A Case Study of Tourism in North Carolina State Parks Using Google Trends

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ABSTRACT

The purpose of this study is to examine available innovative technologies as a means to forecast visitors to the North Carolina State Park system. The research will use Google Trends as the innovative technology and using the data from Google search queries to measure relationship from searches to visitors. This examination will include literature review and data collection methods. Furthermore, the quantitative measures will include the Pearson Correlation Coefficient (Pearson) and Time-Series Linear Modeling (TSLM), which accounts for seasonal and trending values. The data from the state parks were provided by the Public Information Office of the North Carolina Division of Parks and Recreation. Additionally, the search query data was collected from Google Trends. Two locations within the Appalachian Mountains of Western North Carolina were selected due to the exclusivity of the locations and to capture visit behavior in search queries. Those locations are Mount Mitchell State Park and Grandfather Mountain State Park.

KEYWORDS

Appalachian Mountains, Forecasting, Google Trends, Grandfather Mountain, Linear Modeling, Mount Mitchell, North Carolina, Nowcasting, Search Query, State Parks, Time-Series, Visitors

INTRODUCTION

Tourism is a service-focused industry that spurs economic activity. The industry is found to be reflective of economic growth (Tisdell, 2013). In 2018, tourism represented 7.8 million jobs in the American workforce and carried 2.8% of the country’s GDP (Franks & Osborne, 2019). The U.S. Bureau of Economic Analysis (2020) released the 2019 figures indicating higher growth for industries with real GDP recorded at 2.1%. Tourism carries wide-ranging subsectors with varying impact, bringing together cultures within developing or developed regions or countries (Uysal et al., 2016; Kozak & Kozak, 2015). While the calendar year of 2020 will be producing economic numbers marred by the coronavirus global pandemic, it is becoming clear that consumer behavior is changing how travel occurs (Uğur & Akbiyik, 2020).

Tourism, as an industry, relies on other consumption-based industries like transportation, accommodation, food and beverage, recreation, and more (Karuaihe et al., 2015). Both domestic and international tourism were brought into the forefront of economic academics due to the increased per capita income and reduction of transportation costs in western economics after WWII (Polo & Valle, 2015). The act of a consumer engaging in a travel and tourism activity impacts other industries either beneficially or negatively. Generally, positive impacts are discussed around growth activities to the local, state, and national economy. On the other hand, the negative impacts which are discussed
among academics and stakeholders are income inequality (Assadzadeh & Yalghouzaghaj, 2015), over-dependency (Rezapouraghdam et al., 2018), carbon emissions (Akadiri et al., 2018) and more.

For the local economy to flourish as a tourist destination, it needs to create an environment for optimally efficient cooperation from politicians, business leaders, and community (Niță, 2014). Tourism has historically proven the adaptations of the industry and relevancy are possible in local economics (Rodriguez et al., 2020). An economic impact study at one of North Carolina’s state parks, Hanging Rock State Park, concluded visitors contributed $26.65 per person to the local economy (Bergstrom et al., 1990). While the economic impact relevancy thirty years later would not hold the same monetary value to local business leaders, it still provides research in how tourism assists and impacts other local industries within the economy. Economic impact studies are a vital tool for assisting the local business leaders in understanding what tourist find the most relevant within their visits and can assist in bettering those segments within their jurisdiction.

Google Trends is a platform that allows researchers across many fields to understand the popularity of search query topics, over time (West, 2020). The platform is accessible to the general public via the online web. Google records samples of search query data from users to measure on a normalized scale in a particular city, state, region, or country (Padhi & Pati, 2017). Google Trends (2020) measures the search volume on a scale from 0 to 100 and sets the highest volume at 100. Due to time being an infinite measure, Google Trends peak scale of 100 will be adjusted to the newest maximum peak and all other data will be adjusted per the scale (Google Trends, 2020). Both state park examples have recorded new peaks during the 2020 global coronavirus pandemic.

BACKGROUND

Google holds a 66.7% of market share worldwide and is the largest search engine used in the United States (Yang et al., 2014). Google trends has been used to show search query data can assist in stronger forecasting on behavior (Choi & Varian, 2009; Höpken et al., 2018). Previous research has shown Google Trends abilities with tourism in Switzerland (Siliverstovs & Wochner, 2018), Portugal (Dinis et al., 2017), and Japan (Chang et al., 2017), along with many other countries. At the time of writing, there has been no other major publications studying Google Trends and American domestic tourism. As seen in the Bergstrom et al (1990) research, forecasting experts use economic viability data as a measure of potential tourism impact. Therefore, it can be concluded that examining the relationship of Google search query data and tourism activity can be viewed as both, modernizing and advantageous.

METHODOLOGY

The data from the state parks were provided by the Public Information Office of the North Carolina Division of Parks and Recreation. Additionally, the search query data was collected from Google Trends. The data for state parks had to be requested for a time period from January 2015 until July 2020, most recent data reported. The data had missing visitor totals reported for the month of April 2019 and April 2020. Interpolation was used by averaging previous recorded April data in the set. The data was provided with additional comments from the park operators on tourism numbers. These comments are provided when it appears visitor numbers were correlated to poor weather, road access, and local traffic pattern shifts. Even though weather may have caused lower attendance, it would be assumed that same weather conditions would also shift interest in Google searches. Therefore, these variables were kept and measured against Google Trends data.

The methodology of selecting two North Carolina state parks, Grandfather Mountain State Park and Mount Mitchell State Park, are the lack of national attention and the regional influence from tourism in Asheville and Boone, North Carolina markets. Additionally, within the region is the largest U.S. National Park by visitors, Great Smoky Mountains National Park (National Park Service, 2020). Asheville, North Carolina was ranked number three in Travel & Leisure magazine’s top fifty places
to travel in 2020 (Bake, 2020). Furthermore, Boone is home to Appalachian State University, which has a student enrollment of 19,280 (Bruffy, 2019).

The methods of examining the data will include Pearson correlation coefficient (Pearson) and time-series linear modeling (TSLM). Using Pearson as a method for examining search engine queries and visitors is a method that has been used in previous research (Yang et al., 2014; Chang et al., 2017). The first method, much like Yang et al. (2014), would be to examine Google search query data for a range of 0 to 7 months and seek the highest correlation coefficient. Afterwards, the data can be processed through a time-series linear model and reviewing the summaries. Using time-series linear modeling will account for seasonality and trends. The use of TSLM function is a forecasting package within the R program; which, uses linear modeling with options of seasonality and trend (Chen et al., 2019).

RESULTS

The Pearson results were compiled through a series of lagged search results to visitors at each state park between 0 to 7 months. The highest Pearson results for both state parks were during the non-lagged data. Pearson indicated 0.601 and 0.642 for Mount Mitchell State Park and Grandfather Mountain State Park, respectively for the full time period. As the lagging process continued, the results became less significant. Using the Pearson test, there are different time periods which produce the best possible correlation. Using the time period from January 2017 to July 2020, Mount Mitchell data returned a 0.67 correlation. Data from Grandfather Mountain between July 2018 to July 2020 produced the highest return, beating the threshold set by previous researchers at 0.76 (Yang et al., 2014). Dividing the initial time frame into smaller periods is consistent with research suggesting consumer sentiment and tourism activity work together (Bayih & Singh, 2020). The time periods for observation were matched to consumer sentiment and public knowledge of political uncertainty around 2016 President election and high-profile committee hearings around impeachment inquiries (University of Michigan, 2020).

Figure 1. Pearson Correlation Coefficient

| Monthly Visitors to Monthly Google Trends Data, Jan 2015 - Jul 2020 |
|---------------------------------------------------------------|
| Non-Lag | Lag 1 | Lag 2 | Lag 3 | Lag 4 | Lag 5 | Lag 6 | Lag 7 |
| Mount Mitchell | 0.601359 | 0.430091 | 0.363268 | 0.165937 | -0.062220 | -0.324793 | -0.490193 | -0.463655 |
| Grandfather Mountain | 0.642529 | 0.446326 | 0.196825 | 0.027831 | -0.197280 | -0.362067 | -0.482527 | -0.45621 |

| Monthly Visitors to Monthly Google Trends Data, Jan 2017 - Jul 2020 |
|---------------------------------------------------------------|
| Non-Lag | Lag 1 | Lag 2 | Lag 3 | Lag 4 | Lag 5 | Lag 6 | Lag 7 |
| Mount Mitchell | 0.670700 | 0.535123 | 0.408512 | 0.087123 | -0.172505 | -0.382674 | -0.567894 | -0.66129 |
| Grandfather Mountain | 0.732871 | 0.569420 | 0.223880 | 0.041472 | -0.127606 | -0.313935 | -0.408729 | -0.43849 |

Data collected from NC State Parks and Google Trends

Mount Mitchell State Park produced a model that did not find significance with Google search query data or trend. The model does note eight months of the year, seasonality is statistically significant
with a higher adjusted r-square (Table-4). When examining Grandfather Mountain State Park output, seasonality and trend were not statistically significant. Although, Grandfather Mountain State Park shows Google search query data as statistically significant. The intercept is not significant (Table-5). Overall, the Grandfather Mountain model has an adjusted r-square of 0.604 with a significant p-value and f-statistic. Therefore, roughly 60% of the visitors to Grandfather Mountain State Park can be explained by Google search query volumes.

**CONCLUSION**

When examining the Pearson results, it becomes clear that nowcasting Google search query data to visitors are possible for the parks. The time-series linear regression produced results that were statistically significant for one park out of the two observed. The Pearson correlation coefficient for Grandfather Mountain State Park yielded higher correlations greater than Yang et al. (2014). Furthermore, to the best of the author’s knowledge there has been no studies using the time-series linear model as a tool to examine forecasting capabilities. Even more so, using the combined guidelines set forth by previous work to measure American domestic tourism. The relationship for Google search query data and attendance at the state parks would be expected to continuously improve over time due to technological advancements and potential pushes for further digital reliance from the 2020 global coronavirus pandemic. Therefore, continuous research on this topic and potentially using other innovative technologies as a medium of nowcasting should be further explored. This study concludes that Google Trends can assist stakeholders in creating stronger forecasting for park visits.

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APPENDIX A - TABLES

Table 1. 2015 – 2017 Raw Data collected from NC State Parks and Google Trends

| Year | Month | Visit_Mitchell | Visit_Grandfather | GTSQ_Mitchell | GTSQ_Grandfather |
|------|-------|----------------|-------------------|---------------|-----------------|
| 2015 | 1     | 1400           | 2255              | 6             |                 |
| 2015 | 2     | 188            | 910               | 7             | 6               |
| 2015 | 3     | 5018           | 3657              | 12            | 11              |
| 2015 | 4     | 12981          | 7375              | 8             | 4               |
| 2015 | 5     | 23383          | 10306             | 12            | 24              |
| 2015 | 6     | 52072          | 9944              | 20            | 20              |
| 2015 | 7     | 52270          | 15180             | 21            | 17              |
| 2015 | 8     | 41593          | 13632             | 12            | 25              |
| 2015 | 9     | 33858          | 7797              | 8             | 17              |
| 2015 | 10    | 71200          | 12181             | 18            | 25              |
| 2015 | 11    | 15726          | 5377              | 16            | 9               |
| 2015 | 12    | 6280           | 5983              | 8             | 13              |
| 2016 | 1     | 2880           | 2621              | 32            | 9               |
| 2016 | 2     | 323            | 1193              | 12            | 14              |
| 2016 | 3     | 8272           | 6947              | 15            | 11              |
| 2016 | 4     | 17200          | 7109              | 5             | 20              |
| 2016 | 5     | 39117          | 6299              | 22            | 20              |
| 2016 | 6     | 51840          | 9533              | 25            | 35              |
| 2016 | 7     | 64752          | 14401             | 30            | 52              |
| 2016 | 8     | 50998          | 6777              | 25            | 32              |
| 2016 | 9     | 49456          | 7678              | 14            | 17              |
| 2016 | 10    | 93184          | 13596             | 16            | 24              |
| 2016 | 11    | 14791          | 7382              | 4             | 13              |
| 2016 | 12    | 5278           | 3566              | 7             | 17              |
| 2017 | 1     | 6084           | 2941              | 5             | 30              |
| 2017 | 2     | 7973           | 4600              | 7             | 12              |
| 2017 | 3     | 7398           | 4866              | 6             | 4               |
| 2017 | 4     | 25508          | 9309              | 15            | 29              |
| 2017 | 5     | 36452          | 7495              | 18            | 37              |
| 2017 | 6     | 46087          | 10594             | 22            | 65              |
| 2017 | 7     | 64896          | 11696             | 25            | 51              |
| 2017 | 8     | 47217          | 9659              | 12            | 16              |
| 2017 | 9     | 39888          | 10331             | 21            | 12              |
| 2017 | 10    | 69549          | 8633              | 26            | 27              |
| 2017 | 11    | 19745          | 4742              | 14            | 16              |
| 2017 | 12    | 4674           | 2782              | 6             | 13              |

Data collected from NC State Parks and Google Trends
Table 2. 2018 – 2020 Raw Data collected form NC State Parks and Google Trends

| Year | Month | NC State Parks | Google Trends | Rank | Rank |
|------|-------|----------------|---------------|------|------|
| 2018 | 1     | 428            | 666           | 9    | 9    |
| 2018 | 2     | 6437           | 1874          | 7    | 6    |
| 2018 | 3     | 5609           | 2808          | 16   | 15   |
| 2018 | 4     | 17566          | 6059          | 13   | 16   |
| 2018 | 5     | 32234          | 4142          | 16   | 28   |
| 2018 | 6     | 45932          | 6384          | 14   | 22   |
| 2018 | 7     | 60307          | 7866          | 23   | 36   |
| 2018 | 8     | 44065          | 6282          | 20   | 25   |
| 2018 | 9     | 35721          | 6577          | 13   | 23   |
| 2018 | 10    | 63722          | 4604          | 10   | 18   |
| 2018 | 11    | 9041           | 2707          | 9    | 15   |
| 2018 | 12    | 2803           | 1712          | 8    | 14   |
| 2019 | 1     | 5371           | 1187          | 5    | 17   |
| 2019 | 2     | 3365           | 4620          | 7    | 15   |
| 2019 | 3     | 11441          | 3376          | 9    | 11   |
| 2019 | 4     | 18314          | 7463          | 11   | 30   |
| 2019 | 5     | 45016          | 5035          | 21   | 32   |
| 2019 | 6     | 49007          | 5920          | 18   | 30   |
| 2019 | 7     | 63192          | 8637          | 21   | 36   |
| 2019 | 8     | 6282           | 8296          | 17   | 23   |
| 2019 | 9     | 56176          | 7558          | 11   | 37   |
| 2019 | 10    | 69381          | 8001          | 29   | 45   |
| 2019 | 11    | 18911          | 8621          | 12   | 20   |
| 2019 | 12    | 8893           | 3949          | 5    | 11   |
| 2020 | 1     | 2495           | 1637          | 14   | 12   |
| 2020 | 2     | 1424           | 1650          | 14   | 13   |
| 2020 | 3     | 5131           | 2490          | 8    | 13   |
| 2020 | 4     | 18314          | 7463          | 3    | 6    |
| 2020 | 5     | 10845          | 4440          | 23   | 32   |
| 2020 | 6     | 24071          | 24072         | 31   | 65   |
| 2020 | 7     | 69128          | 15093         | 41   | 88   |

Data collected from NC State Parks and Google Trends
Table 3. Part 1 showing 2015 – 2017 Pearson Correlation Coefficient Test for Mount Mitchell State Park

| Year | Month | Visit_Mitchell | Non_Lag | Lag_1 | Lag_2 | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
|------|-------|----------------|---------|-------|-------|-------|-------|-------|-------|-------|
| 2015 | 1     | 1400           | 4       | Lag_1 | Lag_2 | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 2     | 188            | 7       | 4     | Lag_2 | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 3     | 5918           | 12      | 7     | 4     | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 4     | 12981          | 8       | 12    | 7     | 4     | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 5     | 23383          | 12      | 8     | 12    | 7     | 4     | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 6     | 52072          | 20      | 12    | 8     | 12    | 7     | 4     | Lag_6 | Lag_7 |
| 2015 | 7     | 52270          | 21      | 20    | 12    | 8     | 12    | 7     | 4     | Lag_7 |
| 2015 | 8     | 41593          | 12      | 21    | 20    | 12    | 8     | 12    | 7     | 4     |
| 2015 | 9     | 33858          | 8       | 12    | 21    | 20    | 12    | 8     | 12    | 7     |
| 2015 | 10    | 71200          | 18      | 8     | 12    | 21    | 20    | 12    | 8     | 12    |
| 2015 | 11    | 15726          | 16      | 18    | 8     | 12    | 21    | 20    | 12    | 8     |
| 2015 | 12    | 6280           | 8       | 16    | 18    | 8     | 12    | 21    | 20    | 12    |
| 2016 | 1     | 2880           | 32      | 8     | 16    | 18    | 8     | 12    | 21    | 20    |
| 2016 | 2     | 323            | 12      | 32    | 8     | 16    | 18    | 8     | 12    | 21    |
| 2016 | 3     | 8272           | 15      | 12    | 32    | 8     | 16    | 18    | 8     | 12    |
| 2016 | 4     | 17200          | 5       | 15    | 12    | 32    | 8     | 16    | 18    | 8     |
| 2016 | 5     | 39117          | 22      | 5     | 15    | 12    | 32    | 8     | 16    | 18    |
| 2016 | 6     | 51840          | 25      | 22    | 5     | 15    | 12    | 32    | 8     | 16    |
| 2016 | 7     | 64752          | 30      | 25    | 22    | 5     | 15    | 12    | 32    | 8     |
| 2016 | 8     | 50998          | 25      | 30    | 25    | 22    | 5     | 15    | 12    | 32    |
| 2016 | 9     | 49456          | 14      | 25    | 30    | 25    | 22    | 5     | 15    | 12    |
| 2016 | 10    | 93184          | 16      | 14    | 25    | 30    | 25    | 22    | 5     | 15    |
| 2016 | 11    | 14791          | 4       | 16    | 14    | 25    | 30    | 25    | 22    | 5     |
| 2016 | 12    | 5278           | 7       | 4     | 16    | 14    | 25    | 30    | 25    | 22    |
| 2017 | 1     | 6084           | 5       | 7     | 4     | 16    | 14    | 25    | 30    | 22    |
| 2017 | 2     | 7973           | 7       | 5     | 7     | 4     | 16    | 14    | 25    | 30    |
| 2017 | 3     | 7398           | 6       | 7     | 5     | 7     | 4     | 16    | 14    | 25    |
| 2017 | 4     | 25508          | 15      | 6     | 15    | 5     | 7     | 4     | 16    | 14    |
| 2017 | 5     | 36452          | 18      | 15    | 6     | 7     | 5     | 7     | 4     | 16    |
| 2017 | 6     | 46087          | 22      | 18    | 5     | 7     | 5     | 7     | 4     | 16    |
| 2017 | 7     | 64896          | 25      | 22    | 18    | 5     | 7     | 5     | 7     | 4     |
| 2017 | 8     | 47217          | 12      | 25    | 22    | 18    | 5     | 7     | 5     | 7     |
| 2017 | 9     | 39888          | 21      | 12    | 25    | 22    | 18    | 5     | 7     | 6     |
| 2017 | 10    | 69549          | 26      | 21    | 12    | 25    | 22    | 18    | 5     | 6     |
| 2017 | 11    | 19745          | 14      | 26    | 21    | 12    | 25    | 22    | 18    | 5     |
| 2017 | 12    | 4674           | 6       | 14    | 26    | 21    | 12    | 25    | 22    | 18    |

Data collected from NC State Parks and Google Trends
Table 4. Part 2 Continued after 2018, Pearson Correlation Coefficient Test for Mount Mitchell State Park

| Year | Month | Visit Mitchell | Non_Lag | Lag_1 | Lag_2 | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
|------|-------|----------------|---------|-------|-------|-------|-------|-------|-------|-------|
| 2018 | 1     | 428            | 9       | 6     | 14    | 26    | 21    | 12    | 25    | 22    |
| 2018 | 2     | 6437           | 7       | 9     | 6     | 14    | 26    | 21    | 12    | 25    |
| 2018 | 3     | 5609           | 16      | 7     | 9     | 6     | 14    | 26    | 21    | 12    |
| 2018 | 4     | 17566          | 13      | 16    | 7     | 9     | 6     | 14    | 26    | 21    |
| 2018 | 5     | 32234          | 16      | 13    | 16    | 7     | 9     | 6     | 14    | 26    |
| 2018 | 6     | 45932          | 14      | 16    | 13    | 16    | 16    | 7     | 9     | 6     |
| 2018 | 7     | 63037          | 23      | 14    | 16    | 13    | 16    | 7     | 9     | 6     |
| 2018 | 8     | 44065          | 20      | 23    | 14    | 16    | 13    | 16    | 7     | 9     |
| 2018 | 9     | 35721          | 13      | 20    | 23    | 14    | 10    | 13    | 16    | 7     |
| 2018 | 10    | 63722          | 10      | 13    | 20    | 23    | 14    | 16    | 13    | 16    |
| 2018 | 11    | 9041           | 9       | 10    | 13    | 20    | 23    | 14    | 16    | 13    |
| 2018 | 12    | 2803           | 8       | 9     | 10    | 13    | 20    | 23    | 14    | 16    |
| 2019 | 1     | 5371           | 5       | 8     | 9     | 10    | 13    | 20    | 23    | 14    |
| 2019 | 2     | 3365           | 7       | 5     | 8     | 9     | 10    | 13    | 20    | 23    |
| 2019 | 3     | 11441          | 9       | 7     | 5     | 8     | 9     | 10    | 13    | 20    |
| 2019 | 4     | 18314          | 11      | 9     | 7     | 5     | 8     | 9     | 10    | 13    |
| 2019 | 5     | 45016          | 21      | 11    | 9     | 7     | 5     | 8     | 9     | 10    |
| 2019 | 6     | 49907          | 18      | 21    | 11    | 9     | 7     | 5     | 8     | 9     |
| 2019 | 7     | 63192          | 21      | 18    | 21    | 11    | 9     | 7     | 5     | 8     |
| 2019 | 8     | 6282           | 17      | 21    | 21    | 11    | 9     | 7     | 5     | 7     |
| 2019 | 9     | 56176          | 11      | 17    | 21    | 18    | 21    | 11    | 9     | 7     |
| 2019 | 10    | 69381          | 29      | 11    | 17    | 21    | 18    | 21    | 11    | 9     |
| 2019 | 11    | 18911          | 12      | 29    | 11    | 17    | 21    | 18    | 21    | 11    |
| 2019 | 12    | 8893           | 5       | 12    | 29    | 11    | 17    | 21    | 18    | 21    |
| 2020 | 1     | 2405           | 14      | 5     | 12    | 29    | 11    | 17    | 21    | 18    |
| 2020 | 2     | 1424           | 14      | 14    | 5     | 12    | 29    | 11    | 17    | 21    |
| 2020 | 3     | 5131           | 8       | 14    | 14    | 5     | 12    | 29    | 11    | 17    |
| 2020 | 4     | 18314          | 3       | 8     | 14    | 14    | 5     | 12    | 29    | 11    |
| 2020 | 5     | 10845          | 23      | 3     | 8     | 14    | 14    | 5     | 12    | 29    |
| 2020 | 6     | 24071          | 31      | 23    | 3     | 8     | 14    | 14    | 5     | 12    |
| 2020 | 7     | 69128          | 41      | 31    | 23    | 3     | 8     | 14    | 14    | 5     |

Pearson Correlation Coefficient

| Period       | Jan 2015 - Jul 2020 | Jan 2017 - Jul 2020 | Jul 2018 - Jul 2020 |
|--------------|---------------------|---------------------|---------------------|
| Value        | 0.601359            | 0.6707              | 0.594646            |
| Value        | 0.430691            | 0.535123            | 0.445367            |
| Value        | 0.363268            | 0.408512            | 0.469558            |
| Value        | 0.165397            | 0.087123            | 0.000886            |
| Value        | -0.06222            | -0.1725             | -0.16881            |
| Value        | -0.28796            | -0.38267            | -0.26259            |
| Value        | -0.49019            | -0.56789            | -0.46961            |
| Value        | -0.46656            | -0.6613             | -0.62971            |

Data collected from NC State Parks and Google Trends
Table 5. Part 1 showing 2015 – 2017, Pearson Correlation Coefficient Test for Grandfather Mountain State Park

| Year | Month | Visit Grandfather | Non_Lag | Lag_1 | Lag_2 | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
|------|-------|-------------------|---------|-------|-------|-------|-------|-------|-------|-------|
| 2015 | 1     | 2255              | 6       | Lag_1 | Lag_2 | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 2     | 910               | 6       | 6     | Lag_2 | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 3     | 3657              | 11      | 6     | 6     | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 4     | 7375              | 4       | 11    | 6     | 6     | Lag_4 | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 5     | 10366             | 24      | 4     | 11    | 6     | 6     | Lag_5 | Lag_6 | Lag_7 |
| 2015 | 6     | 9944              | 20      | 24    | 4     | 11    | 6     | 6     | Lag_6 | Lag_7 |
| 2015 | 7     | 15180             | 17      | 24    | 4     | 11    | 6     | 6     | Lag_7 | Lag_7 |
| 2015 | 8     | 13632             | 25      | 17    | 20    | 4     | 11    | 6     | 6     | Lag_7 |
| 2015 | 9     | 7797              | 17      | 25    | 17    | 20    | 4     | 11    | 6     | Lag_7 |
| 2015 | 10    | 12181             | 25      | 17    | 25    | 17    | 20    | 4     | 11    | Lag_7 |
| 2015 | 11    | 5377              | 9       | 25    | 17    | 25    | 17    | 20    | 4     | Lag_7 |
| 2015 | 12    | 5983              | 9       | 25    | 17    | 25    | 17    | 20    | 4     | Lag_7 |
| 2016 | 1     | 2621              | 9       | 13    | 9     | 25    | 17    | 25    | 17    | Lag_7 |
| 2016 | 2     | 1393              | 9       | 13    | 9     | 25    | 17    | 25    | 17    | Lag_7 |
| 2016 | 3     | 6947              | 11      | 14    | 9     | 13    | 9     | 25    | 17    | Lag_7 |
| 2016 | 4     | 7109              | 20      | 11    | 14    | 9     | 13    | 9     | 25    | Lag_7 |
| 2016 | 5     | 6209              | 20      | 20    | 11    | 14    | 9     | 13    | 9     | Lag_7 |
| 2016 | 6     | 9533              | 35      | 20    | 11    | 14    | 9     | 13    | 9     | Lag_7 |
| 2016 | 7     | 14401             | 52      | 35    | 20    | 11    | 14    | 9     | 13    | Lag_7 |
| 2016 | 8     | 6777              | 32      | 52    | 35    | 20    | 11    | 14    | 9     | Lag_7 |
| 2016 | 9     | 7678              | 17      | 32    | 52    | 35    | 20    | 11    | 14    | Lag_7 |
| 2016 | 10    | 13596             | 24      | 17    | 32    | 52    | 35    | 20    | 11    | Lag_7 |
| 2016 | 11    | 7382              | 13      | 24    | 17    | 32    | 52    | 35    | 20    | Lag_7 |
| 2016 | 12    | 3566              | 17      | 13    | 24    | 17    | 32    | 52    | 35    | Lag_7 |
| 2017 | 1     | 2941              | 30      | 17    | 13    | 24    | 17    | 32    | 52    | Lag_7 |
| 2017 | 2     | 4609              | 12      | 30    | 17    | 13    | 24    | 17    | 32    | Lag_7 |
| 2017 | 3     | 4866              | 4       | 12    | 30    | 17    | 13    | 24    | 17    | Lag_7 |
| 2017 | 4     | 9309              | 29      | 4     | 12    | 30    | 17    | 13    | 24    | Lag_7 |
| 2017 | 5     | 7495              | 37      | 29    | 4     | 12    | 30    | 17    | 13    | Lag_7 |
| 2017 | 6     | 10594             | 65      | 37    | 29    | 4     | 12    | 30    | 17    | Lag_7 |
| 2017 | 7     | 11696             | 51      | 65    | 37    | 29    | 4     | 12    | 30    | Lag_7 |
| 2017 | 8     | 9659              | 16      | 51    | 65    | 37    | 29    | 4     | 12    | Lag_7 |
| 2017 | 9     | 10331             | 12      | 16    | 51    | 65    | 37    | 29    | 4     | Lag_7 |
| 2017 | 10    | 8633              | 27      | 12    | 16    | 51    | 65    | 37    | 29    | Lag_7 |
| 2017 | 11    | 4742              | 16      | 27    | 12    | 16    | 51    | 65    | 37    | Lag_7 |
| 2017 | 12    | 2782              | 13      | 16    | 27    | 12    | 16    | 51    | 65    | 37    |

Data collected from NC State Parks and Google Trends
### Table 6. Part 2 Continued after 2018, Pearson Correlation Coefficient Test for Grandfather Mountain State Park

| Year | Month | Visit to Grandfather | Nourishment Lag | Lag_1 | Lag_2 | Lag_3 | Lag_4 | Lag_5 | Lag_6 | Lag_7 | Pearson Correlation Coefficient |
|------|-------|-----------------------|----------------|-------|-------|-------|-------|-------|-------|-------|---------------------------------|
| 2018 | 1     | 666                   | 9              | 13    | 16    | 27    | 12    | 16    | 51    | 65    | 0.642529                       |
| 2018 | 2     | 1874                  | 6              | 9     | 13    | 16    | 27    | 12    | 16    | 51    | 0.446326                       |
| 2018 | 3     | 2808                  | 15             | 6     | 9     | 13    | 16    | 27    | 12    | 16    | 0.196825                       |
| 2018 | 4     | 6059                  | 16             | 15    | 6     | 9     | 13    | 16    | 27    | 12    | 0.027831                       |
| 2018 | 5     | 4142                  | 28             | 16    | 15    | 6     | 9     | 13    | 16    | 27    | -0.19728                       |
| 2018 | 6     | 6381                  | 22             | 28    | 16    | 15    | 6     | 9     | 13    | 16    | -0.362072                      |
| 2018 | 7     | 7866                  | 36             | 22    | 28    | 16    | 15    | 6     | 9     | 13    | -0.48253                       |
| 2018 | 8     | 6282                  | 25             | 36    | 22    | 28    | 16    | 15    | 6     | 9     | -0.45621                       |
| 2018 | 9     | 6577                  | 22             | 25    | 36    | 22    | 28    | 16    | 15    | 6     | -0.35621                       |
| 2018 | 10    | 4604                  | 18             | 23    | 25    | 36    | 22    | 28    | 16    | 15    | -0.35621                       |
| 2018 | 11    | 2707                  | 15             | 18    | 23    | 25    | 36    | 22    | 28    | 16    | -0.35621                       |
| 2018 | 12    | 1712                  | 14             | 15    | 18    | 23    | 25    | 36    | 22    | 28    | -0.35621                       |
| 2019 | 1     | 1187                  | 17             | 14    | 15    | 18    | 23    | 25    | 36    | 22    | -0.35621                       |
| 2019 | 2     | 4629                  | 15             | 17    | 14    | 15    | 18    | 23    | 25    | 36    | -0.35621                       |
| 2019 | 3     | 3376                  | 11             | 15    | 17    | 14    | 15    | 18    | 23    | 25    | -0.35621                       |
| 2019 | 4     | 7463                  | 30             | 11    | 15    | 17    | 14    | 15    | 18    | 23    | -0.35621                       |
| 2019 | 5     | 5035                  | 32             | 30    | 11    | 15    | 17    | 14    | 15    | 18    | -0.35621                       |
| 2019 | 6     | 9520                  | 30             | 32    | 30    | 11    | 15    | 17    | 14    | 15    | -0.35621                       |
| 2019 | 7     | 8637                  | 36             | 30    | 32    | 30    | 11    | 15    | 17    | 14    | -0.35621                       |
| 2019 | 8     | 8296                  | 23             | 36    | 30    | 32    | 30    | 11    | 15    | 17    | -0.35621                       |
| 2019 | 9     | 7558                  | 37             | 23    | 36    | 30    | 32    | 30    | 11    | 15    | -0.35621                       |
| 2019 | 10    | 8001                  | 45             | 37    | 23    | 36    | 30    | 32    | 30    | 11    | -0.35621                       |
| 2019 | 11    | 8621                  | 20             | 45    | 37    | 23    | 36    | 30    | 32    | 30    | -0.35621                       |
| 2019 | 12    | 3949                  | 11             | 20    | 45    | 37    | 23    | 36    | 30    | 32    | -0.35621                       |
| 2020 | 1     | 1637                  | 12             | 11    | 20    | 45    | 37    | 23    | 36    | 30    | -0.35621                       |
| 2020 | 2     | 1650                  | 13             | 12    | 11    | 20    | 45    | 37    | 23    | 36    | -0.35621                       |
| 2020 | 3     | 2490                  | 13             | 13    | 12    | 11    | 20    | 45    | 37    | 23    | -0.35621                       |
| 2020 | 4     | 7463                  | 6              | 13    | 13    | 12    | 11    | 20    | 45    | 37    | -0.35621                       |
| 2020 | 5     | 4440                  | 32             | 6     | 13    | 13    | 12    | 11    | 20    | 45    | -0.35621                       |
| 2020 | 6     | 24072                 | 65             | 32    | 6     | 13    | 13    | 12    | 11    | 20    | -0.35621                       |
| 2020 | 7     | 15963                 | 88             | 65    | 32    | 6     | 13    | 13    | 12    | 11    | -0.35621                       |

Data collected from NC State Parks and Google Trends
Table 7. Jan 2017 – Jul 2020, Mount Mitchell State Park Time-Series Linear Model

```r
> summary(tslm(MMitchell~MMGoogle+season+trend))

Call:
  tslm(formula = MMitchell ~ MMGoogle + season + trend)

Residuals:
     Min      1Q  Median      3Q     Max
-23987.5 -3416.8   303.1    2994.7   15176.6

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)       8217.2      5284.4    1.555 0.130792
MMGoogle          -147.0       290.6   -0.506 0.616885
season2           1458.2      6294.8    0.232 0.818432
season3           4379.7      6308.4    0.694 0.493040
season4           17200.1     6328.0    2.718 0.010964 *
season5          29913.6      7060.1    4.237 0.000209 ***
season6          40487.8      7297.7    5.548 5.54e-06 ***
season7          65374.8      8348.4    7.831 1.23e-08 ***
season8          30294.3      7184.1    4.217 0.000221 ***
season9          41684.9      7064.1    5.901 2.09e-06 ***
season10         66466.5      7806.2    8.515 2.22e-09 ***
season11         13524.6      6869.6    1.969 0.058604 .
season12         2477.9       6853.2    0.362 0.720293
trend           -179.5        113.3   -1.584 0.123963

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 8899 on 29 degrees of freedom
Multiple R-squared:  0.8991,  Adjusted R-squared:  0.8539
F-statistic: 19.88 on 13 and 29 DF,  p-value: 5.266e-11
```

Data collected from NC State Parks and Google Trends
Table 8. Jul 2018 – Jul 2020, Grandfather Mountain State Park Time-Series Linear Model

|                    | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------|----------|------------|---------|----------|
| (Intercept)        | -2294.34 | 2474.14    | -0.927  | 0.3737   |
| GFD.Google         | 164.17   | 61.56      | 2.667   | 0.0219   *|
| season2            | 1703.09  | 3043.90    | 0.560   | 0.5870   |
| season3            | 1727.43  | 3057.84    | 0.565   | 0.5835   |
| season4            | 5170.44  | 3054.62    | 1.693   | 0.1186   |
| season5            | 44.60    | 3185.14    | 0.014   | 0.9891   |
| season6            | 7656.51  | 3550.81    | 2.156   | 0.0541   |
| season7            | 2744.83  | 3663.68    | 0.749   | 0.4695   |
| season8            | 4827.37  | 3189.78    | 1.513   | 0.1584   |
| season9            | 3518.88  | 3276.31    | 1.074   | 0.3058   |
| season10           | 2405.63  | 3281.82    | 0.733   | 0.4789   |
| season11           | 3963.48  | 3060.58    | 1.295   | 0.2218   |
| season12           | 1848.83  | 3043.62    | 0.607   | 0.5559   |
| trend              | 101.99   | 105.98     | 0.962   | 0.3565   |

Residual standard error: 3041 on 11 degrees of freedom
Multiple R-squared: 0.8185, Adjusted R-squared: 0.604
F-statistic: 3.815 on 13 and 11 DF, p-value: 0.01633

Data collected from NC State Parks and Google Trends