2018 Park Break Report: Developing a Visitation Forecasting Tool and Management Recommendations for the Mojave Desert Region NPS Units



Aug. 14, 2018

Dani Dagan: Kansas State University

Iree Wheeler: University of Montana

Leah Beck: University of Maine

Adrian Benedetti: Penn State University

Michael Blacketer: Clemson University

Matt Clark: Boise State University

Kate McHugh: Northern Arizona University

Clay Noss: University of California, Berkeley

Julia Sizek: University of California, Berkeley

Emily Wilkins: Utah State University

Dr. Robert B. Powell: Clemson University

Dr. Ryan L. Sharp: Kansas State University

Acknowledgements

This project was made possible with support from the National Park Service and the George Wright Society. Special thanks to Jane Rodgers at Joshua Tree National Park for organizing the logistics for this program and sharing her expertise and insight while showing us around Joshua Tree National Park and the surrounding communities. Thank you also to Josh Hoines at Death Valley National Park and Debra Hughson at Mojave National Preserve for their logistical support and for providing insight into their respective park units.

Table of Contents

1. Overview and Goals

Visitation to Joshua Tree National Park (JOTR) has more than doubled since 2013. This has led to periods of congestion within and outside park boundaries, stressed staff resources, exceeded the capacity of facilities such as campgrounds, bathrooms, and visitor centers, and potentially impacted the natural resources of the park. Demand for park experiences is expected to continue to increase suggesting that visitation to JOTR will likely remain high; it is also expected that visitation to the greater Mojave region, including Death Valley National Park (DEVA) and Mojave National Preserve (MOJA) may see corresponding visitation increases. Over 22 million people live within 100 miles drive of JOTR, MOJA, and DEVA, and changing social conditions, including increased prevalence of social media, may be contributing to the high concentration of visitors in certain areas. Additionally, increased local tourism advertising by the Greater Palm Springs Convention and Visitors Bureau and the Las Vegas Convention and Visitors Bureau may bring further increases in visitation to the region.

During the 2018 George Wright Society Park Break, ten graduate students traveled to the three National Park Service (NPS) units in the Mojave Desert Region: Joshua Tree National Park, Death Valley National Park, and Mojave National Preserve to explore issues related to increasing visitation and spikes in visitation and brainstorm solutions on both individual unit and regional system scales. The visit included on-site observations of conditions, as well as conversations with park managers and local and regional stakeholders. As a product of the experience, we aimed to explore management scenarios to address the rapid growth in park visitation as well as pilot methods to better predict changes in the rates of growth. Therefore, this report is divided into two sections. First, it reports the results of an exploration of freely available social media (including Google Trends data) and demographic data that may be useful for

forecasting visitation at Joshua Tree National Park. The report then presents a web application that uses Google Trends data that allows managers to input current conditions and display anticipated visitation levels. Second, we present and assess a range of potential management actions that could reduce visitor management issues in all three NPS units using the Interagency Visitor Use Management Framework sliding scale of analysis (IVUMF, 2016).

2. Forecasting Visitation: The Google Data Mine

2.1 Purpose

Large increases in park visitation may lead to stress on natural, cultural, and human resources and potentially decrease the quality of visitor experiences. Without forewarning and sufficient time to prepare, a dramatic increase in visitation may necessitate that staff enter "triage mode," where only the most pressing and dramatic needs are addressed. In an effort to address these challenges, the managers of JOTR, MOJA, and DEVA desire a regional monitoring system for visitor use that would forecast future visitation and projected conditions at key attractions within each unit. Presently, the National Park Service predicts future visitation based on historic visitation from the previous five years (Ziesler, 2016). While past visitation may be a reasonably accurate predictor of future visitation, this does not account for outside factors, such as the overall state of the economy and stochastic events (e.g. superblooms). Managers would benefit from having a more accurate method for predicting future visitation quickly and comprehensively. Improved forecasting ability could help managers better understand trends in future visitation. For example, managers could assess whether a recent spike in visitation is a new baseline, a unique anomaly, or whether visitation will continue to increase. Finally,

predicting visitation numbers and trends can help determine which management actions park officials should consider and implement.

Our goal is to investigate a range of readily available data, especially Google Trends data, to develop a forecasting model for parks. By using the digital footprints that visitors leave behind, it may be possible to predict changes in rates of visitation that are not captured by the current NPS forecasting model. It is important to note that the scope of this analysis is relatively narrow when considered in the context of NPS visitor use statistics broadly, and it is not intended to create a final or prescriptive forecasting tool; Rather, our goal is to test a new method that may be altered, refined, or reassessed after further research. This section begins by exploring Google Trends as a data source (2.2), including strengths and limitations, and continues by describing the methods and results of a pilot model for forecasting visitation at Joshua Tree National Park (2.3).

2.2 Google Trends Overview

While some research has attempted to improve understanding of what influences visitation to NPS lands (e.g. McIntosh and Wilmot, 2011), there is very little literature that applies more advanced forecasting methods to NPS units. Therefore, the NPS could benefit from incorporating lessons learned in related fields and improving forecasting models. For example, Bangwayo-Skeete and Skeete (2014) tested whether Google search data can predict visitor arrivals at popular tourist destinations in the Caribbean Islands, and found that Google search data significantly improved the ability of the models to forecast future visitation. Additionally, Li and colleagues (2017) found that using a search index to forecast future tourism demand in Beijing was more accurate than traditional models using past visitation alone.

While improved forecasting ability would enable managers to mitigate impacts of rapidly increasing visitation, the ability of managers to develop models and access data is a concern. Thus, the development of this forecasting tool prioritized data that is freely available and easily accessed. Therefore, the forecasting models in this report employ Google Trends, a free tool that enables users to view Google search volume on virtually any topic. The Google Trends data has the potential to improve the current NPS forecasting model by reflecting not only past visitation data, but also capturing social media, news media, and other cultural or social shifts that influence public desire to visit any given park unit. Additionally, it allows managers to make predictions at a finer temporal scale, which is increasingly important as digital media disseminates information at faster rates and is associated with spikes in visitation. In this report, we test several models using historical data from JOTR and DEVA to confirm the predicative ability of Google Trends[1].

2.3 Using Google Trends

Google Trends can be accessed at https://trends.google.com/trends/. For any search term, data is available from 2004 – present including the time range of interest. In order to complete the search instantly, Google analyzes a sample of the total volume of searches and the data is then indexed from 0 to 100, where 100 is the highest volume of searches for the selected range. A value of 50 indicates there are half as many searches for the term that month compared to the month indexed at 100. In summary, the indexed Google Trends data represents the total number of people searching for the specified term, compared to the total volume of searches in the selected area, scaled such that the highest value in the selected time frame is set to 100. Since

[1] *We elected not to use MOJA visitation data because of inaccuracies in data collection reported by NPS personnel.*

U.S. national parks receive visitors from all over the world, we recommend looking at worldwide trends, although specific countries can be selected.

Google Trends provides the option to track either search terms or topics. While search terms represent only those who type in the exact phrase in a specified language, topics represent anyone searching for the specified concept, in any language. We therefore recommend using topics rather than search terms due to the ability to capture a broader array of search terms and searches in other languages. When using Google Trends, the output will look something like Figure 1. This output shows that the highest interest in Joshua Tree National Park from 2008 – 2017 on Google was in October 2017. The index numbers can easily be downloaded into a CSV file by clicking on the ⬇ symbol just above the graph.

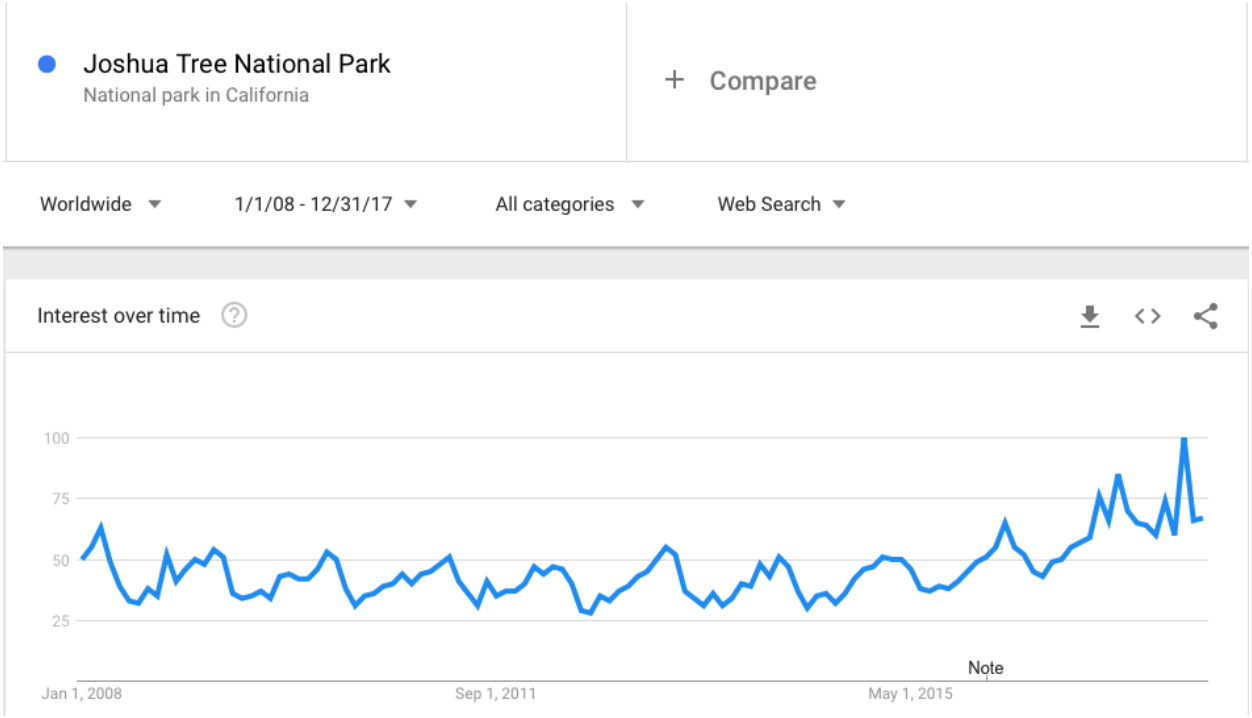

Figure 1. Google Trends output for Joshua Tree National Park, from January 2008 – December 2017. Obtained from https://trends.google.com/trends/

Although not useful for modeling visitation numbers, Google Trends also shows the interest by region. These numbers are indexed the same way as above, with 100 representing the highest proportion of searches for the specified topic or term compared to the total volume of searches by country or city. These numbers can be downloaded into a CSV the same way as the Google Trends data above, and can either be grouped by country or city. Figure 2 shows that the five highest indices for Joshua Tree by country are the U.S., Canada, Switzerland, Ireland, and the Netherlands. The five cities with the highest indices are Joshua Tree, Yucca Valley, Twentynine Palms, Palm Springs, and Palm Desert. This appears to indicate that many people are searching for information about the park when they are in the area.

Figure 2. Google Trends output for Joshua Tree National Park showing interest by country from January 2008 – December 2017. Countries in blue indicate a Google Trends index of one or greater. The dark blue color of the U.S. represents an index of 100. Obtained from https://trends.google.com/trends/

The most important thing to remember while using Google Trends is that these numbers are relative. Therefore, the indexed numbers will change when looking at different time periods, different countries, or comparing multiple search topics (locations or iteration of the same term, such as Joshua Tree, JOTR, JTNP, etc.). In each search, there is always one index of 100 that

represents the most popular place or time for that search, within the spatial and temporal parameters set for that query. For example, if one examines searches for Joshua Tree from Australia during January 2008 – December 2017, the month with the most searches will be indexed at 100 and all other months will be relative to the number of searches in that month.

2.4 Testing the Predictive Power of Google Trends

Before creating models to predict future visitation, we explored the correlations between Google Trends data from the same month, the previous month, and one year prior and NPS monthly visitation for JOTR and DEVA. This helps us better understand the utility of Google Trends data for future modeling, and for preliminary consideration of lag times. This exploration and corresponding results is a preliminary analysis to understand the potential use of Google Trends in a National Park context. We then used the most promising data to develop the most predictive model and the corresponding web application.

Methods. Negative binomial regressions were run for JOTR and DEVA using reported monthly visitation as the dependent variable, and Google Trends data with no lag (predicting the present), a one-month lag (predicting one month ahead), and a one-year lag (predicting a year in advance), and a combination of all three as the independent variables. Since the aim of this exploration was to investigate the utility of Google Trends for predicting park visitation, no other variables were included in this exploratory model.

In addition to the JOTR specific model, we also created a hierarchical model, which uses data on 2006-2017 visitation to all national park units. Because we wanted to compare these estimates to the estimates displayed in the NPS statistical abstracts for each park, we used this model to estimate park visitation on the yearly scale. This model uses the google trends value for each NPS unit from one year before the year being estimated and the visitation from the previous

two years. We validated this model using block cross validation, using the visitation for all parks for years 2008-2010, 2011-2012, 2013-2014, and 2015-2016 as blocks (Roberts et al., 2017).

Results. For JOTR, Google Trends had significant predictive ability for all lag times (Table 1). The Google Trends data that explained reported visitation rates the best was the combination variable, followed by real time, one-year lag, then one month lag. Current month Google Trends alone explained 64% of the variation in monthly visitation. The same model for DEVA returned no statistically significant results and very little predictive ability.

	JOTR	**DEVA**
Current month of Google Trends	0.642*	0.004
One-month lag of Google Trends	0.567*	0.002
One-year lag of Google Trends	0.593*	0.019
Current month + one-month lag + one-year lag of Google Trends	0.703*	0.030

** Significant at $p < 0.01$*

Table 1. Nagelkerke pseudo-R^2 for negative binomial regression models predicting NPS-measured monthly visitation at both parks.

Discussion. Google Trend data at any time lag are strongly correlated with reported visitation for JOTR. A possible explanation for why the "current month" data explain the most variation in reported visitation is that the "location of interest by city/region of searches" data suggests that visitors are searching for JOTR-related information in real time while visiting the park. The results also suggest that the one-year lag provides slightly more explanatory power than the "one-month lag" data because of the strong relationship between season and visitation, however all four variables tested demonstrate very strong correlations.

Due to the lack of significant results for DEVA, we cannot make conclusions on the usability of Google Trends data beyond JOTR. Therefore, use of this tool is currently only applied to JOTR. According to management in DEVA, a possible explanation for why Google Trends does not predict reported visitation at DEVA (Figure 3) is that the park does not currently

have the capacity to accurately count visitors given their geographic layout, which includes a high number of cherry-stemmed roads, and several points of entry that are difficult to accurately monitor. Additionally, while some literature suggests that Google Trends can adequately describe current and future conditions, it has rarely been applied to park settings, so more research is needed to understand whether limitations to this technique are influencing the model. Preliminary results from subsequent analysis using the Google Trends model for all NPS National Park Units suggests that Google Trends data consistently predicts visitation across all 59 units (subsequent paper in preparation). Future research could investigate how well Google Trends can predict visitation across other NPS units; however, the current scope of this report and analysis is limited to only JOTR and DEVA, and the pilot model applies only to JOTR.

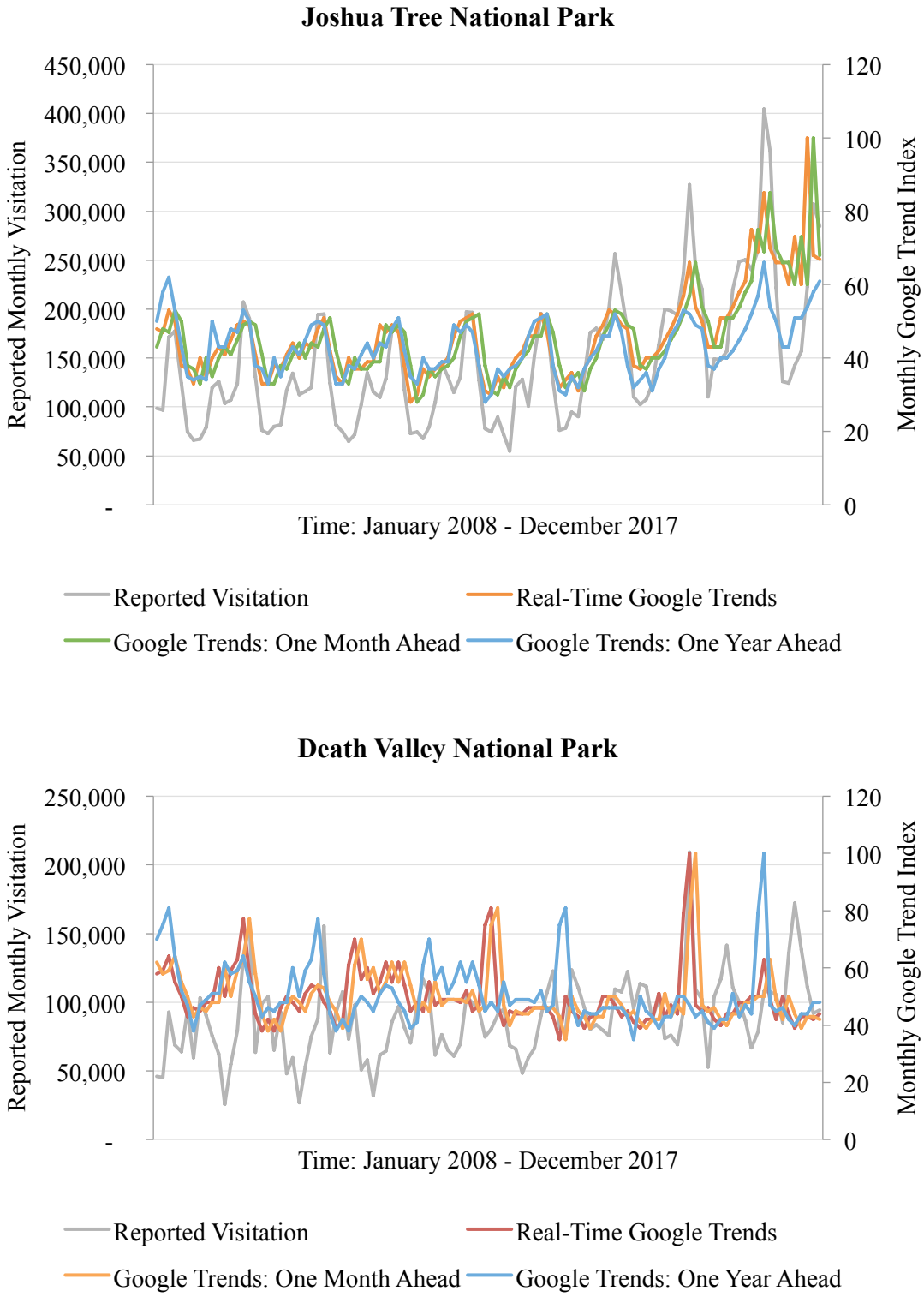

Figure 3. Reported visitation and Google Trend data from 2008 – 2017 for JOTR and DEVA.

2.5 Google Trends Limitations and Future Work

Users must take care to consider how Google Trends data are indexed when interpreting the output. Google Trends reports indices on a scale of 1 to 100, where 100 is always the highest volume of searches for the selected time range. This has two major implications: First, every time there is a new highest high in Google search interest, the data will rescale. Second, the values Google reports may vary based on the time range selected. It is therefore not possible to create a permanent database of trend numbers, nor is it possible to make an assessment about visitation based on a single number. Any given value on Google Trends lacks meaning alone, but rather needs to be interpreted in the context of trends over time. Additionally, values cannot be compared across search topics or time frames and it cannot be assumed that a certain value means the same thing each time Google Trends data are viewed. This preliminary exploration points to the need for additional research to understand how to control for or incorporate this scaling process in the model. For example, it is possible that data can be interpreted by comparing values to other peak times, where reported visitation is known, in the same data view.

Additionally, while it is possible that this tool could be used to predict dispersal trends within NPS units, that cannot be recommended at this time. Because reported visitation data does not exist for sites within units, it is not possible to test the ability of Google Trends to forecast visitor concentrations at specific sites. Limited internet access while on site might also impact the accuracy of Google Trends for predicting specific site visitation even if NPS visitor data was available, however the data may help us understand the role of social media in attracting visitors to specific sites within a park prior to arrival. Further research is needed to better understand the utility of this and similar digital metrics in forecasting visitor concentrations at sites within park units. We suggest the NPS approach Google to explore whether the actual number of searches is

available instead of the indexed data as this will alleviate many of the limitations and allow for more accurate longitudinal analyses. Future research may also wish to explore the relationship between Google Trends data and individual park visitor center numbers.

2.6 Further Development of a Forecasting Model and App

A primary goal of this project was to produce a visitation forecasting tool with which park unit managers can accurately predict future park visitation based on a small set of readily available variables. As part of the construction of this tool, the authors identified and focused on three essential components.

1. The model predictions must be accurate enough to allow for their incorporation in real-time park management decisions.
2. The temporal scale of the inputs/predictions must be in a realistic timeframe for their incorporation in management decisions (i.e. predicting visitation one hour before the visitors get there is not as useful as one month in advance).
3. All variables required for model input must be readily accessible for park managers.

Variables Considered. Through a review of relevant literature and informal conversations with NPS staff and stakeholders, several possible types of data were identified for inclusion in the model to predict JOTR and DEVA visitation (Table 2). Economic indicators and population measures have been utilized in previous research to forecast visitation to NPS units (Wilmot & McIntosh, 2014). Social media variables, along with Google Trends, may also predict changes in trends that previous visitation and economic indicators have not been able to measure.

Variables included (final model)	How it was measured
Consumer Confidence Index	Available from the Organization for Economic Co-operation and Development
Google Trends	Available from Google
Seasonality	Spring, summer, fall, or winter
Variables dropped during model selection	**How it was measured**
Overall social media popularity	Total aggregate global users of Instagram, Facebook, and Twitter (in millions)
Populations of Los Angeles and Las Vegas	Available from the Census Bureau (yearly data)
General NPS interest	Aggregate visitation at all NPS units, minus the unit of interest
Gas prices	Available from the U.S. Energy Information Administration
Social Media outreach	Tweets per month from @JoshuaTreeNPS and @DeathValleyNPS
Variables considered but not tested	**Reason for not including**
Temperature and precipitation	Future temperature and precipitation are unknown and highly variable, so this would not necessarily be helpful in models predicting future visitation
Festival attendance (e.g. Coachella)	Festival attendance always sells out and is therefore a function of whatever number the festival caps attendance at rather than interest
Earned media (e.g. news articles)	We were not able to obtain these data
Social media followers	No data were available on past monthly followers for any major social media site
Advertising dollars spent by nearby CVBs	We were not able to obtain these data

Table 2. Variables included in the model, as well as variables we considered including and the reason they were ultimately not included. All of these variables were obtained on a monthly scale from January 2008 – December 2017, except populations were obtained from the Census Bureau on a yearly scale.

Data Collection. Monthly visitation data and overnight monthly stays for Joshua Tree National Park were downloaded from the NPS Integrated Resource Management Applications (NPS, 2018). These were the dependent variables in the models. Google Trends data was collected freely from Google, using the search topic "Joshua Tree National Park," worldwide, from the time period of January 2008 – December 2017 (Google, 2018). Consumer Confidence

Index is a measure of the U.S. economy and was downloaded on a monthly scale, for only the U.S., over the same time period, from the Organization for Economic Co-operation and Development at https://data.oecd.org/leadind/consumer-confidence-index-cci.htm (OECD, 2018).

Data Analysis. In order to create a model which maximizes predictive ability, we analyzed these data in four key steps: 1) Distribution selection 2) Identification and elimination of insignificant parameters 3) Model selection, and 4) Bayesian analysis and posterior identification (see Appendix for further explanation of methods).

Results. After following the above framework for distribution, parameter, and model selection, the model with the best performance contained six variables for forecasting visitation to Joshua Tree National Park. These variables included the median Consumer Confidence Index (CCI) from the previous season, the median Google Search Term index score from the previous season, and parameters for seasonality; Winter (Dec-Feb), Spring (March-May), Summer (June-Aug), and Fall (Sept-Nov). We used the median values opposed to the mean values in order to best characterize the entire season (not monthly) and eliminate skew from very high monthly values. We used this same model to predict both total seasonal visitation to the park and overnight seasonal visitation to the park.

To evaluate the predictive ability of our model, we used leave-one-out cross validation (Appendix Figure A.2) along with analyzing the R^2 and RMSE values (Table 3). These results indicate that our model accurately predicts 87.8% of all seasonal variation in total park visitation and 71.5% of all seasonal variation in overnight visitation from 2008 to 2017.

	R^2	RMSE
Total visitation (poisson)	0.876	471,637
Total visitation (negative binomial)	0.878	471,637
Overnight visitation (poisson)	0.712	471,639
Overnight visitation (negative binomial)	0.715	471,639

Table 3. R^2 and RMSE values from leave-one-out cross validation of generalized linear models predicting total and overnight seasonal visitation in Joshua Tree National Park.

Leave-one-out cross validation evaluates the ability of our model to estimate each datapoint, when the model is constructed without that specific datapoint informing the model (Kohavi, 1995). In addition to determining what percentage of the variation we were capturing with our model, we were also interested in determining if our model was able to predict the sharp spike in visitation that was seen in 2013. To do this, we plotted our predicted visitation values for each season from 2008-2017 against the observed visitation values (Appendix Figure A.1). We examined the posterior distributions (n=4,000) of each of our parameter estimates, comparing them to each other and to 0 (Appendix Figure A.3). These results suggest that while Google Search Terms are useful for predicting visitor use in JOTR, seasonality and economic factors are still the primary indicators of visitation to the park.

Application. To achieve our overarching goal of making this research immediately applicable for incorporation into park management strategies, we developed an app that allows park managers to input values for the specified parameters and receive a posterior distribution of expected visitation for the following season. This application can be found at https://matthewclark.shinyapps.io/seasonal_forecasting_using_google_search_termsr/ and was developed using R Shiny (Chang, Cheng, Allaire, Xie, & McPherson, 2017). Figure 4 shows the interface for the variables the user is expected to enter. The app then outputs a graph showing the distribution and 50% credibility interval for expected visitation the following season (Figure 5). A 50% credibility interval is appropriate in this case, because for the data used in this

application, 92.3% of the observed total season visitation counts and 87.2% of the overnight visitation counts are accurately predicted by the 50% credibility interval. A credibility of over 50% would produce a range of numbers too wide for any real-world application. Currently, this tool should ONLY be used to predict visitation one season ahead.

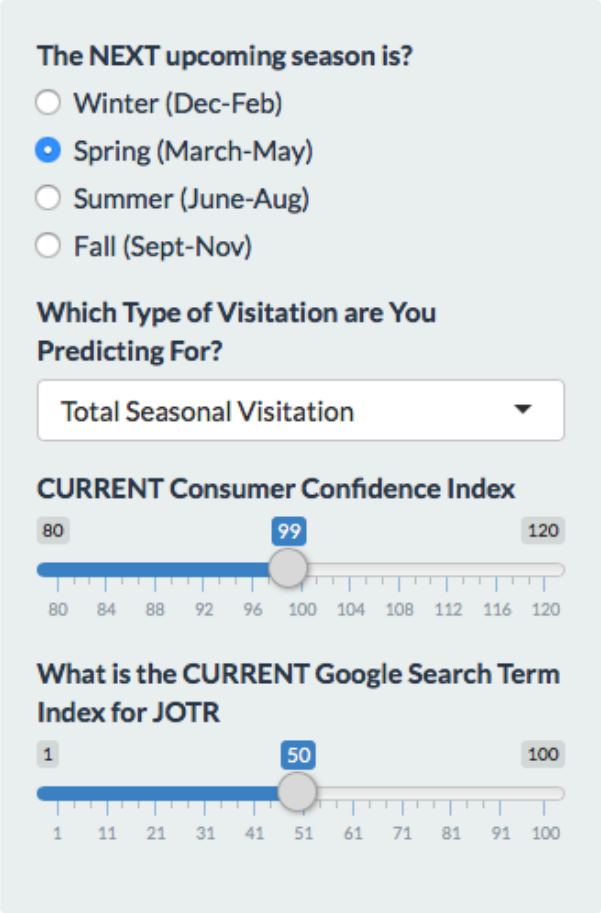

Figure 4. Adjustable inputs for the application.

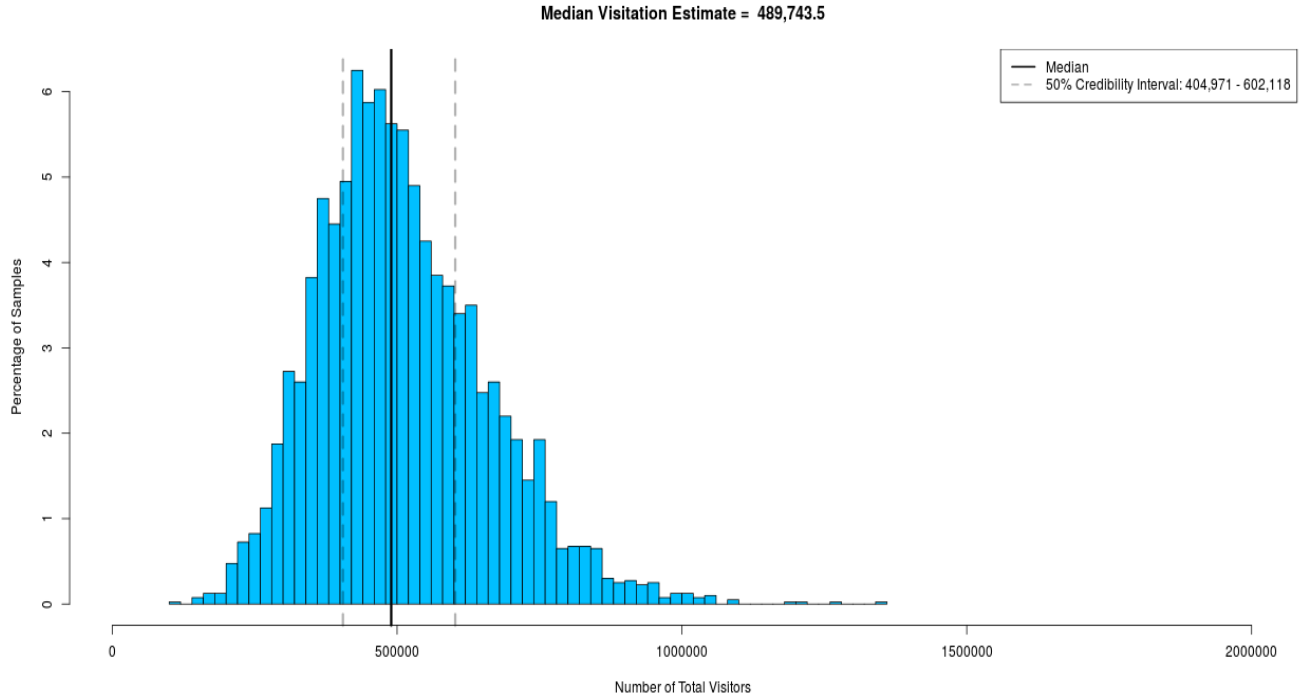

Figure 5. An example output from the app.

2.7 Conclusion

A simple tool that more accurately forecasts visitation on a variety of temporal scales would assist managers and planners to be better prepared for changes in visitor use, especially when stochastic events change conditions. Use of freely available Google Trends data, as well as future app development, will allow park units to proactively manage increased visitation before it occurs, allowing managers to avoid crisis mode, improve the visitor experience, and mitigate impacts to natural and culture resources more effectively. Additionally, future research may want to investigate how JOTR visitation can be used to model future visitation in DEVA and MOJA.

3. Management Recommendations

3.1 Purpose

In order to address increased visitation on a regional scale, this report includes recommendations for proactive management of visitors. Park Break participants present a wide-ranging list of 24 possible future management actions, which were rated by the authors on a sliding scale of analysis developed by the Interagency Visitor Use Management Council for resource (social and natural) indicators (IVUMF, 2016). The criteria outlined in the framework are issue uncertainty, impact risk, stakeholder involvement, and potential for conflict.

Additionally, five of these recommendations were selected to highlight and expand upon based on a rubric developed by the authors based on salient themes from conversations with NPS managers, including recommendations that are innovative, economically feasible, will likely appeal to stakeholders, and address problems or solutions at a regional scale.

3.2 Selection of Management Recommendations

After visiting all three units (JOTR, DEVA, MOJA), speaking with stakeholders, and reading relevant planning documents, the authors compiled a list of 45 potential management actions to improve visitor experiences and visitor management. These recommendations were ranked by each author using a Google Poll as high, medium, or low priority; authors also indicated one recommendation as the most important. Recommendations having too many "low priority" or too few "high priority" designations were eliminated from the list. The authors then assessed how to nest remaining items to both eliminate redundancies and ensure a comprehensive body of recommendations. Finally, based on a literature review and conversations with NPS staff and stakeholders, these refined recommendations were scored

using the Interagency Visitor Use Management Framework's 7-point sliding scale (IVUMF, 2016) based on the categories in Table 4 (below). Each IVUMF metric is addressed following each management recommendation.

Issue Uncertainty	This metric suggests how well any given management action is understood. Thus, it is a measure of how confident the authors are that an action accurately addresses a problem. Ideally, this metric should be low.
Impact Risk	This metric addresses the likelihood that the management recommendation, if enacted, would have a negative impact on community, cooperation, or ecological integrity. Ideally, this metric should be low.
Stakeholder Involvement	This metric measures the level of coordination and/or consensus necessitated by involving appropriate stakeholders. While a high level of stakeholder involvement is not necessarily undesirable, it is likely to correlate with complicated scenarios. Thus, this metric should be qualified with justification for any stakeholders who may be involved.
Potential for Conflict	This metric addresses whether the action considered might generate: public dissent, political entanglement, or internal policy disagreement. It is thus a measure of how difficult or easy it might be to implement any given management recommendation. Ideally, this metric would be low, but due to the fact that some conflicts cannot be avoided, this rating might be used to address certain actions at more strategic points in time.

Table 4. Interagency Visitor Use Management Framework's 7-point sliding scale

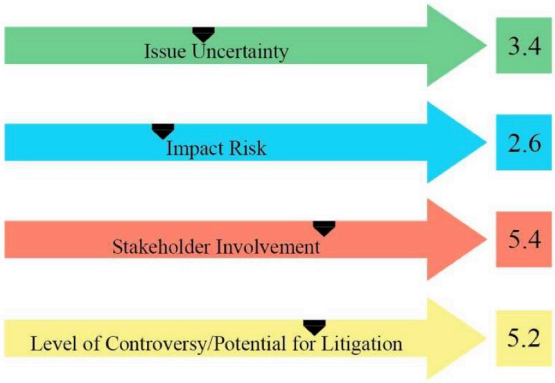

Figure 6. Sliding scale analysis from Interagency Visitor Use Management Framework

The scale for each management recommendations is illustrated according to Figure 6.

Furthermore, to select the top five recommendations that are described in Sections 3.3-3.7, a rubric was composed based on the salient themes that emerged through discussions with NPS staff and stakeholders (Table 5), and those items that best fit the rubric were selected.

Innovation	High priority is given to novel ideas as the purpose of this report is to uncover innovative solutions. Additionally, new ideas necessarily require greater elaboration.
Regional Integration	Priority is given to ideas that either consider the units as a single system, or explicitly address issues that relate to dispersal of visitors between units.
Economic Feasibility	Recommendations with greater economic feasibility were prioritized based on fiscal scope, time needed to implement, and other similar criteria.
Stakeholder Appeal	Items with high stakeholder appeal were prioritized so as to avoid issues that may arise due to stakeholder complexity and concerns. Stakeholders include outlying communities, vendors, and the general public.

Table 5. Rubric for selection of top management recommendations.

3.3 Recommendation: Regional NPS Information

3.3.1 Description of Problem and Proposed Action. During the evaluation of possible VUM recommendations, the authors considered establishing a Mojave Desert regional park pass. Due to challenges in implementation and fee structure (discussed below), a regional pass for park entrance appears unfeasible. However, the dispersal of visitors from JOTR to other NPS units in the region might be addressed by coordinating interpretation across parks, especially providing information to JOTR visitors who may be interested but unaware of other Mojave units. Conversations with MOJA staff indicate that many visitors may be unaware of the recreational opportunities in the Mojave National Preserve, resulting in many drive-through visitors who might benefit from increased awareness of local attractions. This problem is compounded by the fact that many visitors have already passed by major attractions before reaching the primary interpretive information for MOJA, which is located near the center of the National Preserve in Kelso. Increasing the distribution of information to visitors before their visit should therefore be a central part of MOJA's strategy to encourage appropriate visitor use. It is important to consider however, that any visitor dispersal actions implemented by JOTR or MOJA may have impacts on the visitor use patterns of the third NPS unit in the region: Death Valley National Park (DEVA). The impacts of management actions on DEVA must be considered before implementation. This section (3.2) outlines possible methods to provide regional Mojave Desert information including all NPS units, with the goal of alleviating visitation pressure from popular JOTR areas, encouraging visitor safety in backcountry areas of the park, and providing visitors with better information about recreation opportunities across the California desert.

3.3.2 Phasing-Out of Multi-Park Passes. One idea that the authors considered was a Mojave Desert regional pass. This pass would have been modeled after the regional passes used

to encourage visitation at other NPS units. While such a pass, enacted in 2014, is still utilized in Hawaii (https://www.nps.gov/havo/planyourvisit/fees.htm), other regional passes have been discontinued. The former Yellowstone-Grand Teton joint seven-day entrance pass was phased out on June 1, 2018 (Wright, 2018). As was a joint pass between the Arapaho National Forest and Rocky Mountain National Park (https://www.nps.gov/romo/planyourvisit/fees.htm), due to cost considerations and changing fee schedules. Managers at these units identified the many challenges to regional fee structure, including loss of fee revenue across the federally-managed lands, the complexity of the fee schedule for visitors, and other economic demands of individual NPS units. These challenges make this potential management recommendation difficult to pursue at this time.

3.3.3 Regional NPS Information Packet. Provide visitors with regional information and advice regarding the unique recreational opportunities across the greater Mojave region and offered by each NPS unit. This information could be provided in a brochure and website that details available attractions and recreation opportunities and compares different NPS units against each other. Such information could be distributed through NPS unit visitor centers, the NPS website, external collaborators such as the Palm Springs CVB, on the Roadrunner shuttle, and in regional rental cars. Categories of information to be compared include services and recreational opportunities such as:

- Services: Gas, lodging, groceries, cell phone access
- Hiking: Cross-country hiking, backpacking, maintained trails
- Primary Attractions
- Camping: Established campsites in park units, campsites outside park units, primitive camping

- Historic Preservation: Historic tours of mining and ranching history, military history
- Auto-Touring: Passenger vehicles vs. 4WD roads, scenic drives
- Pets: Dog policies
- Other Recreation: Climbing, bouldering, mountain biking, road biking, canyoneering, hunting, birding, geology, wildflower viewing

This resource could also include a list of attractions at each of the NPS units, encouraging visitors to seek the types of opportunities that match their interests. Coordination between NPS units would be central to the success of this effort and would help clarify communication between the units while putting key information about other NPS units at interpretation specialists' fingertips.

Local partnerships and existing resources could also be used to create and disseminate this information. The Mojave Desert Land Trust initiative's Monument Kit, which includes information about the three southeastern California National Monuments established in 2016, is one example of this strategy in action. This monument kit includes information about desert attractions, recreation opportunities, desert safety concerns, and locations of goods and services. Much of the Monument Kit is available through http://www.mojavemonuments.org. Another possible partnership would be with JTLab, a group that already designs new interpretive signage and other design-based recommendations for NPS.

3.3.4 Monitoring and Adaptive Management. In order to measure the success of the Regional NPS Information Packet on dispersing visitors throughout the Mojave Desert Region, ongoing monitoring would be necessary. Monitoring protocols could use existing data collection efforts, including car counts and visitor interactions at ranger stations to see if there were any

changes in visitor behavior after the implementation of Regional NPS Information Packets. It would also be important to consult with staff in Interpretation following the introduction of the packets to gather feedback regarding visitor's reactions to the new information.

3.3.5 Alternative Pass Options. Like Rocky Mountain National Park, JOTR could consider selling week-long passes online (https://www.nps.gov/romo/planyourvisit/fees.htm). This could reduce wait times in entrance areas as well as help the park anticipate visitation levels on a day-to-day basis as the program grows in popularity. Another option to consider would the development of a "fast pass" option as utilized at tollbooths. This would reduce waiting at entrance gates and their information would be recorded by remote sensor.

3.3.6 IVUMF Analysis for Regional NPS Information Packets.

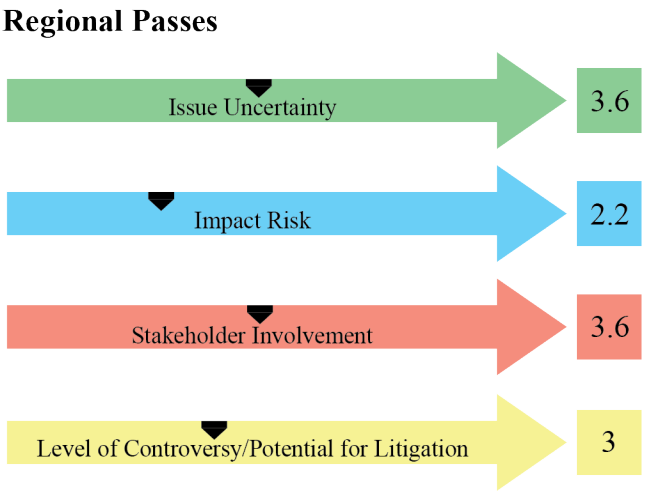

Figure 7. Sliding scale analysis for Regional NPS Information Packets

Issue uncertainty. The development of regional information and passes would proactively address visitor concentration and dispersal and visitor compliance with preferred behaviors, and could improve the visitor experience. Though it is difficult to predict how the visitors will disperse within and between park units, regional information would allow the park units to encourage the dispersal of visitors throughout the region. Additionally, regional NPS

Information distributed by the park units would allow managers to have a say in where visitors are being instructed to go.

Impact risk. There is some impact risk associated with providing visitors with information that could encourage them to spread their use across more of the region. However, this risk can be mitigated by having managers determine which locations/resources are resilient to visitation and types of activities.

Stakeholder involvement. The involvement of stakeholders in this management action can vary depending on the interests of the managers. Community partners and local businesses could be included in the information materials.

Potential for conflict or litigation. The potential for conflict in this management suggestion is moderate. There is some potential conflict between stakeholder groups who may not want certain locations advertised. Though this is not a major concern.

3.4 Recommendation: Real-time Park Notifications

3.4.1 Description of problem and proposed action. In an age of increased social media use and smart phone apps, there are emerging opportunities to engage with visitors in real time. An increased presence of the park units on smart phone applications and social media could allow for the dissemination of important information prior to visitor arrival, and guide visitors during their park experiences from the palms of their hands.

While there may be no unifying answer to whether it is better to concentrate visitors or disperse them, visitor-use managers rely on strategies to influence the spatial distribution of visitors (Leung and Marion, 1999). Use of real-time park notifications regarding use levels at key attractions and entrance stations can improve the ability of parks to implement these strategies by

reaching more visitors and increasing responsiveness. Currently Glacier National Park is using Twitter to provide real-time notices regarding parking lot capacities, road closures, and other park conditions. An obvious constraint to the use of digital media to inform visitor experiences in real-time is the limited cellular and internet signal while in the Mojave parks. However, this data is most useful for people before they enter the park to provide guidance for immediate trip planning. There are also emerging and alternative opportunities to utilize cell phone technology to manage visitor impacts and experiences. These opportunities are detailed in the following paragraphs.

In order to give visitors location-based information updates, geofences could be utilized even without cellular signal. Geofences are an emerging technology that allows app developers to use physical boundaries to send notifications to users' mobile devices. It is ostensibly possible to design a system that uses mobile device GPS location rather than cell signal or internet connection (Apple Inc, 2016). For example, a function called "offline maps" is currently built into the Google Maps application, where users can store a part of the map for offline use and use Google Maps navigation using GPS as if the phone is online. A similar technology could be used in the development of an app that sends users notifications informing them of unique opportunities and restrictions in their present location, like designated wilderness.

Another approach would be to utilize beacons within the park units to specify geographic ranges (Grainger, 2013). While geofence-triggered notifications would be unique to location, as opposed to "push" notifications that address visitors when conditions change throughout the day, they could still be effective in addressing real-time conditions on a day-to-day basis. For example, an app could be developed that would allow managers to alter notifications and update the app from the backend each day. With such an app, if managers know a certain campground is

full, office staff with internet connection could update geofence notifications to inform visitors when they are nearing that campground. Alternatively, the app could be set to deploy different notifications during busy weekends or peak times.

Real-time information via social media can be a strong tool for managing visitor plans and expectations, especially as tourists increasingly rely on social media for making decisions (Hudson and Thal, 2013). Currently, if someone Google searches for "Joshua Tree National Park", "Death Valley National Park", or "Mojave National Preserve" the top results are NPS websites. With the exception of JOTR, those are the only information outlets controlled by the parks that appear on the first page of results. It should be noted here that searches for the above terms were conducted using Google Chrome's "Incognito" feature on a desktop so that previous web use did not influence search results. The remainder of first-page search results are external blog posts, news articles, Trip Advisor web pages, and web pages on Visit California (a non-profit that markets destinations in the state). For the JOTR search, the park's Facebook page appears on the first page as well. By utilizing principles of Search Engine Optimization (SEO) and ensuring that real-time updates are posted on social media, parks can elevate their social media pages higher in the Google algorithm, which allows them to better influence visitor choices during the pre-trip planning phase. (For more information about SEO, Google provides a starter guide at https://support.google.com/webmasters/answer/7451184).

Social media updates regarding current conditions could help to inform visitors about congested areas and other real-time conditions in the park units. For example, at JOTR the current line length and estimated wait time at the Joshua Tree entrance station could be posted with a suggestion to use 29 Palms entrance station. This could serve as an important tool for managers to disperse visitors to improve visitor experience and safety, and protect significant

natural and cultural resources. Additionally, such an app (such as parking apps/social media tools) could broadcast campsite availability and real-time parking space availability at high-use areas to reduce congestion and circling vehicles.

Another benefit of an app would be to engage visitors who do not receive NPS employee contact associated with going through an entrance station or stopping at a visitor center. Especially at DEVA and MOJA this application could disseminate cautionary information, such as warnings about weather, reminders to carry extra water or keep dogs on a leash, and interpretive information about the area that visitors to these units might not otherwise receive.

The development of mobile device applications and real-time updates on social media is more impactful the sooner it can be implemented. Preemptive implementation would allow the Mojave Desert Region Park Service Units to proactively manage visitation, rather than react to visitation by making targeted social media communications. Individual visitors as well as external organizations, such as the Greater Palm Springs Convention and Visitor Bureau, will likely continue to produce and share content about these National Park units. Therefore, strong social media presence and development of smart phone applications allows the park units to better control messages that are being disseminated and manage the dispersal of visitors within and between each park unit.

3.4.2 IVUMF Analysis for Real-time Park Notifications

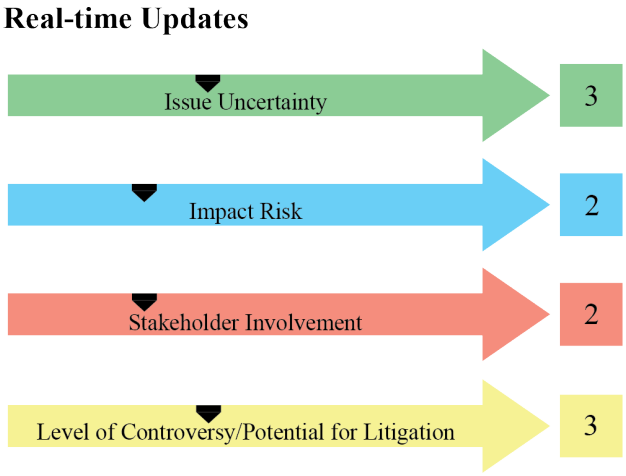

Figure 8. Sliding scale analysis for Real-Time Park Notifications

Issue uncertainty. There are low levels of uncertainty regarding the development of real-time digital and social media park updates. These efforts would proactively address visitation, including visitor concentration and dispersal, visitor compliance, and the quality of the visitor experience. While it is possible to forecast visitation growth to some degree, there is fundamental uncertainty regarding stochastic changes in public interest for these park units. Furthermore, it is difficult to predict how the visitors will disperse within and between park units. Therefore, real-time updates allow the park units to direct that dispersal by intercepting visitors as they plan their trips, and respond according to on-the-ground conditions that may not be captured in forecasting models. Additionally, app development that utilizes geofencing can inform or remind visitors of rules and regulations in various areas of the park, which may increase compliance without requiring additional law enforcement staff. It is however, important to note that uncertainty could be higher due to the pure volume of JOTR related apps currently on the market and how this offering could compete.

Impact risk. The implementation of this proposal has little to no risk to park resources. However, the concentration and dispersal of visitors is of utmost importance when considering impacts to natural, cultural, and experiential resources. Concepts such as carrying capacity and visitor satisfaction models are used to help managers identify visitor thresholds at which the area can no longer sustain visitors without significant impact risks (Manning, 2011). While management is moving away from making decisions simply based on carrying capacity, reduction of risk/impacts to park resources is still largely about managing visitor use on spatial and temporal scales (Marion, 2016). The recommendations presented here would allow managers to implement such strategies in more proactive and targeted ways, addressing modern developments in tourism decision-making and communication strategies. There is a risk of financial and human capital investments in developing this option, and it is important to note the cost/benefit of this investment.

Stakeholder involvement. Stakeholder involvement is likely unnecessary to implement these suggestions unless the information being shared via this digital media directs visitors to or away from concessionaires or businesses in outlying communities.

Potential for conflict or litigation. Early stages of app development or social media use would likely not result in conflict or litigation, especially as the National Park Service already utilizes social media, and has created and released applications for several park units including Cape Hatteras and Yellowstone (NPS, n.d.). However, as technology use increases in park units, some members of the public have resisted developments. For example, the non-profit group Public Employees for Environmental Responsibility has deemed cell phone towers inappropriate and launched a campaign to resist them (PEER, n.d.). In March of 2018, PEER filed a lawsuit

related to release of public records in response to cell tower development in Grand Teton National Park (Gruver, 2018).

3.5 Recommendation: Enhance Partnerships with Convention and Visitor Bureaus and Friends Groups

3.5.1 Description of Problem and Proposed Action. Collaborations and partnerships with local stakeholders can assist in carrying out management actions to address increases in visitation, and other visitor use management concerns. With NPS units experiencing staff reductions and personnel being redirected toward other projects, additional time and resources are necessary to tackle emerging problems. New and expanded partnerships between NPS units and their local friend groups and neighboring Convention and Visitor Bureaus are suggested to broaden communication and outreach, tap into additional funding sources, and coordinate volunteer labor.

3.5.2 Engaging Neighbor Convention and Visitor Bureaus. Convention and Visitor Bureaus (CVB) have a vested interest in providing potential visitors to their regions with accurate information regarding regional attractions. It is also in the interest of these attractions to provide the CVB with information, especially when it comes to visitation to NPS units, since visitor interaction with the high-desert environment is fairly unique and potentially a new experience for visitors. Additional promotional material can be co-developed with regional NPS units input to educate potential visitors regarding park access, usage, and safety concerns. Additionally, the more CVBs become aware of park management realities, the more assistance they may be able to provide, as well as bringing more potential businesses, donors, and collaborators to the table.

Since all three parks are located along a touristic corridor between Los Angeles and Las Vegas, it is reasonable to engage the following CVBs: The Greater Palm Springs Visitor Bureau, the Las Vegas Convention and Visitors Authority, Los Angeles Tourism and Convention Bureau, as well as the non-profit Visit California. Currently, Palm Springs and Visit California mainly feature JOTR, while MOJA and DEVA are only mentioned on Palm Springs' website, and DEVA is only mentioned in Visit California's site. Initial approaches should be made to those CVBs. Local towns that are organized with Chambers of Commerce should also continue to be engaged, such 29 Palms and Joshua Tree. Initial goals of collaboration could be as follows:

- Coordinated production and distribution of **promotional material** would ensure consistent messaging, the safety of visitors, and protection of natural and cultural resources.
- Exploring the possibility of **placing information** regarding "how to be safe in your high desert experience," "how to avoid the crowds", or "how to care for the desert" in CVB materials.
- Bridging potential **collaborations with local businesses** that also benefit from National Park tourism, such as car rental companies. Placing brochures that promote "a safe visit to your high desert National Park" could reach those visitors who do not engage directly with interpretive materials on site.
- **Production of videos, interactive maps, and printed materials** advertising the diversity of regional attractions could make the Greater Palm Springs Visitors Bureau' approach to promoting all three NPS units more robust (see section 3.2 for more on regional information), especially in terms of showcasing the

proximity of units to one another as well as the diversity of attractions that each offers.

It is important that units like JOTR become actively engaged in collaborating on the messaging that regional CVB currently produce. Hence, a first step in this recommendation would for JOTR to work with the GPSVB to ensure proactive coordination before new promotional material is produced to be able to safeguard that messaging and the activities that are depicted in the campaigns demonstrate appropriate park use. Once a consistent working relationship is established it could serve a model for working with other CVB in the future.

3.5.3 Promote Regional Friends Group Collaborations. It became apparent during our visit that staff reductions were a significant challenge facing all three park units. Hence, it could be of great assistance to the units if each park's friends group collaborated on some of the ideas mentioned above, especially the development of the regional route. Friends groups could also work together with regional CVBs to co-organize fundraising events to meet specific unit needs or for the continued development of a regional visitor management approach. One example would be the development or further promotion of a regional-information-map for the areas surrounding the NPS units. This effort could possibly be framed within a more robust and official regional IVUMF analysis that could allow all three units and stakeholders to plan together on a common regional vision that incorporates proper impact mitigation strategies.

Friends of Joshua Tree (FoJT) currently communicates trail restoration projects, Leave No Trace education and best practices for rock climbers via public gatherings, town hall meetings, other events, and on the internet so expanding the content of their efforts is recommended. Friend Groups for the two other park units, in addition to FoJT, can be utilized for volunteer mobilization, program development, advocacy, and fundraising.

3.5.4. IVUMF Analysis for Collaborations and Partnerships.

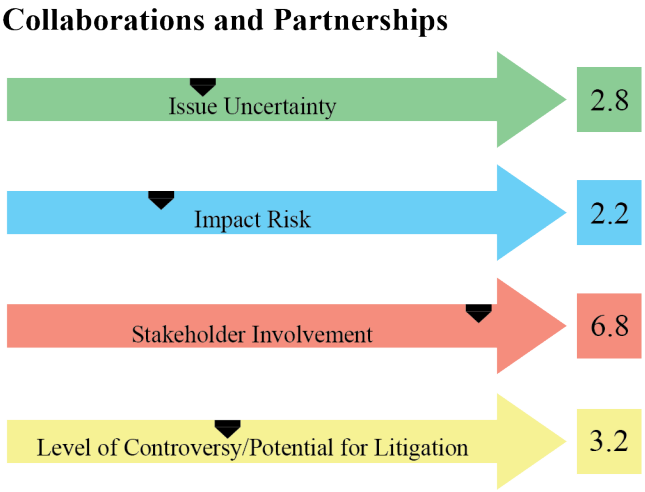

Figure 9. Sliding scale analysis for Collaborations and Partnerships

Issue Uncertainty. There are a couple points of uncertainty to consider when engaging neighboring CVBs. The Greater Palm Springs Visitors Bureau (GPSVB) is hoping to attract more than 16 million visitors to the valley by 2026 whereas Joshua Tree NP managers may not be interested in promoting more visitors to park units because of the aforementioned issues associated with overuse, (GPSCVB Sales and Marketing Plan, 2018). Moreover, promotional plans listed in the GPSVB Destination Development plan imply an emphasis on attracting off-season visitors and advertising week day versus weekend visitation. Once again, Joshua Tree NP manager goals may be similar but differ fundamentally. The Park is hoping to shift visitation to off-season and weekday attendance, rather than bring in additional visitation on those days. This example indicates that proactive regional engagement with regional CVB is important for park units. Differences in goals should be explored and park units should be explicit in their communication and collaboration with CVBs.

Partnerships between Friends Groups already exist and therefore the uncertainty associated with this issue is low overall. The amount of time, effort, and money that can be contributed by friend groups is a possible source of uncertainty.

Impact Risk. There is a relatively low impact risk for engaging neighbor CVBs. Real time visitor experiences will not be affected by this management strategy; however, cooperative promotional material and advertising may impact experiences when visitors are planning their trip.

Similarly to engaging CVBs, promoting partnerships with Friend Groups and other entities has a low impact risk. If more volunteer presence is in the park due to this management suggestion, or if education efforts reach more visitors through Friend Groups there is a small risk of negatively impacting experiences before and during a visit.

Stakeholder Involvement. Stakeholder Involvement for all collaborative efforts suggested in this section is considered very high. Currently, no CVBs have an active relationship with the park units, so trust will need to be built with these entities in order to move forward with any joint efforts. CVBs are well-funded in this area and can be considered highly engaged in their communities. Although the stakeholder involvement for this section is considered high, the overall effort asked of CVBs will be low because outreach, advertising, and promoting of Park units is already happening at some level.

Stakeholder Involvement for collaboration based management suggestions are considered very high because of the nature of the recommendations. Like CVBs, Friend Groups are well organized and, for Joshua Tree especially, they are well established and engaged. Trust has previously been established and any collaborative efforts will be decided upon by both the Park and the Friends Group of interest.

Level of Controversy or Potential for Litigation. There is fairly low potential for or litigation for engaging CVBs and creating new partnerships. However, using this management strategy may imply the promotion of bringing more visitors to park units, which could be controversial. Many National Park units around the country coordinate with friend groups to tackle problems, and combine resources so suggesting further collaboration in this area will have low potential for litigation and fairly low levels of controversy.

3.6 Recommendation: Sustainable Transportation in JOTR

3.6.1 Description of Problem and Proposed Action. The current volume of automobiles moving through JOTR during certain peak weekends may negatively affect visitor experiences and the park's ecological integrity, therefore threatening two central pillars of the NPS' mission (Ament et al., 2008; Coffin, 2007; Manning et al., 2014). Additionally, traffic increases place higher demand on law enforcement personnel and other staff. The current RoadRunner Shuttle program transports visitors through the surrounding communities of Joshua Tree and Twentynine Palms as well as through the most heavily visited parts of the park. Expanding this program would prioritize moving people instead of moving personal automobiles into and throughout JOTR, alleviating many problems associated with increased visitation. Here, we provide recommendations for the future of the shuttle program at JOTR, with the important caveat that the ultimate structure of the shuttle program should be informed by data from the Spring 2018 Roadrunner pilot.

Additionally, the NPS should identify desired conditions for JOTR (see Additional Management Recommendations #19) so that thresholds for more intensive actions – including an expanded shuttle fleet, seasonally mandatory shuttles, etc., - can be identified (Pettengill et al.,

2012). Thresholds should be based on understandings of the relationship between traffic volume and variables related to visitor experience (i.e. 'acceptability'), visitor safety, and ecological integrity (i.e. roadkill).

3.6.2 Collect Pilot Data on Spring 2018 Effort. The effect of the Roadrunner shuttle on JOTR's visitors, staff, surrounding communities, and natural resources should be monitored and these data used to inform the future program (Manning et al., 2014). Please see Ament et al. (2008), Brittoni and Marquit (2015), Lawson et al. (2011), and Pettengill et al. (2012), and references therein, for ideas on what key variables to monitor and how. These data should continue to be collected after the shuttle program is expanded, so the program can be guided by a data driven adaptive management framework (Manning et al., 2014).

3.6.3 Coordinate with Local Partners. Shuttle programs that proactively engage gateway communities are more successful than those that do not (Dunning, 2015; Turnbull, 2009). Promotion of the Roadrunner Shuttle should be a central component of increased coordination with local CVBs, regional friends groups and local businesses (See Section 3.4). Although the Roadrunner Shuttle is prominently featured on the official JOTR website, neither the Joshua Tree National Park Association nor Friends of Joshua Tree currently mention the shuttle (Friends of Joshua Tree, 2018; JTNPA, 2012). Roadrunner shuttles should service not only town centers, but also establishments that provide extended parking for visitors. These establishments may include hotels and campgrounds outside of the park. A cooperative agreement between lodging establishments, JOTR management, and Roadrunner operators would alleviate the need for NPS to build additional parking infrastructure or even possibly reclaim some parking areas for restoration or other service provisions (see Vendor Support below). Care should be taken, however, to communicate who is running the shuttle to visitors. In

Acadia National Park, diffuse responsibilities have led to visitor uncertainty concerning who runs a private shuttle into the park (More et al., 2008).

3.6.4 Vendor Support for Shuttle Passengers. People choosing to ride the Roadrunner must necessarily travel more lightly than they might when using their own vehicle. While many visitors may welcome the freedom that travelling lightly on the Roadrunner offers, it stands to reason that occasionally they might need extra support in light of their limited capacity to carry additional clothing, food, water, sunscreen, or first aid supplies. To compensate for visitors' potential planning deficits when riding the Roadrunner, we suggest providing access to the aforementioned provisions through vendors positioned strategically throughout the park (possibly via mobile vendors) or increasing the availability and diversity of items available for sale at JOTR visitor centers.

3.6.5 Transit-Only Lanes. In addition to providing more efficient transportation to and within JOTR, shuttles travelling in dedicated lanes on park roads would enjoy fewer traffic obstructions. Decreased vehicular traffic would provide increased safety for riders, pedestrians, and cyclists as well as decreasing noise and air pollution in the park. The park might consider a trial run of a transit-only scenario during a week or weekend in a shoulder season, wherein temporary transit-only lanes are demarcated by cones or pylons. This option could be coupled with a one-way only traffic pattern on the main roads within JOTR (this option was not explored in this report because it was deemed controversial although it has great potential for addressing visitor congestion).

3.6.6 Bike Program. If access and circulation around JOTR is limited—either due to increased or mandated shuttle service—the reduction in vehicular traffic is likely to provide improved safety for bicycles on park roads. This would be especially true if existing road space

is redistributed/re-designated for shuttle-only and bicycle-only lanes. If shuttle use is not mandated as the only way to access the park, bicycle use could be encouraged in tandem with shuttle ridership during appropriate seasons. Visitors who wish to bicycle from site to site around the park would be able to do so safely and freely, but could still choose to park their bicycles to ride the shuttle if the need arose.

3.6.7 IVUMF Analysis for Sustainable Transportation in JOTR. Based on a literature review and conversations with NPS staff and stakeholders, the following sliding scale evaluations were conducted. Please note that because there are many different forms that a shuttle program could take at JOTR, this analysis was less precise than for other sections.

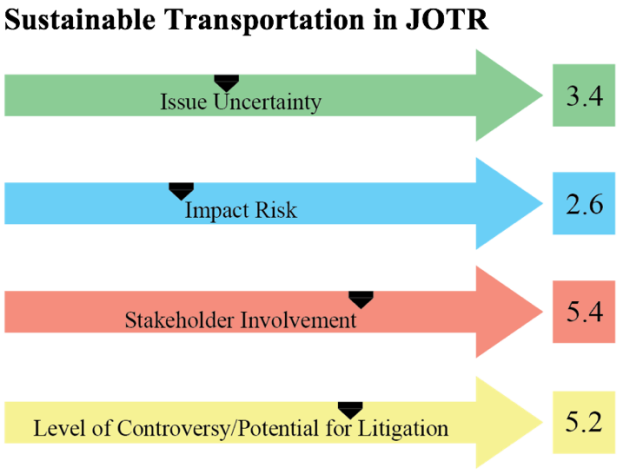

Figure 10. Sliding scale analysis for Shuttle and Transportation

Issue Uncertainty. The establishment of shuttle programs have generally had positive impacts on visitor experience and ecological integrity in US National Parks (Manning et al., 2014). Certain components of a shuttle program—such as designated lanes, mandatory shuttles, partnerships with local businesses, etc. —may be less predictable due to the social complexities of JOTR. For this reason, we again stress that data should continuously be collected on the

impacts of a shuttle program and so an adaptive management technique can be used (Manning et al., 2014).

Impact Risk. Similar to Issue Uncertainty, there are many different forms a shuttle program could take and the impacts are likely to be positive, but impacts should be monitored (Manning et al., 2014).

Stakeholder Involvement. Shuttle programs that are more integrated with surrounding communities and stakeholders are generally more successful (Dunning, 2015; Turnbull, 2009). This being said, stakeholder involvement can be difficult and time consuming, and JOTR can seek differing levels of involvement depending on objectives and resources.

Level of Controversy or Potential for Litigation. Depending on multiple factors, including the stakeholder involvement, and whether they are mandatory, shuttles can be controversial (Manning et al., 2014; White, 2007). Certain components of shuttle programs have been components of litigation involving the NPS in the past, but these are generally bound with broader management issues (Gladfelter and Mason, 2012). We again stress that JOTR should continuously connect with surrounding communities and other stakeholders to minimize controversy and the potential for litigation (Dunning, 2015; Turnbull, 2009).

3.7 Recommendation: Visitor Assessments and Reporting at JOTR, MOJA, and DEVA

3.7.1 Description of problem and proposed action. Providing accurate visitation data is critical for maintenance and service-related planning. Currently, there is a need for improved visitor assessments and reporting in all three parks. Traditional methods for counting visitors in parks include traffic counters at entrance stations, bathroom door counters, trail counters, contacts at visitor centers, spending on bathroom supplies or maintenance, or even sales at snack bars or gift shops (NPCA, 2016). Visitor surveys, observation, permit data, and patrol reports

also represent visitation assessment methods (UDSI, 2018a). An analysis of park visitors and facilities determines the type of visitation count that is appropriate for that unit. More sophisticated analyses generally consider multiple datasets (Beaman and Stanley, 1999).

Currently, Joshua Tree NP maintains visitation data through the use of traffic counters. These traffic counters are deployed at each of the park's entrance stations. Figure 11 illustrates park visitation from 1940-2017 in Joshua Tree NP (USDI, 2018b).

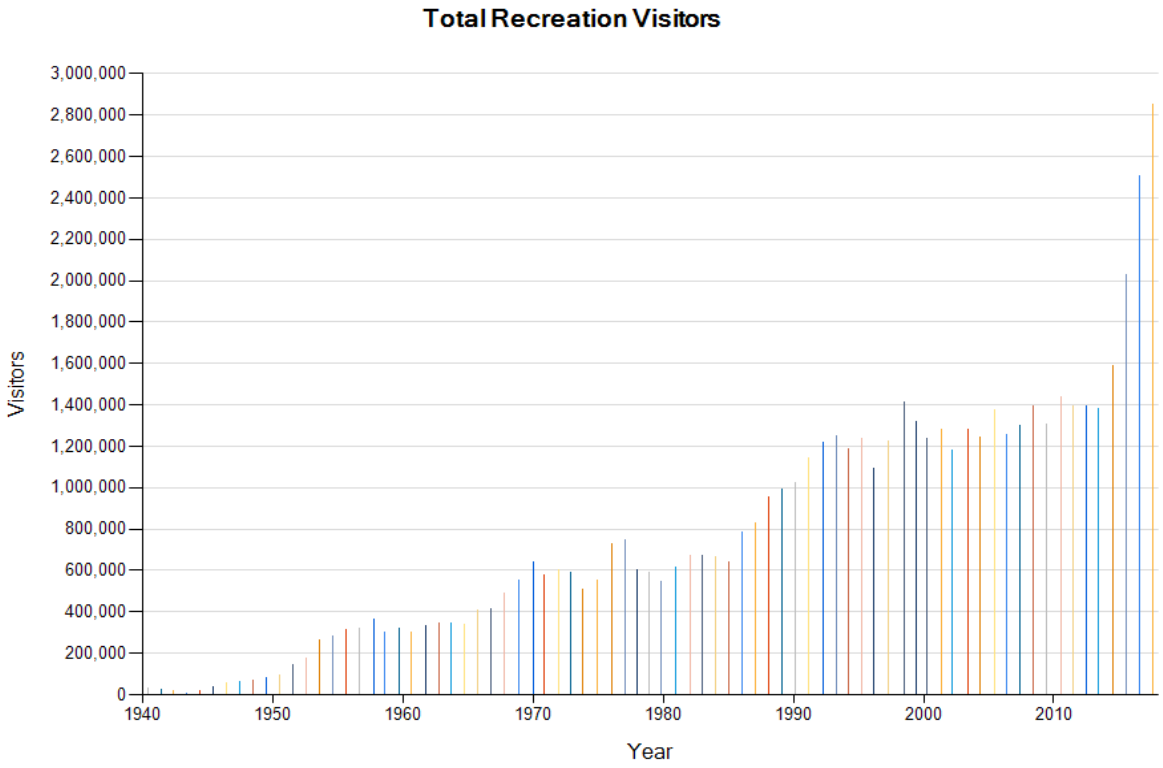

Figure 11: Joshua Tree NP Total Recreation Visitors 1940-2018 (USDI, 2018b)

3.7.2 MOJA and DEVA Entrance Stations. We recommend establishing fee or entrance stations (staffed or unstaffed) at the most highly used entry points. DEVA requires an entrance fee payable at the visitor centers or remote kiosks at popular location (Josh Hoines, 2018). MOJA is a fee-free park (USDI, 2018f). Currently, neither MOJA nor DEVA have entrance stations.

Visitors to DEVA have access to two NPS visitor centers, Furnace Creek and Scotty's Castle, as well as two interagency visitor centers outside the park boundary. Road ownership through MOJA and DEVA makes the construction of entrance stations difficult (e.g. the NPS owns the roads through MOJA, but they are maintained by federal highways) (Hoines, 2018; Hughson, 2018). Alternate solutions that remove the entrance station from blocking the roadway, such as developing an entrance station or kiosk that employs scanning technology for "fast-passes" seems the most realistic but if a more traditional point of contact is desired then a parking area or pullout style station could mitigate this issue but would not capture through traffic. Rather these stations serve as additional visitor contact points, similar to the function of the current visitor centers.

Mojave Preserve currently has three visitor centers, two located inside the park at Kelso Depot and Hole in the Rock, and the other located outside of the park in Bartsow, CA. To our knowledge, traffic counters are utilized intermittently in MOJA and DEVA for the purpose of collecting visitation data but they are irregularly maintained and do not cover every possible point of entry into the parks.

3.7.3 JOTR Backcountry Permitting System Improvements. Currently, JOTR maintains a self-registration backcountry camping permit system (USDI, 2000). There are multiple designated "backcountry boards" distributed across the park that allow overnight parking, offer visitor information, and have a kiosk for the non-fee, self-registration permit. Permit data is counted for the number of user nights per month for each backcountry board location, and park-wide monthly totals are recorded and are publicly available (USDI, 2018e). The current level of permit compliance is unknown (USDI, 2018c).

JOTR maintains a classic wilderness experience where the visitor can enter the landscape for free and without planning or competing for a permit. This open backcountry permit system as it exists in JOTR is somewhat unique for a busy National Park although less-visited parks also use non-fee or self-registration backcountry permit systems including parks such as Lassen Volcanic NP. More developed permit systems are commonly implemented in more heavily visited NPS units to balance the values of opportunities for solitude and resource protection, with a more constrained system of access.

The implementation of a reservation permit system at JOTR could ensure that park resources are protected while also maintaining positive visitor experiences and opportunities for solitude. One of the purposes of JOTR is to provide these experiences to a burgeoning urban population in the surrounding areas (USDI, 2015). This value must be carefully upheld to meet one of the foundational purposes of the park.

In response to comments from JOTR staff and community stakeholders that many park visitors have little-to-no outdoor skills or experience, we recommend that backcountry permit applicants be required to review and acknowledge some degree of wilderness orientation material, e.g. short videos or other training material such as at Glacier NP, Olympic National Park, Cape Hatteras National Seashore, and others. Information could include: safety, Leave No Trace, and basic natural and cultural history information, in addition to details about the terms and conditions of the permit. The need for improved education for the visitors, as identified by park staff and community members, could be addressed by developing visitor education.

To better understand overnight backcountry use, implementing a reservation system would better track the number people in the park, their destination choices, as well as their perceptions and expectations of their experience in the park. Backcountry permit reservation

systems would additionally help distribute visitors widely and evenly into wilderness areas and provide the highest quality experiences, especially for visitors who are deliberately seeking solitude. This system also allows for the establishment of use limits to manage resource impacts.

If patterns of use increase, there may be the need for adapting the permit system to limit use to popular areas, designating campsites, and managing backcountry overnight commercial services. These components of a more complex backcountry permit system potentially allow for greater resource protection and visitor experience management.

3.7.6 IVUMF Analysis for Visitor Assessment and Reporting

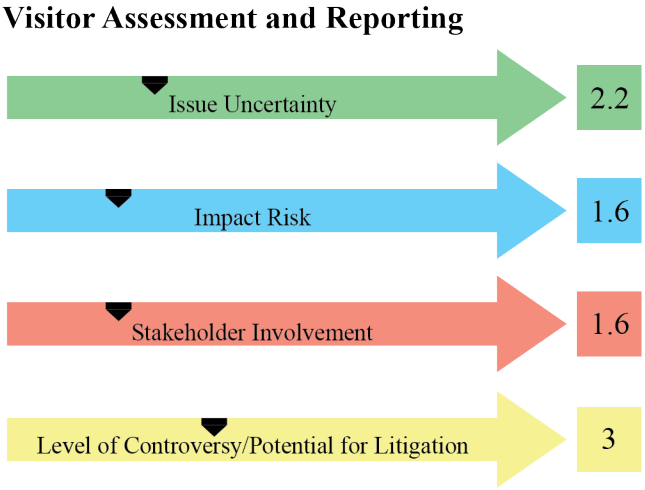

Figure 12. Sliding scale analysis for Visitor Assessment and Reporting

Issue Uncertainty. Enhancing visitor assessments and reporting generally has low levels of uncertainty. The addition of visitor centers or entrance stations in MOJA has the potential for unintended consequences especially considering the high volume of pass-through traffic and local residents that may not support these efforts.

The complexity of overnight backcountry use in Joshua Tree is not fully understood due to lack of data management by the park historically, as well as irregular or understaffed enforcement efforts (USDI, 2018c). Efforts are being taken to better understand the overnight backcountry

visitor and this data will be critical in making more decisions about the needs of the backcountry permitting system. Lack of recreational impact assessments in JOTR makes it difficult to determine the carrying capacity of the natural and cultural resources in the area. There are no established backcountry campgrounds. JOTR regulations currently stipulate that all camping should be dispersed, one mile from the trailhead, and at least 500 feet from the trail (USDI, 2000).

Impact Risk. Traffic counters at key portals pose a low impact risk. The addition of entrance stations poses significant impact risk to park facilities maintenance, staffing needs, inholder relationships, and visitor experiences. Although most stakeholders associated with the parks would be impacted, those who would be primarily impacted by implementation of entrance stations are visitors and inholders. Inholdings are present in the interiors of both MOJA and DEVA.

The implementation of a more regulated backcountry permit system would help to manage the impact of visitors throughout the backcountry. **Additionally, implementing a permit system is a complicated process with a high intital investment of time and resources (that theoretically has low to moderate recurring costs once established).**

Stakeholder Involvement. Involved stakeholders include inholders, wilderness advocates, California Department of Transportation, local convention and visitors bureaus, the Department of the Interior, tribes, and in the case of Mojave Preserve, hunters. In Mojave Preserve, some inholders are known to have tense relationships with the government in general and specifically with the park (Debra Hughson, 2018). DEVA has approximately 300 acres of Timbisha Shoshone tribal lands in the Furnace Creek area (US PL 106-423, 2000) as well as large commercial operators maintaining a golf course and hotel.

Groups that may be concerned about the implementation of a more complex backcountry permit system could be the general public, recreationists, and wilderness watch groups.

Level of Controversy or Potential for Litigation. There is low controversy with traffic counters, though there is a risk for data loss related to vandalism of the devices. There is a significant potential for litigation or controversy surrounding the addition of entrance stations on roads through MOJA and DEVA. Potential for litigation over changes to the backcountry permit system is unknown.

3.7.7 Discussion. Increased understanding of visitation in these parks using the most accurate methods reasonable is a critical component to making a functional visitation forecasting tool. Ultimately, understanding the number of visitors—and ideally their destination choices, perceptions, and expectations for their trip—allow the parks to provide optimal visitor experiences while reducing resource degradation.

Multi-dimensionality of visitation should be considered when statistically representing visitors. It is agreed upon in academic literature that the best visitor use statistics are compiled from multiple data sources (Beaman and Stanley, 1999). Visitor use data should be applied strategically to guide visitor services and maintenance. Additionally, care should be taken to utilize additional data that can guide different and specific actions pertaining to facilities and services particular to niche user-groups which are a smaller subset of the total park visitation (Beaman and Stanley, 1999).

3.8 – Overall Conclusions. Park Break provided an opportunity for students to visit three parks for a week to discuss issues, challenges and successes. Much was accomplished. Time was spent at JOTR, MOJA and DEVA, with most of the time being spent at JOTR. As a result, this report mostly focuses on JOTR, however, much of the process that was undertaken at JOTR

can be applied to the other parks (and other parks in the system). Considering the amount of time spent talking with three park managers (5 days total), we were able garner enough information to inform this report. However, this project also highlights the difficulty in developing a regionally scaled visitor use monitoring effort. A single week to tour all three parks may have been too ambitious a plan. The complexity of JOTR, DEVA and MOJA would require their own week long Park Break to gain, at the very least, a cursory understanding of the issues and how to address them. Taking this into consideration, if we had not visited all three parks, the report and the regionally focused thought process, may have suffered from short sightedness. In the end, this process provided us with a tremendous opportunity to learn about the parks, the issues that managers face and how we can frame our own research to help answer some of these pressing concerns. Our hope is that this report acts as a starting point for future research and planning.

4. Citations

Ament, R., Clevenger, A. P., Yu, O., & Hardy, A. (2008). An assessment of road impacts on wildlife populations in US National Parks. *Environmental Management*, *42*(3), 480.

Bangwayo-Skeete, P. and Skeete, R. (2015). Can Google data improve the forecasting performance of tourist arrivals? Mixed-data sampling approach. *Tourism Management*, 46, 454-464. DOI: 10.1016/j.tourman.2014.07.014.

Beaman, J., & Stanley, D. (1996). Counting visitors at national parks: Concepts and issues. Parks Canada, Socioeconomic Branch.in: Benchmarking and Best Practice for National Parks and Protected Areas: National Data Standards on Protected Areas Visitation, Appendix, 8.

Bergmeir, C., & Benítez, J. M. (2012). On the use of cross-validation for time series predictor evaluation. Information Sciences, 191, 192–213.

Chang, W., Cheng, J., Allaire, J.J., Xie, Y. & McPherson, J. (2017). shiny: Web Application Framework for R. R package version 1.0.5. https://CRAN.R-project.org/package=shiny

Coffin, A. W. (2007). From roadkill to road ecology: a review of the ecological effects of roads. *Journal of transport Geography*, *15*(5), 396-406.

Dunning, A. (2015). 21 Helping gateway communities embrace alternative transportation. *Sustainable Transportation in Natural and Protected Areas*, 261.

Friends of Joshua Tree. (2018). Retrieved May 15, 2018, from http://www.friendsofjosh.org/

Gardner, W., Mulvey, E. P., & Shaw, E. C. (1995). Regression analyses of counts and rates: Poisson, overdispersed Poisson, and negative binomial models. *Psychological bulletin*, *118*(3), 392.

Gladfelter, S., and R.J. Mason. (2012). "Beyond boundaries: An assessment of the Yosemite National Park geotourism initiative." *Tourism Planing and Devlopment* 9.4: 355-368

GPSCVB 2018 Sales and Marketing Plan (2018). Retrieved from: https://www.visitgreaterpalmsprings.com/about/gps-reports/

GPSCVB Destination Development Plan (2016). Retrieved from: https://www.visitgreaterpalmsprings.com/about/gps-reports/

Grainger, M., Mayor, R., & Huang, R. K. (2013). *U.S. Patent No. 8,396,485*. Washington, DC: U.S. Patent and Trademark Office.

Gruver, M. (2018, March 23). Public has been kept in the dark on plans to add cell towers in Grand Teton, group says. *Billings Gazette*. Retrieved from: http://billingsgazette.com/news/state-and-regional/wyoming/public-has-been-kept-in-the-dark-on-plans-to/article_b79352fe-f921-5f1d-8991-d0bb37c610c7.html

Hudson, S., & Thal, K. (2013). The impact of social media on the consumer decision process: Implications for tourism marketing. Journal of Travel & Tourism Marketing, 30(1-2), 156-160.

Interview with Josh Hoines, DEVA Chief of Resources, March 29, 2018. Park Break.

Interview with Debra Hughson, MOJA Chief of Resources, March 28, 2018. Park Break.

Joshua Tree National Park Association- JTNPA. (2012). Retrieved May 15, 2018, from http://www.joshuatree.org/

Kohavi, R. (1995, August). A study of cross-validation and bootstrap for accuracy estimation and model selection. In *Ijcai*(Vol. 14, No. 2, pp. 1137-1145).

Lawson, S., Chamberlin, R., Choi, J., Swanson, B., Kiser, B., Newman, P., ... & Gamble, L. (2011). Modeling the effects of shuttle service on transportation system performance and

quality of visitor experience in Rocky Mountain National Park. *Transportation Research Record: Journal of the Transportation Research Board*, (2244), 97-106.

Leung, Y. F., & Marion, J. L. (1999). Spatial strategies for managing visitor impacts in. Journal of Park and Recreation Administration, 17(4), 20-38.

Li, X., Pan, B., Law, R., & Huang, X. (2017). Forecasting tourism demand with composite search index. *Tourism Management, 59*, 57-66.

MACE, B. L., & MARQUIT, J. D. (2015). Park visitor and gateway community perceptions of mandatory shuttle buses. In *Sustainable Transportation in Natural and Protected Areas* (pp. 86-97). Routledge.

Manning, R. E. (1986). Studies in outdoor recreation-a review and synthesis of the social science literature in outdoor recreation. Oregon State University Press.

Manning, R. E., Lawson, S., Newman, P., Halo, J., & Monz, C. (2014). Sustainable transportation in the national parks: From Acadia to Zion.

Marion, J. L. (2016). A review and synthesis of recreation ecology research supporting carrying capacity and visitor use management decision making. Journal of Forestry, 114(3), 339-351.

McIntosh, C.R. and Wilmot, N. (2011). An empirical study of the influences of recreational park visitation: the case of US National Park Service sites. *Tourism Economics*. 17(2), 425-435. DOI: 10.5367/te.2011.0036

More, T. A., Urdaneta, B., & Stevens, T. H. (2008). Shifting National Park Policies and Local People: A Case Study of Acadia National Park. *Journal of Park & Recreation Administration*, *26*(4).

National Parks Conservation Association. (2016). *Who counts?* Retrieved from https://www.npca.org/articles/1146-who-counts-a-closer-look-at-parks-record-visitation-numbers

National Park Service. (2018). Recreation Visitors by Month Joshua Tree NP. Available from https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Recreation%20Visitors%20By%20Month%20(1979%20-%20Last%20Calendar%20Year)?Park=MOJA

NPS (National Park Service). (n.d.). National Park Service Apps. Retrieved from: https://www.nps.gov/subjects/digital/nps-apps.htm

OECD. 2018. Consumer confidence index (CCI) (indicator). doi: 10.1787/46434d78-en

PEER (Public Employees for Environmental Responsibility). (n.d.). Cell Tower Invasion. Retrieved from: https://www.peer.org/campaigns/public-lands/cell-tower-invasion/

Pettengill, P. R., Manning, R. E., Anderson, L. E., Valliere, W., & Reigner, N. (2012). Measuring and managing the quality of transportation at Acadia National Park. *Journal of Park and Recreation Administration*, *30*(1).

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL

Roberts, D. R., Bahn, V., Ciuti, S., Boyce, M. S., Elith, J., Guillera□Arroita, G., … Dormann, C. F. (2017). Cross-validation strategies for data with temporal, spatial, hierarchical, or phylogenetic structure. Ecography, 40(8), 913–929.

Timbisha Shoshone Homeland Act. 16 USC § 410aaa. (2000).

Turnbull, K. F. (2009). Innovative Transportation Planning Partnerships to Enhance National Parks and Gateway Communities.

USDI, National Park Service. (2000). *Joshua Tree National Park Backcountry and Wilderness Management Plan.*

USDI, National Park Service. (2015). *Joshua Tree National Park: Foundation Statement.*

USDI, National Park Service. (2018a). Estimating Denali's Visitation. Retrieved from https://www.nps.gov/articles/denali-visitor-estimation.htm

USDI, National Park Service. (2018b). Joshua Tree NP: Total Recreation Visitors (1940-last calendar year). Retrieved from https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20Graph%20(1904%20-%20Last%20Calendar%20Year)?Park=JOTR

USDI, National Park Service. (2018c). *Joshua Tree National Park: Building Blocks for Wilderness Stewardship.*

USDI, National Park Service. (2018d). Death Valley Maps. Retrieved from https://www.nps.gov/deva/planyourvisit/maps.htm

USDI, National Park Service. (2018e). IRMA Stats. Retrieved from https://irma.nps.gov/Stats/

USDI, National Park Service. (2018f). Mojave National Preserve Fees & Reservations. Retrieved from https://www.nps.gov/moja/planyourvisit/feesandreservations.htm

Ver Hoef, J. M., & Boveng, P. L. (2007). Quasi-poisson Vs. Negative Binomial Regression: How Should We Model Overdispersed Count Data?. *Ecology*, *88*(11), 2766-2772.

White, D. D. (2007). An interpretive study of Yosemite National Park visitors' perspectives toward alternative transportation in Yosemite Valley. *Environmental Management*, *39*(1), 50.

Wilderness.net. (2018). *Find a Wilderness*. Retrieved from https://www.wilderness.net/NWPS/AtoZ

Wilmot, N.A., & McIntosh, C.R. 2014. Forecasting recreational visitation at US National Parks. *Tourism Analysis, 19*, 129-137. doi: 10.3727/108354214X13963557455487

Wright, M. (2018, May 10). National Park Service axing Yellowstone-Teton joint pass. *Bozeman Daily Chronicle.* Retrieved from: https://www.bozemandailychronicle.com/news/yellowstone_national_park/national-park-service-axing-yellowstone-teton-joint-pass/article_64ede662-1482-50b5-b497-d7c81e745b46.html

Ziesler, P.S. (2016). Statistical Abstract: 2015. Natural Resource Data Series NPS/NRSS/EQD/NRDS-2016/1009. National Park Service, Fort Collins, CO. Available from: https://irma.nps.gov/DataStore/DownloadFile/548275

5. Appendix

5.1 Data Analysis. In order to create a model which maximizes predictive ability, we analyzed these data in four key steps: 1) Distribution selection 2) Identification and elimination of insignificant parameters 3) Model selection, and 4) Bayesian analysis and posterior identification.

1. Because our data represents counts of individual visitors to the park, both poisson and negative binomial distributions are appropriate for use in a generalized linear model (Ver Hoef, 2007). The visitation rates in Joshua Tree National Park vary based on a number of different parameters, some known and others not. We created and compared models using both distributions and determined that the negative binomial distribution was more appropriate for predicting visitor use. Because much of the unexpected variability in our data is at the right tail, it is intuitive that the negative binomial distribution would yield better predictive ability. The negative binomial distribution includes an over dispersion parameter, k, which accommodates for variability in data in the right tail (Gardner, 1995).
2. To determine which parameters were significant predictors of visitation in Joshua Tree National Park, we created a frequentist generalized linear model fit to a negative binomial distribution for all parameters for which we had data. We then eliminated the parameter with the highest p-value and ran a subsequent model with the remaining parameters. We continued this process until only significant variables remained as determined by a p-value of < 0.05. Frequentist models were used for this stage in model selection to reduce computational time necessary to fit each model.
3. For model selection, we compared the R^2 and root mean squared error (RMSE) values produced from leave-one-out cross validation for every possible combination of significant parameters to determine which model most accurately predicted the data. We were able to use leave-one-out cross validation because we limited our computational

intensity by performing our model selection in a frequentist context. The resulting R^2 and RMSE values indicated that inclusion of all significant parameters in our model generated the most powerful tool for predicting the sample data without over-parameterizing.

4. To produce a posterior distribution of expected visitation to Joshua Tree National Park, we modeled our selected parameters and distribution in a Bayesian context. Using a Bayesian approach to produce a credibility interval around our visitation estimates gives our model much greater utility and flexibility as compared to a frequentist point estimate coupled with a confidence interval. We ran 4000 iterations of our model and determined the posterior distributions of each of our parameter estimates using Hamiltonian Monte Carlo estimation.

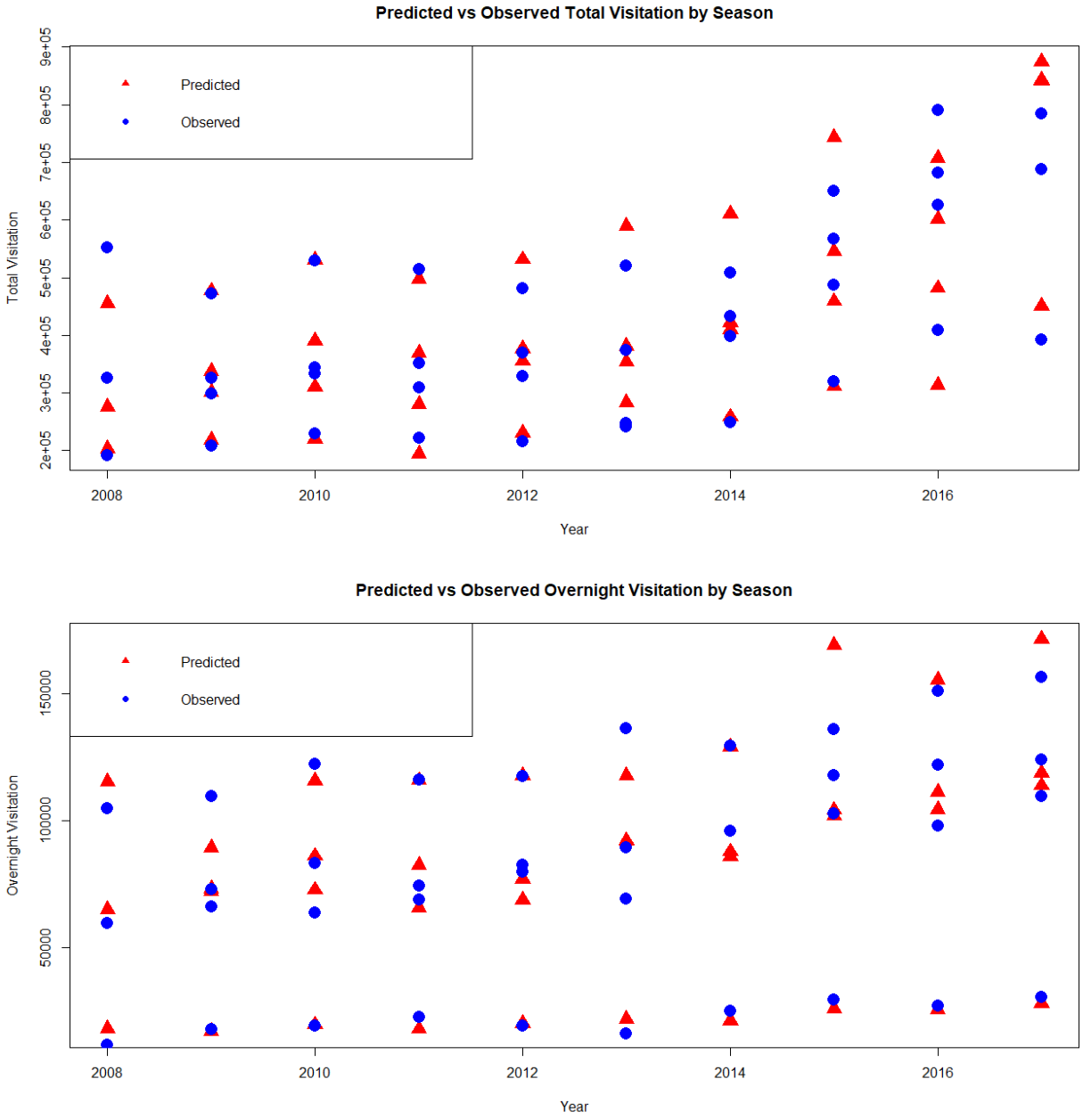

Figure 5A.1. Timeline showing the ability of the described model to predict both total seasonal and overnight seasonal visitation in Joshua Tree National Park.

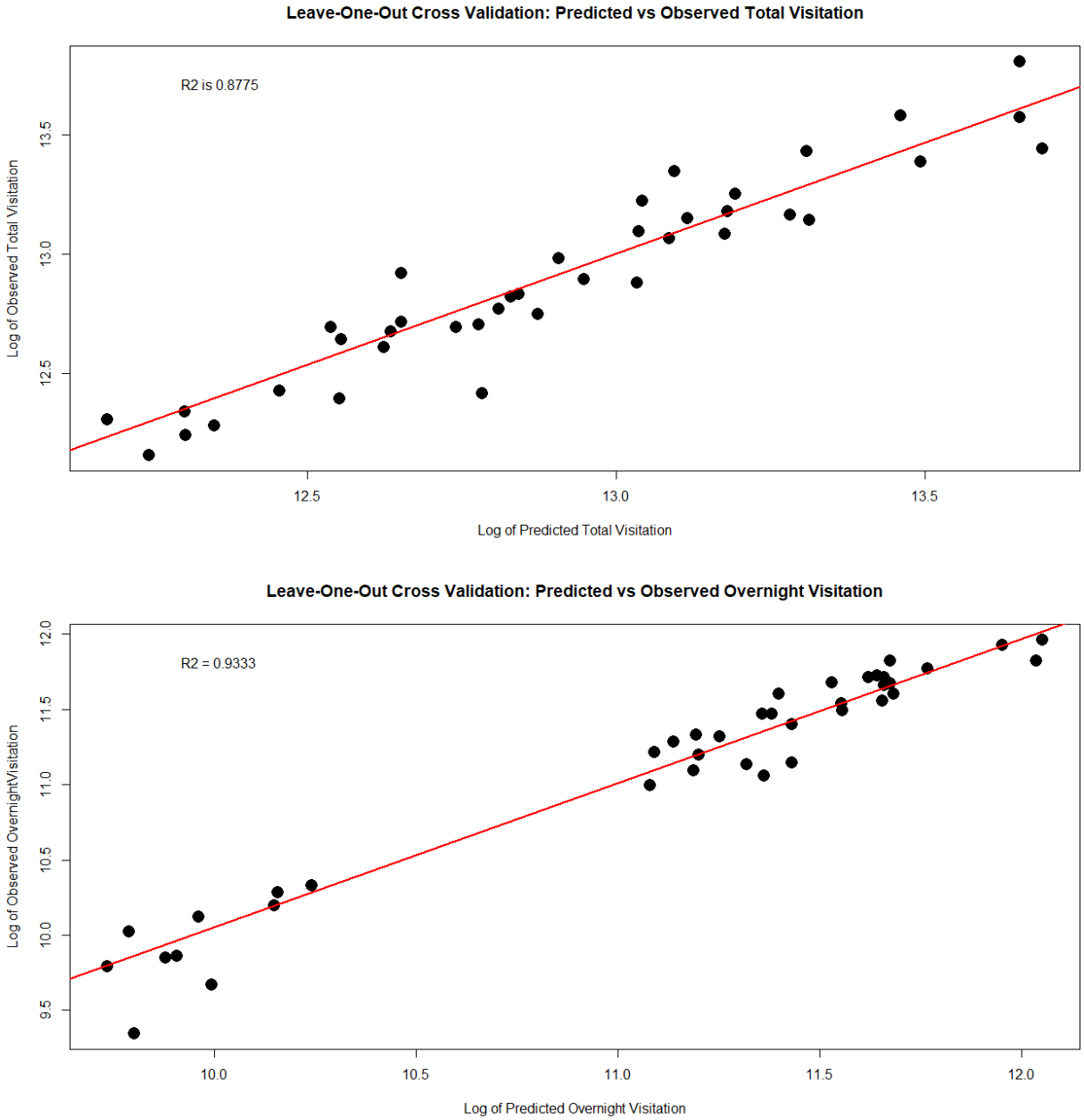

Figure 5A.2. Correlation plots showing the predicted vs. observed values for total and overnight seasonal visitation in Joshua Tree National Park. Axes are logged for visual simplicity.

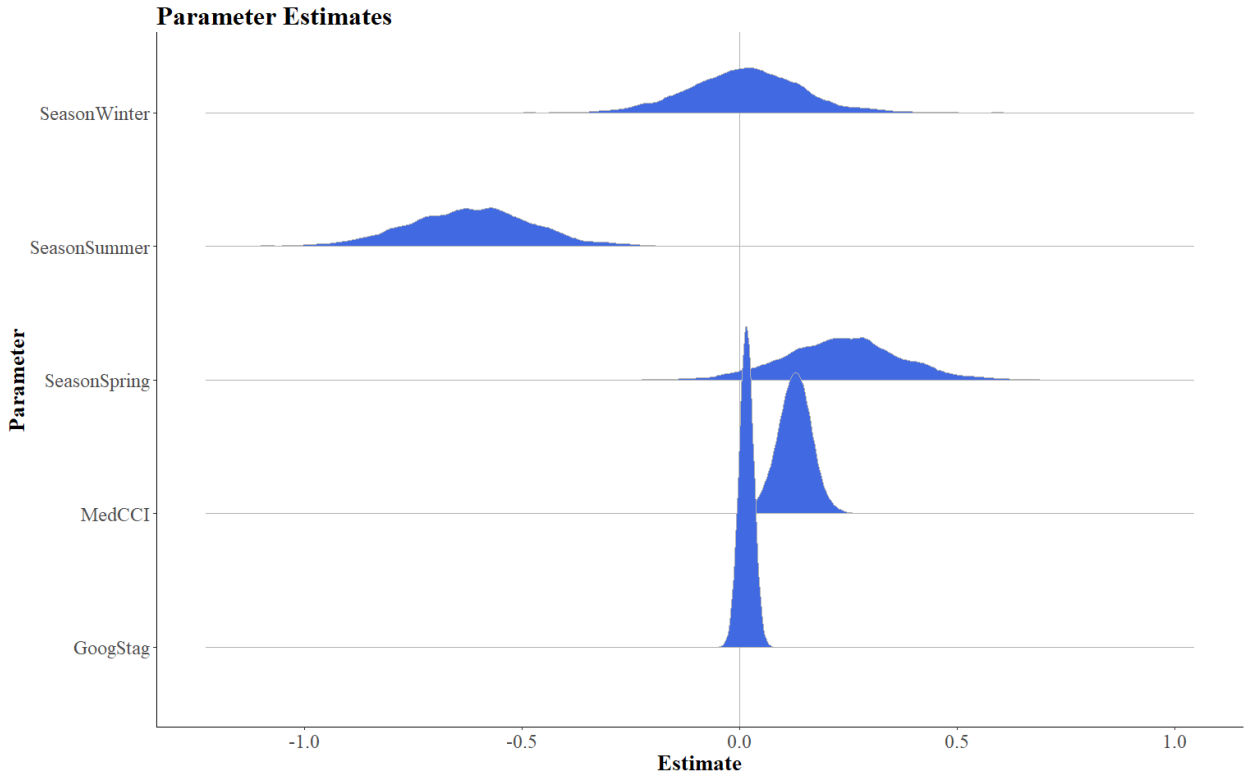

Figure 5A.3: Posterior distributions of the slope estimates for all parameters used to inform our predictive model. "SeasonFall" is used as the intercept for seasonality. Distributions suggest that seasonality and macroeconomic factors most strongly affect visitation to JOTR.

5.2 List of All Additional Management Recommendations

1. Best Practice Brochure/ Tactical emails			
Positive messaging on visitor behavior such as staying on trail and not bringing dogs to prohibited areas.			
Category of Management Action: EDUCATION			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
1.67 - Low	3.22 - Moderate	3.44 - Moderate	1.56 - Low
2. Wilderness signage			
Posted wilderness boundaries so that visitors are aware of where the wilderness areas are.			
Category of Management Action: EDUCATION			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
2.56 - Low	3.56 - Moderate	1.89 - Low	1.89 - Low
3. Positive signage			
Signs encouraging actions such as throwing trash in bins rather than signs discouraging littering.			
Category of Management Action: EDUCATION			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
1.67 - Low	2.22 - Low	1.78 - Low	1.33 - Low
4. Events / Training / Collaborations			
Engaging non-National Park Service Key community members and players.			
Category of Management Action: EDUCATION			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.56 - Moderate	2.56 - Low	6.22 - High	2.22 - Low
5. Proactively engage specific user groups			
One example would be engaging the climbing community in Joshua Tree.			
Category of Management Action: ENGINEERING EDUCATION ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.00 - Moderate	3.63 - Moderate	5.00 - High	1.88 - Low
6. Engaging inholding company's marketing campaigns			
Create joint messaging campaigns with concessioners such as Xanterra in Death Valley.			
Category of Management Action: EDUCATION			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.22 - Moderate	3.00 - Moderate	5.78 - High	2.78 - Low

7. Stipends for volunteers			
Paid climbing stewards to oversee best practices in the popular climbing areas and campgrounds.			
Category of Management Action: ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
2.78 - Low	3.56 - Moderate	4.56 - Moderate	2.56 - Low
8. Roving rangers on trails			
Increased staff on trails to monitor off-trail use and prohibited activities.			
Category of Management Action: ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
2.89 - Low	3.78 - Moderate	2.00 - Low	2.11 - Low
9. One-way road through JOTR to control flow of traffic			
Would consolidate all visitors to one entrance station.			
Category of Management Action: ENGINEERING			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
4.00 - Moderate	5.11 - High	4.44 - Moderate	5.56 - High
10. Improve / increase signage on Highway 62			
Help to inform visitors of where main entrances and visitor centers are located.			
Category of Management Action: ENGINEERING EDUCATION			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
2.11 - Low	3.00 - Moderate	3.33 - Moderate	1.67 - Low
11. 1 car in 1 car out threshold for park			
Category of Management Action: ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.89 - Moderate	4.78 - Moderate	3.67 - Moderate	5.78 - High
12. Discounted fees for bikes and walk-in visitors			
Discounts to encourage visitors to not drive cars into the park.			
Category of Management Action: ENGINEERING EDUCATION ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
2.89 - Low	3.22 - Moderate	3.67 - Moderate	3.33 - Moderate

13. Joshua Tree: New trails in high use climbing areas			
New trails to popular climbing locations for social trail mitigation.			
Category of Management Action: ENGINEERING			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.11 - Moderate	3.89 - Moderate	2.89 - Low	3.33 - Moderate
14. Mojave Preserve: Boulders along major roads + OHV access points			
To block off-road use and side of road parking.			
Category of Management Action: ENGINEERING			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
2.89 - Low	3.56 - Moderate	2.00 - Low	2.78 - Low
15. Parking permits			
For JOTR popular day use areas.			
Category of Management Action: ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.56 - Moderate	4.11 - Moderate	2.78 - Low	5.00 - High
16. Campground reservations			
At all JOTR campgrounds and possibly popular DEVA campgrounds.			
Category of Management Action: ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
2.33 - Low	3.33 - Moderate	3.44 - Moderate	4.44 - Moderate
17. Periodic closures of certain areas			
Closure of sensitive areas during specific times and seasons to mitigate visitor use impacts.			
Category of Management Action: ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
4.00 - Moderate	4.00 - Moderate	3.89 - Moderate	5.22 - High
18. Personnel: Prioritize efforts to increase compliance			
Hiring more law enforcement rangers.			
Category of Management Action: ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.44 - Moderate	3.00 - Moderate	2.11 - Low	3.22 - Moderate

19. Identify explicit desired conditions			
Category of Management Action: ENGINEERING EDUCATION ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
2.78 - Low	2.56 - Low	3.22 - Moderate	2.22 - Low
20. Using forecasting modeling output in conjunction with visitor use management strategies			
Category of Management Action: ENGINEERING EDUCATION ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.11 - Moderate	2.89 - Low	1.89 - Low	2.22 - Low
21. Identify strategies for dealing with the approaching universal satellite internet connections			
Category of Management Action: ENGINEERING EDUCATION ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
4.00 - Moderate	3.44 - Moderate	3.11 - Moderate	2.11 - Low
22. Identify visitor # threshold for safe ambulance access to NPS units			
Category of Management Action: ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.97 - Moderate	3.00 - Moderate	3.11 - Moderate	3.44 - Moderate
23. Capacity thresholds (staffing, enforcement, etc.)			
Category of Management Action: ENGINEERING EDUCATION ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.33 - Moderate	3.44 - Moderate	3.11 - Moderate	4.11 - Moderate
24. Cognitive mapping of parks as individual and integrated systems			
Category of Management Action: ENGINEERING EDUCATION ENFORCEMENT			
Issue Uncertainty	Impact Risk	Stakeholder Involvement	Level of Controversy
3.63 - Moderate	3.13 - Moderate	3.25 - Moderate	1.75 - Low