

Parked in the Park: pandemic traffic congestion in Acadia National Park Based on Regression Analysis

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Abstract. Contemporarily, the COVID-19 has strongly affected plenty of fields including travel industry. This paper takes Acadia National Park in the United States as a reference to investigate the impact of the epidemic on the number of visitors to the park as well as analyze the impact of the change in visitor numbers on businesses in and around the park. To be specific, the data from the national park's official website and hotels near the park on AirDNA will be used to determine the impact on the park and the surrounding economy based on statistical methods and regression equations. According to the results, the number of visitors to Acadia National Park has skyrocketed due to the epidemic, which led to an increase in demand for nearby hotels and hired staff. The increase in visitors also had a negative impact on the sustainability of Acadia National Park, visitor experience, and flora and fauna habitat. To address the issue, the corresponding solutions to are proposed. These results shed light on guiding further explorations for outdoor tourism areas in the post-epidemic era.

Keywords: National parks; Epidemics; Sustainable development; Economy, Regression analysis.

1. Introduction

As a result of COVID-19, countries have introduced prevention and control policies (e.g., travel bans, vaccines, social distancing) to limit people's international travel. On this basis, it has shifted people's choices from long-term international travel to shorter regional and domestic travel. In 2020, outbound travel from the U.S. declined by 66.2% year-over-year and the number of international visitors to the U.S. also declined by 75% [1]. Domestic travel for the U.S., while down 35% in 2020, is up 30.5% in 2021 and the growth trend is expected to continue through 2025 [2]. Whereas leisure and recreation spending declined by 30.5% in 2020, it rose by 18.4% in 2021 and is expected to maintain its upward trend through 2024 [3]. The pandemic has changed travel destination choices. 75% of U.S. travelers in April 2020 said the pandemic has changed their travel plans, with people preferring camping (46%), meeting with friends (26%), and road trips for safety reasons (24%) to domestic air travel, which is 8% [4].

The epidemic has prompted an influx of tourists to domestic and rural tourist destinations. National parks have become popular attractions during the epidemic. In 2021, one saw a 50% spike in the number of visitors to U.S. national parks, which has led to overcrowding in national parks and reflects shortcomings in national park management [5]. Mai reports in the Guardian that Visitors flocked to national parks this summer as COVID-19 regulations were relaxed across the US. The National Park Service reported that half of recreational visits occurred within 5% of all parks, with significant crowds concentrated in the 12 to 15 most popular high-profile destinations [6].

In the era of the epidemic, many countries and regions (e.g., Europe and Asia), have seen an increase in demand from tourists for in-country outdoor attractions, such as hiking, picnicking, parks, and road trips. However, these attractions are not designed to support high numbers of people and management systems, which leads to further deterioration of ecological problems in the parks, thus threatening the sustainability of the attractions and bringing a poor visitor experience [7]. Therefore, this paper will choose Acadia National Park, where the number of visitors surged during the epidemic, as a case study to examine the impact of the epidemic on the park and to give advice on how to solve the problem of surging visitors in the post-epidemic era. The paper also provides suggestions and references for other scenic spots facing the same problem.

The rest part of the paper is organized as follows. The second part of the paper will introduce the research methodology; introduce the data sources, data sample size, time frame, etc. Introduce the linear regression model, and the dependent independent variables. The basic logic of regression analysis in this paper will be described. The third part will discuss the results. Statistical data and regression analysis are used to study the impact of the epidemic on the number of people, facilities, visitor experience, and ecology in Acadia National Park. The corresponding solutions will be given and the limitations will be explained. The fourth section will summarize the conclusions drawn from the data analysis and the outlook for the future.

2. Methodology

2.1 Data

The data in this paper has two sources. The data for Acadia National Park comes from the official website of the National Park Service [8-10]. It contains monthly visitor counts, monthly vehicle counts for the main scenic areas of the park: mountains and beaches, and the number of overnight visitors. To analyze whether the epidemic had an impact on the number of visitors to Acadia National Park and to ensure the accuracy of our conclusions, we will use data from 2005-2022 for this analysis. Data on hotels near the park were obtained from the AirDNA website, which combines data from airbnb, Verbo to analyze hotels near the park, including Historical Occupancy Rate; Occupancy of overall leases, i.e., single-apartment occupancy; Hotel demand growth; Average Daily Rent; Booked properties; Rental Revenue; Historical Market Revenue. This research focuses on hotels and only examines the economic impact of rising park visitor numbers on the neighborhood, so only data from May 2019 to April 2022, after the epidemic, were chosen.

2.2 Model

In this paper, a regression model is used to analyze the relationship between the epidemic and the number of people in the park, the facilities in the park, the visitor experience, and the ecology in the park. The number of people in the park will be the independent variable, and the number of facilities, vehicles, and overnight visitors will be the dependent variables. The regression model will be used to determine the impact of the epidemic on the number of park visitors and the impact of the number of park visitors on the sustainability of the park facilities and ecology. In the hotel data, the number of park visitors will be used as the independent variable, while Historical Occupancy Rate; Occupancy of overall leases, i.e., single-apartment occupancy; Hotel demand growth; Average Daily Rent; Booked properties; Rental Revenue; Historical Market Revenue will be selected as dependent variables. The impact of the number of visitors on the economy of hotels around the park will be analyzed by regression equation.

2.3 Processing & Procedure

Primarily, the regression analysis will be carried out to examine the impact of the epidemic on the number of visitors to the national park, and then analyze the impact of the increase in visitor numbers on the ecology of the park, the visitor experience, and the economy of the park neighborhood. After confirming the authenticity of the data, we preprocessed the data from both regression analyses to make them consistent in time, and data length.

3. Results & Discussion

3.1 The Statistical Analysis

This subsection will analyze whether the epidemic has had an impact on the number of people in the park and the impact of the increased numbers on the park and surrounding economy by using statistical data relating to the park in Acadia National Park. 44. As shown in Figure 1, the number of

visitors to Acadia National Park surges in 2021. The number of visitors in 2021 is 52% higher than in 2020 and 15% higher than in 2018. Visitor visits in 2021 alone exceed the annual visitation record of the last 17 years. The new crown epidemic started in the second half of 2019 and has continued to the present and the development of a new crown vaccine started in April 2020. In contrast, the number of visitors to Acadia National Park surged in 2021 and it can be tentatively concluded that there is an impact of the epidemic on the number of visitors to Acadia National Park. Subsequently, the monthly car park counts for two of the park's most famous attractions, Schoodic Gate and Sand Beach, were calculated to again reflect the impact of the epidemic on park visitors, as well as the change in park visitor numbers and crowding levels over the course of a year.

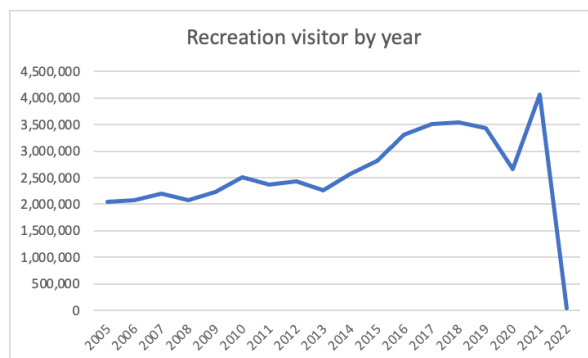


Fig. 1 Acadia National Park Visitors by Year(From 2005.01 to 2022.04)

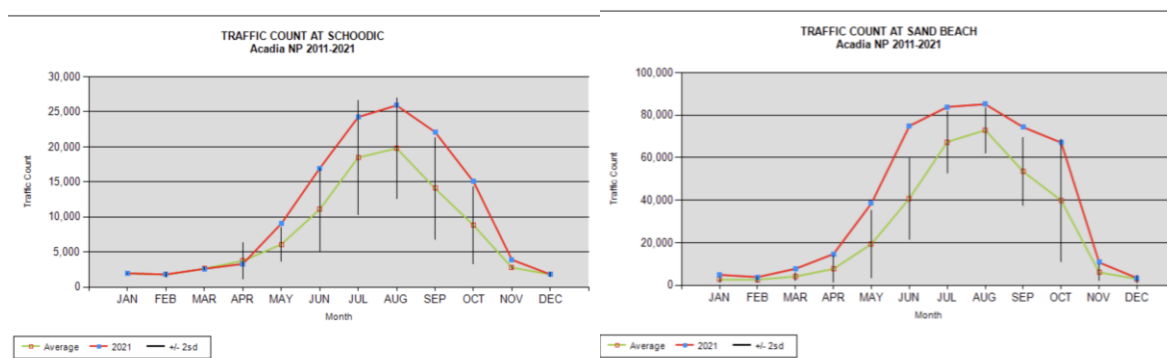


Fig. 2 The number of car parks at the two prominent sites in the park.

Fig. 2 presents the traffic statistics for the Schoodic Gate and Sand beach in Acadia National Park an. from April 2021 to November 2021 there is a substantial increase in the number of stops here compared to the average of previous stops. This is particularly noticeable from June to October 2021. And the graph also reflects the fact that demand for parking is concentrated between May and October. However, due to the increased number of parking in 2021, this could lead to problems with overloading the parking capacity in the park. Seen from the right panel of the Fig. 2, the traffic statistics for Sandy Beach in Acadia National Park, and we can see that the number of parking trips from January 2021 to December 2021 has increased substantially compared to the previous parking average. The demand for parking has increased in some way compared to previous years for almost the entire year, and more significantly from June to October 2021. Besides, it also reflects the fact that demand for parking is concentrated between May and November. Nevertheless, the overall parking demand at Sandy Beach is much less than the parking demand at Schoodic Gate, and it may be relatively easy to solve the parking problem by putting traffic into Sandy Beach. From the traffic statistics of the two sites, one can learn that the number of visitors to Acadia National Park in 2021 is higher than the previous average, and when the number of visitors is higher than the actual carrying capacity of the site, it will trigger many chain reactions (e.g., traffic congestion, affecting the visitor experience, increasing the workload of the scenic staff, exposing the poor management of the site).

Figure 3 depicts the number of overnight visitors to Acadia National Park, and one sees that the park closed overnight services in 2020 due to the epidemic, but the upward trend is evident when it reopens in 2021. It is possible that the impact of the closure of services in 2020, which led to many people not knowing that overnight stays were available, or the impact of post-epidemic park policies, prevented the number of overnight visitors from returning to pre-epidemic levels in 2021. However, the slope of the curve from 2020 to 2021 is large, suggesting that visitors are still returning quickly. In terms of the statistics related to the park, the impact of the epidemic has caused an explosion in the number of visitors to Acadia National Park, while creating traffic congestion and other problems for the park, and the park has adopted policies such as eliminating overnight stays, limiting admission and reserving tickets in order to maintain visitor safety, and the congestion problem and a series of policy changes will certainly cause a decline in the visitor experience and affect the habitat of animals in the park, among a range of problems. The epidemic has worsened the ecological problems in the park and accelerated the exposure of the park's management problems. The impact of soaring tourists in national parks on surrounding economies.

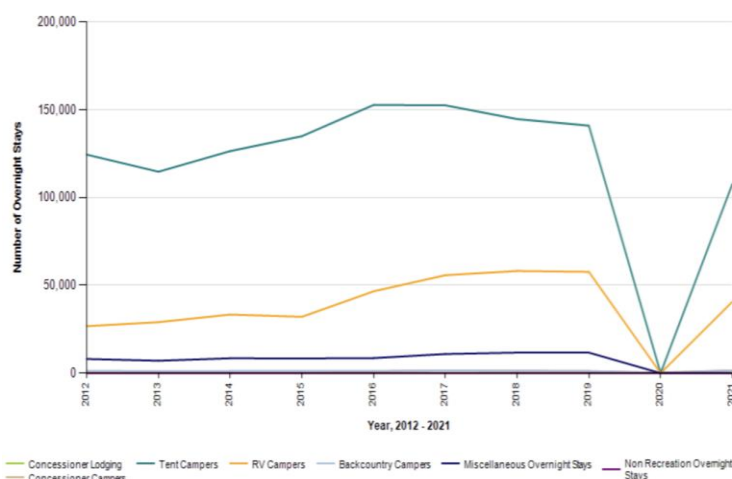


Fig. 3 Overnight visitors in Acadia National Park.

3.2 The impact of soaring tourists in national parks on surrounding economies

As illustrated in left panel of Fig. 4, one sees a 10% increase in hotel employment around Acadia National Park in 2021 compared to 2019. However, the values for the six months from November 2019 to June 2020 appear anomalous, and the epidemic started in late 2019, so it can be assumed that the epidemic affected employment in Acadia National Park. Seen from in the right panel of Fig. 4, demand for hotels around Acadia National Park is expected to increase by 16% year-on-year in 2021. However, hotel demand does not appear to have been affected by the epidemic, and the post-epidemic values have not fallen regionally and have remained at their previous average levels.

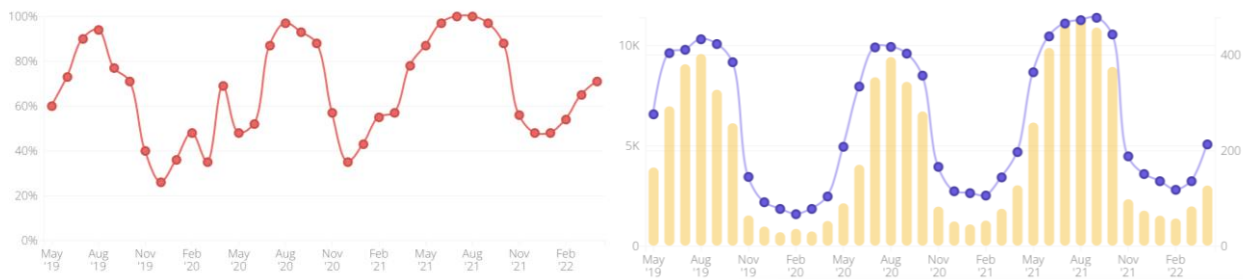


Fig. 4 The 50th percentile historical occupancy rates near Acadia National Park (left panel) and Demand Growth of Hotels near Acadia National Park, 2019-2022.

In the left panel of Figure 5, one sees a 24% increase in short term rental prices from 2019 to 2022, suggesting that the market may have been in short supply of hotels during the peak period of park visitation (May to September). In contrast, from November 2019 to May 2020, which is the low peak period for the epidemic and the park, rents have fallen somewhat compared to previous years, suggesting that the epidemic has had some impact on hotel revenue, but the loss gap is not visible, possibly because it is the low peak period for tourism. As shown in the right panel of Fig. 5, hotel daily rates were also affected by the epidemic, with prices below average from November 2019 to May 2020, but increasing by almost 20% during the peak of the park in 2021, suggesting that even though flat prices fell due to the epidemic, they quickly rebounded to normal levels after 2021, and even during the peak of 2021, with room prices rising above previous levels. This reflects the rapid rebound in hotel demand after 2021, with hotel supply falling short of demand.



Fig. 5 The Historical Market Revenue of Hotels around Acadia National Park, 2019-2022 (left panel) and Average daily rate of Hotels around Acadia National Park, 2019-2022 (right panel).



Fig. 6 Active listings of Hotels around Acadia National Park, 2019-2022 (left panel) and Rental Revenue of Hotels around Acadia National Park, 2019-2022 (right panel).

As given in the left panel of Fig. 6, the number of existing flats did not decrease after the outbreak, but increased by almost 10% from May 2021 to October 2021 compared to 2020 and 2019. The highest demand is for full rentals, followed by individual rooms, indicating that park visitors are mainly families, couples and other groups. Seen from the right panel of Figure 6, rental revenue is not affected by the epidemic, but continues to rise slightly in 2021. Instead, it starts to rise slightly in 2021 and reaches its highest value in August 2021.

According to the data analysis, the epidemic has led to a decline in employment and a decline in demand for housing in hotels near Acadia National Park, but the price and supply of housing has not changed much. The surge in visitors to Acadia National Park, which was indirectly caused by the epidemic, pushed up the price of hotels in the vicinity and boosted employment in the surrounding area during the epidemic. However, this phenomenon has continued to plague the neighborhood, affecting basic short-term rental prices in the area and the livelihoods of nearby residents [11]. It has also affected the sense of visitor experience in Acadia National Park and the habitat of the animals in the park. More serious environmental protection issues and park management problems have been revealed [11].

3.3 Regression analysis

In this section, the extent to which the rise in park attendance is associated with the economy of hotels within and around the park using regression equations, will be analyzed to reflect the relationship between the epidemic in hotels and the park over time. Figure 7 illustrates the number of overnight visitors using caravans and tents. This shows a steady increase in the number of visitors until 2020, which is consistent with the forecast, but with a significant difference in 2020. The reason for this is the closure of the Acadia National Park to caravans and tents as a result of the epidemic.

The left panel of Figure 8 gives the relationship between the number of visitors to the park and the employment rates of nearby hotels, where the general direction is consistent, but the data from August 2019 to May 2020 deviates significantly, which can be interpreted as a small relationship between the impact of the epidemic on visitors to the park and employment rates in the hotel industry. It is more likely that the direct impact of the epidemic on hotels will be greater. The right panel of Fig. 8 shows the relationship between park visitor numbers and nearby hotel revenues, with the lines largely overlapping, but actual revenues from August 2021 to May 2022 being higher than expected, which could be interpreted as the outbreak causing rapid growth in park visitors and growing faster than expected.

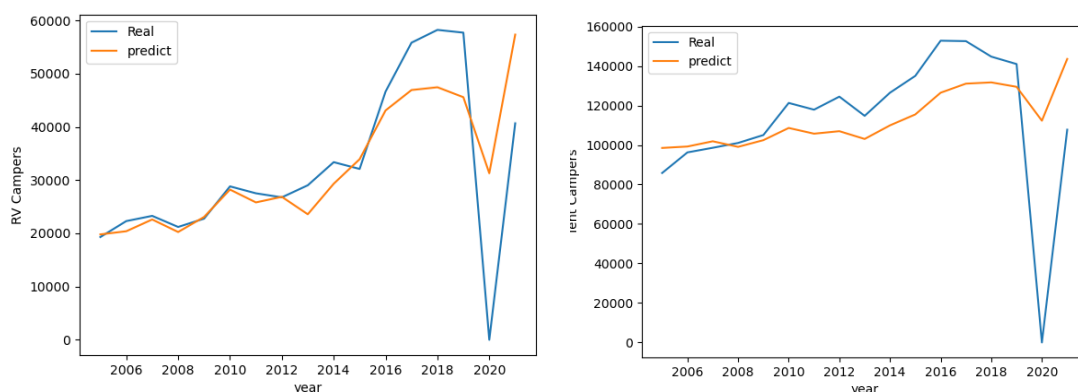


Fig. 7 RV campus and Tent campus visitors in Acadia National Park.

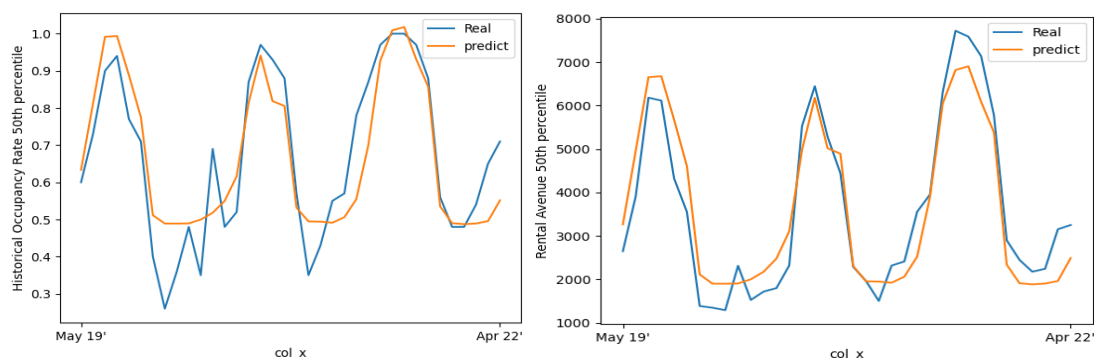


Fig. 8 Occupancy rates of hotels near Acadia National Park, 2019-2022 (left panel) and Rental Revenue of Hotels around Acadia National Park, 2019-2022 (right panel).

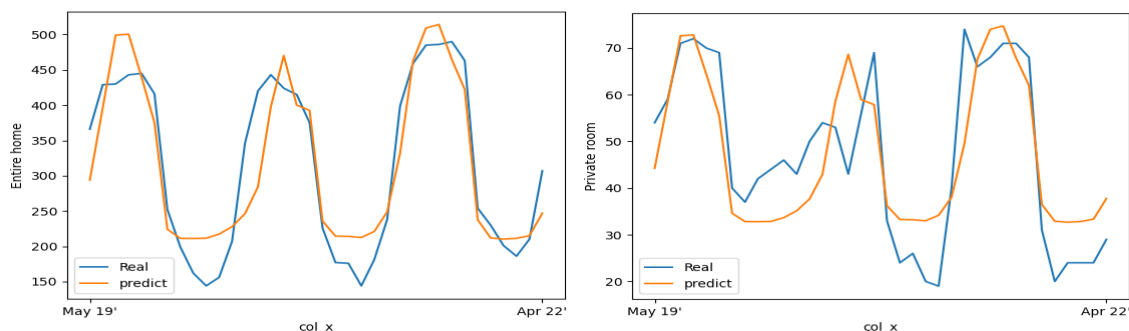


Fig. 9 the Entire home and private room historical Market Revenue of Hotels around Acadia National Park, 2019-2022.

Figure 9 illustrates the relationship between whole-rental and single-rental revenue and park visitors for hotels near Acadia National Park, respectively. The whole-rent graph has a somewhat more closely fitting curve direction than the single-rent curve, with less deviation than single-rent. This indicates that park visitors are mainly families and priorities whole rentals, while single rentals are less in demand and the particular circumstances that occur can easily affect the overall single rental market in terms of demand and income levels. Figure 10 shows the relationship between the Average daily rate of Hotels around Acadia National Park and the number of visitors to the park. The peaks and troughs remain consistent over time, but the overall price deviations are too large to suggest a significant relationship between the two.

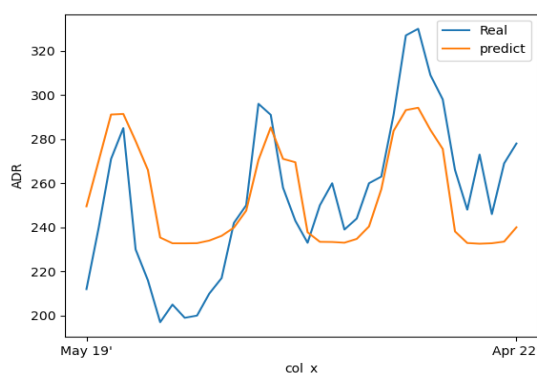


Fig. 10 Average daily rate of Hotels around Acadia National Park, 2019-2022.

From the regression analysis, one can primarily compare the relationship between the number of overnight visitors in the park who used caravans and tents and park visitors; the relationship between hotel employment, occupancy, supply, demand rates, whole and single room rental rates and the number of park visitors, and the impact of the epidemic on these factors in terms of time. The final conclusion is that the epidemic affected park visitor numbers and indirectly led to changes in park policy that affected the number of overnight visitors, but not the overnight category. Overall, the epidemic had a direct effect on hotel employment, it had little to do with the number of park visitors. However, the number of park visitors affected hotel revenue, the demand rate for hotels, and the number of visitors also had a direct impact on the type of rental, with most visitors opting for a whole flat.

3.4 National park management measures to deal with excess visitors

The increase in visitors has forced park managers act to avoid congestion problems, and these measures have also changed the visitor experience in the national park. As for reservation system, parks like Acadia, Yosemite, and Rocky Mountain National Park use advance reservation systems to limit congestion. Visitors who want to enter the park during the peak period (May-October) need to

purchase vehicle passes and tickets online to enter the park. Vehicle passes are sold on a rolling basis thirty percent of tickets are available on the website for 90 days prior to the entry date, with the remaining 70 percent to be announced at 10 a.m. two days prior to the park entry. Regarding to the shuttle system, Acadia National Park has adopted a shuttle system to reduce the number of private cars, but tourists report that the time to wait for the shuttle bus is very long, the travel experience has not improved, and during the pandemic, it was not advisable for many people to take the shuttle bus [12]. Moreover, it is necessary to divert tourists to sparsely populated areas of national parks. Some people suggest that the NPS should build parks in other sparsely populated areas to spread the flow of people. This could be through building multiple camping areas, RV camps, snack areas, statue areas, etc., to control the flow of people.

3.5 Limitation

Nevertheless, it should be noted that the results presented in this paper have certain drawbacks and shortcoming. Primarily, there is no specific data to support the growth of the park population on the visitor experience and ecological environment in the park. In addition, only the service industry of hotels is used in this paper as an analysis of the park's economic impact on the surrounding area [13-15]. In reality, more industry data should be collected, such as restaurants and entertainment, and hotels are inherently susceptible to tourism, and their data do not represent the overall economic level around Acadia National Park.

4. Conclusions

In summary, this paper investigates the impact of the epidemic on Acadia National Park based on a study of the impact of the epidemic on tourism within the territory. Specifically, the impact of the epidemic on Acadia National Park and the impact of the rise in the number of people in the park on the economy and ecology in and around the park were evaluated from the perspective of the results of statistical and regression models. According to the analysis, the arrival of the pandemic increased the number of visitors to Acadia National Park and, through the epidemic, exposed problems in the management of Acadia National Park. In addition, Acadia National Park represents a typical case of the most visited national parks in the United States that occurred in the last two years. We can foresee those similar problems may occur in other countries as well. Nevertheless, if we actively address the difficulties and identify the problems, we can improve ecological sustainability one improvement at a time. In the future, balancing economic development and the environment has always been the most important thing in tourism. Overall, these results provide a guide for other countries and regions. Hopefully, human beings will identify sustainable practices, or the local impact of tourism, in time and work to balance the economy, the environment and the visitor experience.

References

- [1] Statista. 2020. "Travel and Tourism in the U.S, did-10115-1[EB/OL]. Information on: <https://www-statista-com.proxy.library.nyu.edu/study/10115/us-travel-and-tourism-statista-dossier/>.
- [2] Domestic Tourism in the U.S., 2021b, did-23176-1[EB/OL]. Information on: <https://www-statista-com.proxy.library.nyu.edu/study/23176/domestic-tourism-in-the-us-statista-dossier/>.
- [3] Luxury Travel and Tourism amid the Pandemic, 2021c, did-70914-1[EB/OL]. Information on: <https://www-statista-com.proxy.library.nyu.edu/study/70914/luxury-travel-and-tourism-in-europe/>.
- [4] Coronavirus (COVID-19) in the U.S., 2021a, did-71515-1[EB/OL]. Information on: <https://www-statista-com.proxy.library.nyu.edu/study/71515/coronavirus-disease-covid-19-in-the-us/>.
- [5] Iacurci, Greg. National Parks Are Booming. That May Ruin Your next Trip, CNBC, August 22, 2021[EB/OL]. Information on: <https://www.cnn.com/2021/08/22/national-parks-are-booming-that-may-ruin-your-next-trip.html>.

- [6] Mai, Tran. It's Not Sustainable': Overcrowding Is Changing the Soul of US National Parks. The Guardian, September 10, 2021[EB/OL]. Information on: <https://www.theguardian.com/environment/2021/sep/10/overcrowding-changing-us-national-parks>
- [7] Chun J, Kim C K, Kim G S, et al. Social big data informs spatially explicit management options for national parks with high tourism pressures[J]. Tourism Management, 2020, 81: 104136.
- [8] Recreation Visitors By Month (1979 - Last Calendar Year) Acadia National Park., 2022a NPS statistic. [EB/OL]. Information on: [https://irma.nps.gov/STATS/SSRSReports/Park%20Specific%20Reports/Recreation%20Visitors%20By%20Month%20\(1979%20-%20Last%20Calendar%20Year\)?Park=ACAD](https://irma.nps.gov/STATS/SSRSReports/Park%20Specific%20Reports/Recreation%20Visitors%20By%20Month%20(1979%20-%20Last%20Calendar%20Year)?Park=ACAD).
- [9] Traffic Count at Sand Beach:Acadia National Park. 2022b, [EB/OL]. Information on: <https://irma.nps.gov/STATS/SSRSReports/Park%20Specific%20Reports/Traffic%20Counts%20High-Low-Close%20Graph?Park=ACAD>.
- [10] Annual Park Ranking Report for Recreation Visits in: 2021 Park Type: (All), 2022c, National Park Service[EB/OL]. Information on: [https://irma.nps.gov/STATS/SSRSReports/National%20Reports/Annual%20Park%20Ranking%20Report%20\(1979%20-%20Last%20Calendar%20Year\)](https://irma.nps.gov/STATS/SSRSReports/National%20Reports/Annual%20Park%20Ranking%20Report%20(1979%20-%20Last%20Calendar%20Year)).
- [11] Andersson J O, Lindroth M. Ecologically unsustainable trade[J]. Ecological Economics, 2001, 37(1): 113-122.
- [12] Dunphey, Kyle., National Park Visitation Is up. What Are Solutions to Decrease Traffic? Deseret News, October 2021 [EB/OL]. Information on: <https://www.deseret.com/2021/10/10/22683075/national-park-visitation-is-up-what-are-solutions-to-decrease-traffic>.
- [13] Frenchman D, Lane J S. Discussion White Paper Assessment of Preservation and Development in Lowell National Historical Park at its 30-Year Anniversary[R]. National Park Service, 2008.
- [14] Dublin T. The Story of an Industrial City: A Guide to Lowell National Historical Park and Lowell Heritage State Park, Lowell, Massachusetts[M]. Government Printing Office, 1992.
- [15] Morrison A, Lehto X, Day J. The tourism system[M]. Kendall Hunt Publishing, 2018.