the "add from server" option on WordPress. Navigate to the folder that your file is in, select the checkbox and select import. Multiple files can be uploaded at a time and uploading time depends, again, on file size.

