



# Traffic Congestion and Crowdsourcing in Acadia National Park

Exploring a Problem-Solving Cycle for Acadia National Park

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## EXPLORING A PROBLEM-SOLVING CYCLE FOR ACADIA NATIONAL PARK

An Interactive Qualifying Project submitted to the faculty of

**Worcester Polytechnic Institute**

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Professor Frederick Bianchi

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## Abstract

The research and conclusions in this paper are meant to inform visitors of Acadia National Park of the current traffic and congestion issues. After examining the overall traffic patterns throughout the park's roads during the busier times of the year, the team concluded the most efficient ways to navigate the park. This information was then published on the WPI Acadia website to inform visitors of the least congested times and locations throughout the park.

## Acknowledgments

The group would like to spotlight our Professor, Frederick Bianchi. Not only did he give us the tools necessary to complete the project, but he also aimed us in the correct direction. We would also like to extend a thank you to Ermal Toto and Mark Taylor within WPI's IT department.

Although we were unable to use Google Maps for the project, the two of them were a huge help in trying to get the software embedded into the website.

## About The Team

Deniz Terek is a current student at WPI set to graduate in 2023 with a Mechanical Engineering Major and a Minor in Computer Science. Growing up in the Pacific Northwest gave him an appreciation for the outdoors and all the National Parks that have been created throughout the USA.

Shivank Gupta is a current student at WPI set to graduate in 2024 with a Mechanical Engineering Major and a Minor in Robotics Engineering. As a Boy Scout of seven years and Eagle Scout, he is extremely fond of the outdoors. Shivank loves to go camping, backpacking, hiking, snowboarding, and much more. The National Parks hold a special place in his heart.

Emma Gilroy is a current student at WPI set to graduate in 2024 with a major in Mechanical Engineering. Growing up going from campground to campground with her family, she developed a love for the outdoors and National Parks.

## Introduction

National Parks are amazing preservations of Earth that remind people how beautiful the world is. Acadia National Park is a great example. Located in Maine, Acadia is the eighth most visited national park in America. From stargazing to tide pooling to hiking, kids and adults enjoy a large variety of activities. However, there is a noticeable issue with the park. While Acadia lies within the top ten most visited parks, it also remains one of the smallest in the country. As stated by Acadia National Park Management Assistant John Kelly, “If you look at it as visit per acre, we are far and beyond the most densely used or heavily used park” (Bangor Daily News).

To put this into perspective, Acadia generally has 67 visitors per acre of land while the second most dense park remains at 29. This issue is one of great importance yet given little attention. Acadia has tried to address this problem. The park has introduced a free shuttle bus service that runs through the entirety of the park and island. The bus is called the Island Explorer and takes visitors of the park around to help reduce traffic. The Island Explorer system has 17 buses and was initially introduced to the park in 1999. The system has since undergone improvements since then such as real-time location available on a Mobile app that any visitor can download. Adding a free shuttle system to the park has made significant changes to help reduce congestion during peak season. The Island Explorer is not able to completely reduce the congestion within the park, thus inciting further innovation.

The IQP research group has proposed and executed the idea of the WPI Acadia website hosting the hourly breakdown of traffic volume. The goal of this is for future visitors to understand the severity of the congestion problem and find solutions around it themselves. This could be by



visiting at a less crowded time, carpooling, or taking advantage of the free shuttles. All versions of this would be crowdsourcing help from the visitors of the park to reduce the congestion.

Crowdsourcing is the phenomenon of obtaining “services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers” (Merriam-Webster). Crowdsourcing is a strategy that has been around since 2006 and is understood as a practical theory. We hope that our research and proposal, which is broken down in this report, will be a step towards improved traffic conditions in Acadia National Park. The IQP research group believes the use of crowdsourcing will increase activity on the WPI Acadia website and spread awareness about the traffic and congestion issues the park faces. The team hopes that increased viewership and activity on the website will also allow visitors to determine the most optimal times and locations to make the experience more enjoyable and reduce the issues the park faces.

## Background

There are many problems that the park is facing. Addressing all of them at once would unfortunately not be feasible. Some of the many problems the park is facing arise and worsen over time, with one such being climate change. Those problems are long-term oriented. Other problems are more immediate and have solutions that can be addressed in simpler ways. The most prevalent of these short-term problems is traffic congestion, which all visitors must endure if they choose to visit the park during peak season, which is typically the best time to visit the park based on weather conditions.

From 2017 - 2022, the park has had groups come together to address these problems. The big problem that most groups tried to tackle was the issue of park congestion. The park itself has many different high-traffic tourist destinations, such as Cadillac Mountain and Sand Beach. Park Loop Road in Acadia National Park is very highly trafficked and connects many different tourist destinations. Many different solutions to help alleviate traffic congestion have been proposed.

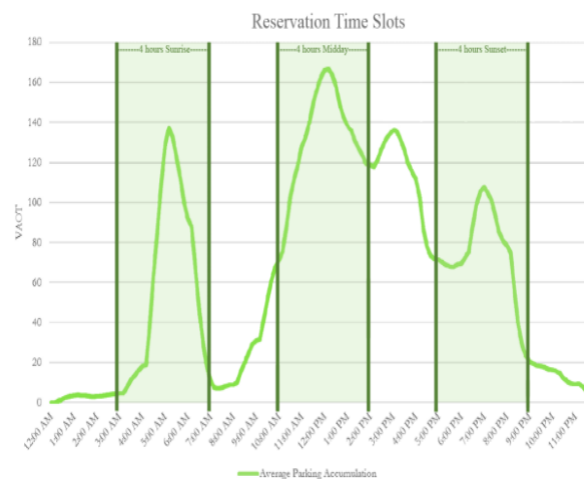
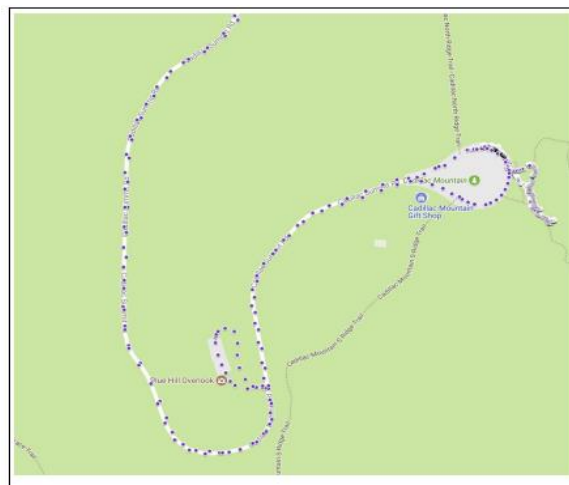


Figure 1 2017's Time Slot System

In 2017, a WPI research team collaborated with the park to explore a reservation system at the Cadillac Mountain summit. This reservation system would allow for the allocation of parking spaces for people in advance so visitors know that they will be able to park their cars once they arrive at the mountain, as seen above in Figure 1. The team surveyed visitors to get a cost range that they are willing to pay to allocate a parking space. They combined data they gathered from visitors and staff at the park with knowledge of gated lot systems to analyze the cost-effectiveness of their proposed solution.



*Figure 2 Map of Tracked User Data*

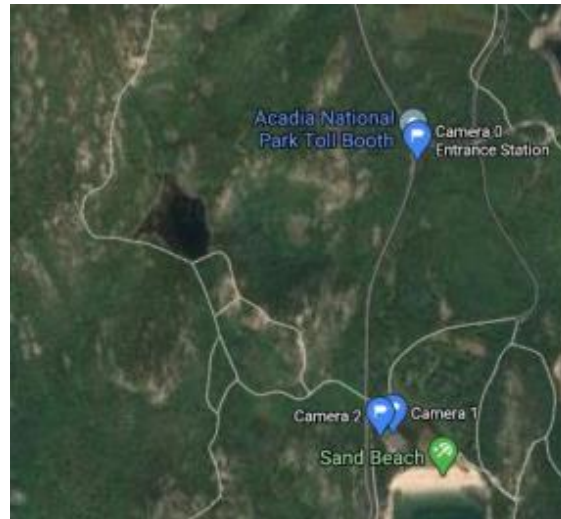
In 2018, a WPI research team attempted to gain deeper insight into congestion in the Park. The team had the idea of creating an Android App that tracks users' location within the park to show congestion on that specific day, in real-time. The map developed from the app can be seen in Figure 2 above. They used tools such as ArcGIS and Google Maps to collect the information to display to the app. For the app-server interaction to work, they used MariaDB, and to build the actual app, they used ReactJS. They then distributed the app to volunteers at the park's Visitors Center to further aid in the collection of data in the park. They were able to determine the feasibility of this application if many other people were using it to traverse the park.

In 2019, a WPI team came together to further expand upon the work of the previous year's team by implementing monitoring systems throughout the park to collect data on traffic. These camera systems would send pictures in real-time to the Acadia Park website for website viewers and tourists to be able to navigate the congestion. In the end, this allowed for the improvement and recognition of the feasibility of these monitoring systems in the park.



*Figure 3 Trail Cam in Park*

In 2020, a WPI team came together to tackle this issue of congestion by analyzing the parking and dwell-time behaviors of people along the Ocean Drive parking lots. They did this by using trail cams that connected to the parking lots and monitored the stay of each car and traffic patterns along these corresponding roads. Figure 3 shows a snapshot from a camera placed by the WPI team. The ongoing reservation system, along with the monitoring system that was put in place, allowed for the collection of data on the effectiveness of the system and the collection of the overall traffic that had accumulated. The number and locations of the cameras can be seen in the Figure 4 below.



*Figure 4 Cams Monitoring Patterns*

2020 was a slow year for the park due to COVID-19, with only 2.6 million visitors throughout the year. In 2021 the park had 4.0 million visitors. Four million visitors place Acadia National Park as the 16th most visited park in the year 2021 out of a total of 423 national parks. The sheer number of individuals who come to the park in their vehicles led to countless traffic standstills inhibiting the number of people that can enjoy their visit. While congestion is annoying to deal with in everyday life, it has negative effects past simple annoyance when happening in a national park. Many visitors may decide to not revisit a national park because of a negative experience. Fewer people visiting the park could lead to the loss of jobs. The park currently supports more than 3,000 various jobs in and around the park (Saunders & Easley, 10).

Congestion does not only lead to cars being stuck in traffic. These cars are either idling or slowly crawling through the roads. This leads to an increase in vehicle emissions within the area because of the increased number of vehicles in the area. The problem is twofold because not only are there more vehicles emitting emissions, but each vehicle is also causing more emissions than normal due to traffic. Many of these vehicles may also be running air conditioning during peak

summer hours due to the weather which leads to even higher emissions. This makes the park less inhabitable for some wildlife species as vehicle emissions spike. In addition, many parking lots and points of interest have only one road traveling to them. A traffic standstill on these roads leads to emergency vehicles being unable to reach their destination. This creates a dangerous environment for park visitors who may not be able to receive the help they need in a timely manner.

Multiple different factors cause the major congestion within the park. Not only does the park have by far the largest ratio of visitors to land, but the roads have their issues as well. Roads are frequently closed due to inclement weather and cannot be reopened until they have been cleaned. The main road that circles the park is one-way in some sections which lead to a lack of options for visitors traveling around the park. This lack of options and confusion of new visitors only adds to the congestion. Different attractions in the park gather their crowds at different times of the day. For example, Cadillac Mountain has an influx of visitors before sunrise who are trying to get to the top of the mountain to watch the sunrise. Other areas such as the Fabri Picnic Area tend to see activity only around midday when visitors are hoping to use the tables provided to eat food. Each different attraction within the park has unique tendencies surrounding the hours when it is busiest. This makes congestion around the park very hard to plan around because it is constantly changing based on the time of year, day of the week, and hour of the day.

There have already been a few successful ventures that the park has taken to help alleviate some of the congestion. However, as time goes on, the traffic problem only gets worse, so solutions keep on needing to be found to make the park more enjoyable and safer for all visitors. Traffic

buildup on narrow roads causes dangerous situations because it limits the number of places that emergency vehicles such as ambulances can go. The Cadillac Mountain trailhead is a great example of this. Traffic will occasionally get backed up and cause massive delays for any emergency vehicles which unfortunately leads to visitors being unable to get the help they need.

## Methodology

Visitors of Acadia National Park are there to see Maine's beauty and do not typically account for the traffic they are stuck in and contributing to. By showing the visitors of the park the traffic issues within the park, they can hopefully plan their trip accordingly. With more people planning their traffic movements, it would lighten the traffic at peak times, giving everyone a more enjoyable experience at the park. This is a strategy known as crowdsourcing.

There currently is information online about the number of annual visitors. But this information does not entail the amount of traffic present when it comes to planning your visit to the park. It does not inform the public about when peak season for the park is, or how the crowd fluctuates throughout the week or day. It was decided that more accurate data was needed. More accurate data should show patterns throughout the year that can be presented to help people plan their trips. While most of the park attractions lie on Park Loop Rd, traffic congestion builds up in tourist-specific areas, not simply across the whole road. The park is large with many different reasons to visit, and each different location may have different times that traffic builds up. Ideally, if this information can be gathered and presented properly, it can be used to plan trips in ways to avoid traffic build-ups as much as possible, and still allow for quick travel.



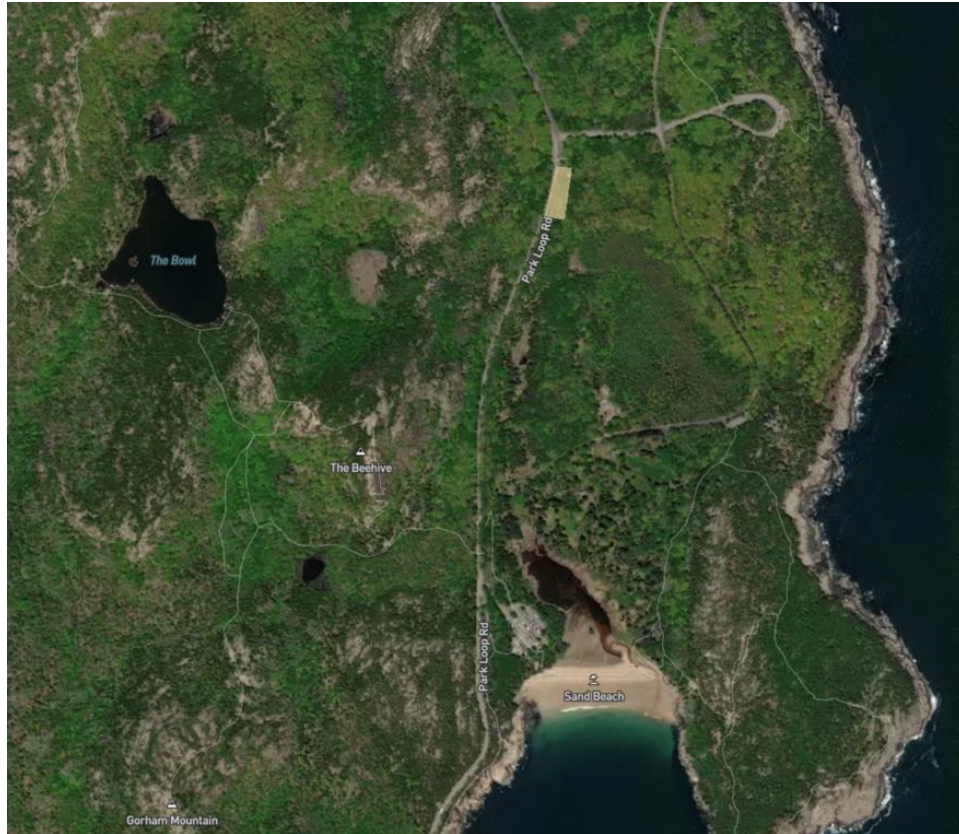
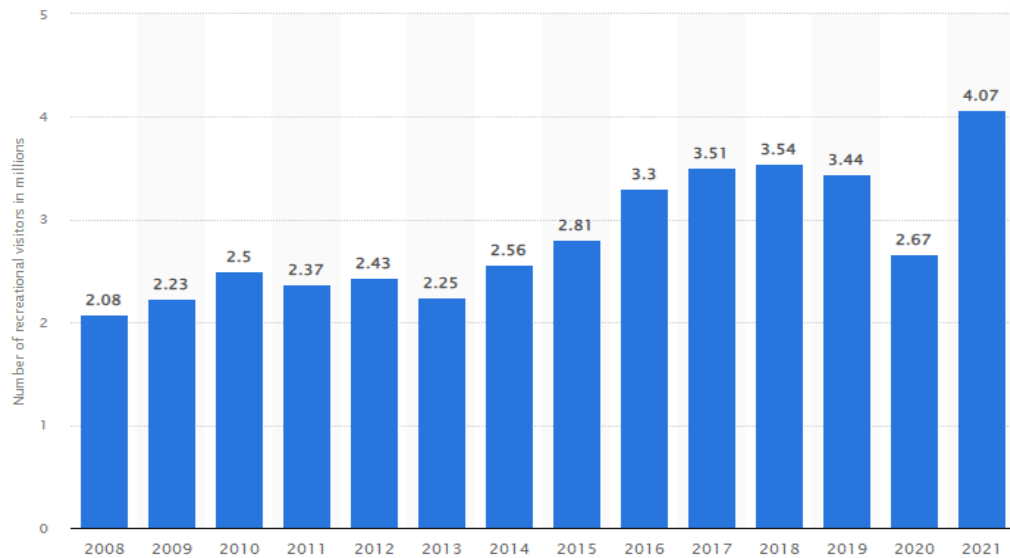


Figure 5 Main Entrance Gate

This precise information was provided to the group by a company called StreetLight. StreetLight allows the search of specific date ranges and places to find traffic patterns. Within StreetLight, a *gate* is placed along a roadway, as seen in Figure 5. StreetLight then outputs data about the traffic flow through that point. Many *gates* were placed throughout the park to measure traffic at the most popular locations.

StreetLight collects data from cars and phones to measure how people are using the roads. They do not have access to the data from every car/phone, but they have access to more than enough to pull predictions and patterns. All this data is combined into what they call “Big Data.” It can then

be searched through to gather information for whatever use. To educate park visitors, gates were placed at busy locations within the park.



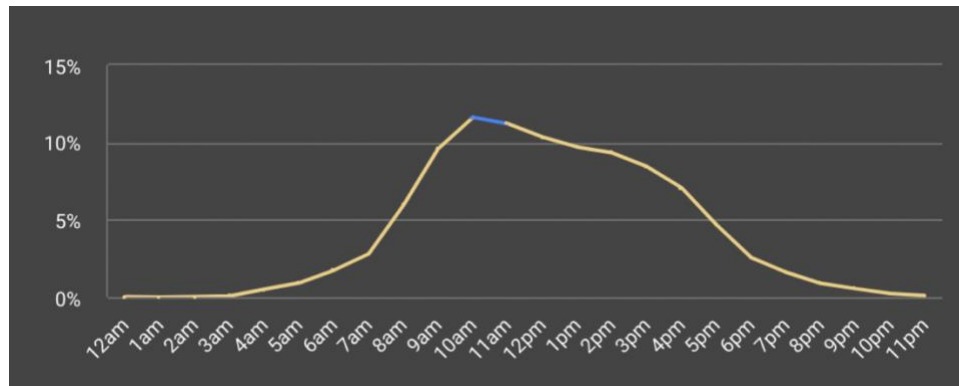
*Figure 6 Number of Acadia Visitors: 2008-2021*

Figure 6 above shows information about the number of visitors coming to Acadia National Park each year (Statista). In 2021, the park reached an all-time high in visitors, due to the loosening of the COVID-19 restrictions. As the year 2022 progresses, a rational assumption would be that park visitors will remain the same or within a tolerance, creating more traffic. This is an example of some of the information that can be crowd-sourced from different websites featuring statistics that are readily available to the public.

### *Use of StreetLight*

In StreetLight, there is a time delay between when traffic happens and when the information regarding it can be accessed. The most recent data that can be accessed via StreetLight is typically 1-2 months in the past. StreetLight can present the data they acquire by predicting future traffic or by showing the raw data they have access to. The program can directly create

graphs based on traffic patterns throughout the day or the raw data can be exported to excel or other formats. This raw data shows the average amount of vehicles that pass through the marked point on the map hourly throughout the week. Both the graphs and the raw data are necessary to properly inform users of the website about traffic patterns.



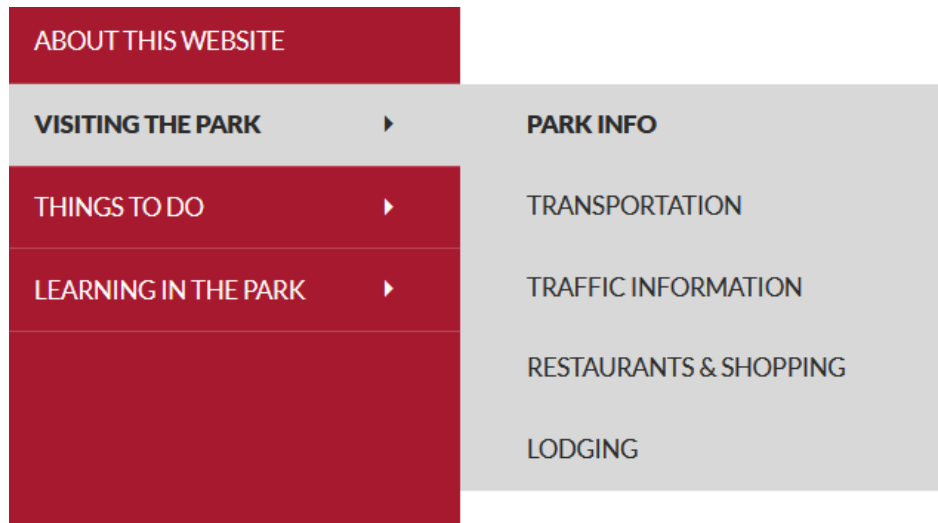
*Figure 7 Raw Traffic Flow - Main Entrance Station*

Figure 7 shows traffic flow through the main entrance station of Acadia National Park. The raw data can be sorted through and condensed into a couple of sentences. At the entrance station, for example, traffic will typically build up during the week around 10 AM. However, on the weekend, traffic will build up around noon, 2 hours later than during the week. The graph would primarily show the 10 AM traffic buildup because it is averaged throughout the whole week. Then in writing, we can inform users of the website that traffic typically builds up at a slightly different time over the weekends so they are properly informed and can plan accordingly.

### *WPI Acadia Website*

WPI's Acadia National Park website already hosts information uploaded about most of the places of interest within the park. A new section was added to the website. This section contains traffic information about the most popular locations within the park for new and returning

visitors to use to plan their trips. When presenting the information on the website there were a few options on how to show it to the website users.



*Figure 8 Side Navigation Menu*

One strategy was to implement the graphs and information with other crowdsourced information about specific points within the park. For example, under the page describing Cadillac Mountain, traffic patterns associated with its parking lots can be inserted. Another strategy would be to compile all traffic information onto one webpage. With these possible strategies, users of the website would be able to see all traffic information at once and compare different locations within the national park, as seen in Figure 8 above. Therefore, assisting users to make informed decisions about where to visit at certain times during the day. This was the strategy that was used to present traffic information.

The traffic information page is now reachable using multiple different methods. It can be viewed by selecting “Traffic Information” via the side navigation menu. The other way to reach the traffic information page is by clicking links within the website itself. Under the descriptions of certain points within the park, there is a hyperlink that navigates the user to the “Traffic

Information” page. There are also links on the Traffic Information page so users can easily see more information about places such as Cadillac Mountain.

## Results

The project focused on adding information to the WPI-operated website [acadiatrails.wpi.edu](http://acadiatrails.wpi.edu). The website itself must be examined to see the results. The website already had useful information about the park such as pictures of the trails and places to visit. More functionality was added to the website for visitors to utilize. The new functionality focused on the traffic problems within the park.

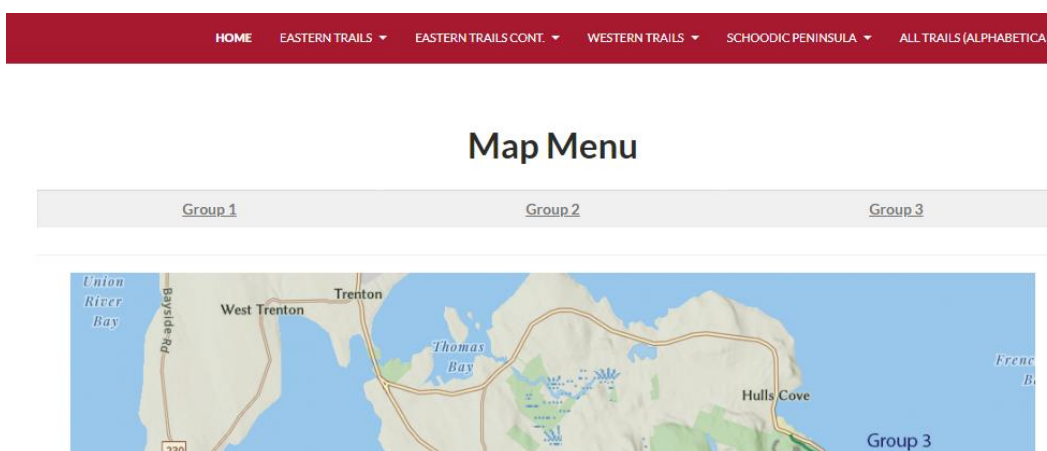


Figure 9 WPI Acadia Website Map Menu

Figure 9 represents one page of the Visiting the Park tab on the website. It includes recent averaged traffic information for each hour in each high-traffic tourist destination in Acadia National Park.



Figure 10 Cadillac Mountain Info

Figure 10 is another example of the information on the Traffic and Congestion page. The text “Cadillac Mountain” will lead any website users directly to the page already implemented onto the website about Cadillac Mountain.

Another page that is useful to the user is the ‘Home’ page of the website. This page includes multiple different links to separate pages of the website that contain areas and information regarding each separate trail in that area. Examples are shown below.

## Group 2 Trails



- [Amphitheater Trail](#)
- [Asticou and Jordan Pond Path](#)
- [Asticou Ridge Trail](#)
- [Bald Peak Trail](#)

Figure 11 Group 2 Trails

## Amphitheater Trail

Amphitheater Trail is a moderately trafficked out and back trail that is located near Northeast Harbor. The trail is a nice hike through a lush evergreen forest and over the Amphitheater bridge. The Amphitheater Trail connects to Hadlock Brook trail, Sargent South Ridge Trail, and Lower Amphitheater.

**Difficulty:** Moderate

**Length:** 1.6 miles



**Parking:** Parking is at Norumbega Mountain Pull parking off of State Route 3, then walk down Hadlock Brook trail till you get to Amphitheater trail

Figure 12 WPI Acadia Website Info - Amphitheater

Due to the nature of the project in providing information to visitors traveling to Acadia National Park via WPI’s website, the results of informing the public are inconclusive. The total website traffic that accumulated during the summer months was from 0-2 new visitors. This was due to the lack of advertisements directing people to the website. Any significant influx in visitors to the Acadia website was due to WPI personnel, including groupmates, editing the website. With

the very small number of new visitors to the website, and the lack of tracking the effective help that the website provided regarding congestion, the results for conclusive evidence on the impact on the traffic in Acadia National Park was, itself, inconclusive. The website itself, however, is fully built and customized to appeal to the users of the website and their needs.



## Conclusion

The US National Park System hosted 297 million visitors in 2021 due to fewer COVID-19 restrictions and the abundance of individuals craving the outdoors after time in quarantine.

While most parks were able to withstand the amount of traffic they encountered, Acadia National Park had another year full of congestion-filled roads, sullyng the experience for visitors unlucky enough to be stuck in this traffic. Acadia National Park has the highest visitor population by acre within the entire US National Park System. This leads to the park facing a unique set of problems. The largest problem currently facing the park is continual traffic congestion during peak season.

This is a problem because of the limited number of roads within the park and undersized parking lots for the park's number of visitors. Congestion leads to added pollution within the park due to the number of cars idling in the area. This air pollution has a very negative impact on the wildlife and species within the park that visitors hope to see.

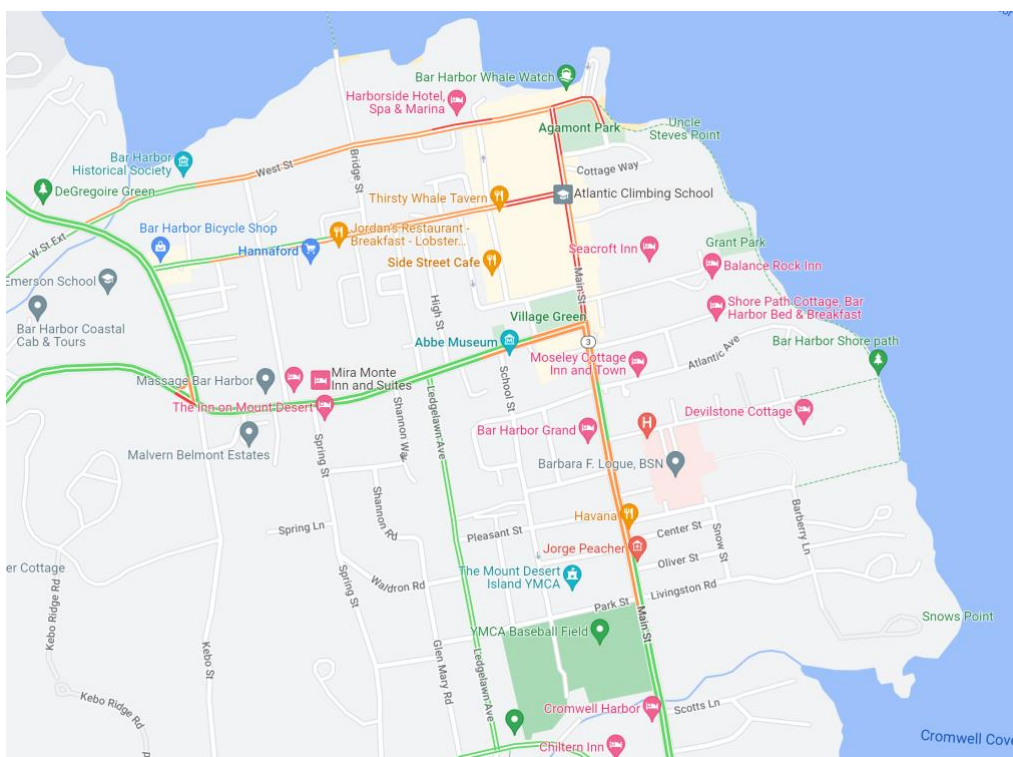


*Figure 13 Acadia National Park Snowy Owl*

The Figure 13 is a snowy owl that calls Acadia National Park its home. Not only does the congestion negatively affect the species within the park, but visitors to the park also have a considerably worse time at the park during peak congestion. Congestion is a problem that is affecting every aspect of the park.

Our original plan was to use live traffic information that could inform visitors how crowded the park currently is, and how crowded it will be throughout the day. A system like this would be able to let visitors see the traffic situation before arriving at the park. They would then be able to alter their plans if necessary for them to avoid the congestion. This would hopefully decrease the number of peak visitors as people would begin planning to go during different times of the day to avoid traffic. This would hopefully create a difference and reduce the amount of congestion within the park by using the visitors of the park to crowdsource a solution.

Adding information to the WPI Acadia Trails website about typical traffic hours within the park should be helpful to users looking for more information about navigating the park and its congestion. This will hopefully create less traffic as more people get educated about the problems the park is facing. This information could be greatly assisted by the implementation of live traffic information onto the website as well. A live traffic tool would allow users to see where traffic is within the park and avoid them. Or it could also incentivize users to seek other transportation options.



*Figure 14 Restaurants Near Acadia National Park*

Figure 14 is a Google Maps view of the restaurant area serving Acadia National Parks where traffic information is shown on the major roads. The colors on the road indicate the severity of traffic currently. Green means that traffic is flowing normally, yellow means that traffic is slowed, and red means traffic is severely slowed or stopped. Adding this information to the website would allow users to decide when they want to go to lunch or go shopping during the

day. Unfortunately, adding live traffic information to the Acadia Trails website was not feasible as the group faced continual problems with implementing live traffic information onto the website.

Many ideas are being posed to help solve the problem of congestion within the park. Most visitors to the parks greatly value them and want to see the National Parks System thrive. Our solution was to help educate the visitors about the problems facing the park and how they can help fix them. If more and more visitors space out their visits to the park to avoid causing massive traffic delays, the park will continue to be an enjoyable experience for its visitors.

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ACADIA NATIONAL PARK, MAINE - December 20, 2018 -- Snowy owl on Sargent

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