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Evaluation of Potential Economic Impacts Associated with the Proposed Arches National Park Reservation System

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prepared for:

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INTRODUCTION AND SUMMARY OF OPINION

Under contract to the National Park Service (NPS), I was asked to undertake an evaluation of potential economic impacts associated with the proposed advance reservation system ("system") at Arches National Park (ARCH) using existing data and information. I am a Principal with Industrial Economics, Inc. (IEc), an economic and public policy consulting firm located in Cambridge, MA. Under my direction and supervision, Jacqueline Willwerth and Alison Surdoval, a Senior Associate and Research Analyst with IEc, respectively, provided technical and administrative support in the preparation of this report. The opinions presented here are based on my professional experience and the data and information described herein. My resume is attached as Appendix A.

Through in-person meetings, interviews, and conference calls, I understand that Moab residents, proprietors, and other tourism-related interests are concerned that the system may result in substantial negative economic impacts to the area. These impacts would be driven by discouraged visitation to ARCH and manifest in reduced revenues, employment and investment in Moab. I also understand that some stakeholders feel that the system is necessary and appropriate, and would be unlikely to cause such impacts.

Because there is no precedent for a system like this at a similar park unit, I take a "weight of evidence" approach in developing my opinions. That is, I collected as much data and information as possible on instances where NPS units (or other parks) implemented a change in access management or policies in order to alleviate congestion. While they are all qualitatively different circumstances, as I describe in Section VI, they may be similar in an economic sense in that they created uncertainty that in turn affected visitation.

Based on these analyses, relevant literature, and professional judgment, it is my opinion that visitation to ARCH may be reduced by five to ten percent of what it otherwise would be during the first year that a system is implemented. This is equivalent to a reduction in total 2019 visits that falls between 2017 and estimated 2018 visitation, if the system were implemented next year. Relying on NPS estimates of ARCH visitor spending, this could result in a reduction in spending of $11 to $22 million relative to what otherwise would be predicted in that first year, which in turn could reduce overall output, employment, wages, and tax receipts through associated multipliers.

Separately, representatives from the International Inbound Travel Association Board (IITAB) have suggested that regardless of whether a system is implemented next year or not, there will likely be a reduction in foreign bus tours booked due to concerns about the system.

Available information and data are insufficient to predict whether and to what extent impacts would occur in subsequent years. However, I expect that after a full year of implementation, commercial operators and individuals would better understand and adapt to the system, and that visitation would revert to what it would otherwise be under the system by year three.

There are a number of important caveats and uncertainties associated with these estimates. Foremost is that they are based solely on existing data and information regarding imperfect analogies. In addition, they do not account for the potential to mitigate impacts through additional education and outreach regarding the proposed system.

I. INFORMATION RELIED UPON

On March 21 – 23, I visited Moab to meet with representatives from ARCH, tour the Park, and conduct a series of group and individual meetings with various stakeholders. In addition to information gathered during these meetings, I relied upon the following sources:

- The NPS Traffic Congestion Management Plan Environmental Assessment released in October 2017 (hereafter "EA");
- Reports and published literature on recreational behavior and congestion management;
- ARCH visitation data and visitor survey information;
- Visitation data from several other NPS units available at https://irma.nps.gov/Stats/;
- Visitation to other sites in the Moab area provided by the Bureau of Land Management (BLM);
- Additional publicly-available data on weather and additional factors potentially relevant to ARCH visitation; and,
- Data on historical Moab area hotel occupancy and demand acquired from STR, Inc. (https://www.str.com/).

II. ORGANIZATION OF REPORT

This report contains seven main sections, as summarized below:

- First I discuss the standard economic framework for assessing impacts (both negative and positive) of a change in natural resource management such as the proposed system.
- Next, I describe our approach to estimating future visitation to ARCH without a system that will be compared to predictions of changes that may occur with the system.
- Third, I discuss the connection between ARCH visitation, and Moab visitation and economic activity.
- Fourth, I describe the mechanisms by which I believe visitation to ARCH and Moab may be affected if the system is implemented.

- Fifth, I present a series of statistical models that examine the relationship between visitation to parks and changes in access management or policies.
- Sixth, based on these analyses, I provide a range of predicted changes in ARCH visitation and associated changes in spending within the local economy.
- Finally, I describe important caveats and uncertainties associated with those estimates.

III. ECONOMIC IMPACTS

The system is designed to alleviate congestion, and in so doing may enhance visitor experience and increase the economic *value* of trips to ARCH. Some existing studies have examined the increase in trip value associated with reduced crowding (e.g., see Siderelis et al. 2000); however, none are sufficiently comparable to support an estimate of the potential change in value associated with the system. Such an analysis would likely require the conduct of a primary study.

In addition to potentially increasing the value of trips by improving visitor experience, the system may actually increase the likelihood that certain individuals visit the Park because it guarantees entry for a given date and time for advance reservation holders, and would likely reduce wait times at the entrance.[1]

Alternatively, the system may discourage some visitors from taking trips because of uncertainty associated with gaining entry to the Park. If fewer trips are taken to Moab as a result, there will be implications in terms of regional economic activity due to reduced visitor spending. It is important to distinguish between these two categories of impacts- economic value versus expenditures.

The economic value of a park visit is measured by what an individual is willing to pay for that experience above and beyond what they are required to spend to participate (i.e., travel, lodging, entry fees, etc.). Referred to as consumer surplus, it is the appropriate measure to characterize changes in recreational opportunities that do not have market prices, and is regularly applied in benefit-cost analysis and natural resource damage assessment.[2] The relationship between expenditures and consumer surplus is illustrated in Exhibit 1.

Exhibit 1 depicts a hypothetical individual's demand curve for visits to a park- that is, what they would be willing to pay for different numbers of trips over a given time period. The downward slope reflects the conventional notion that the lower (higher) the cost per trip, the more (fewer) trips an individual will take. As shown, at a cost per trip of $15, the individual would take 10 trips. Additional trips at that price would exceed what the

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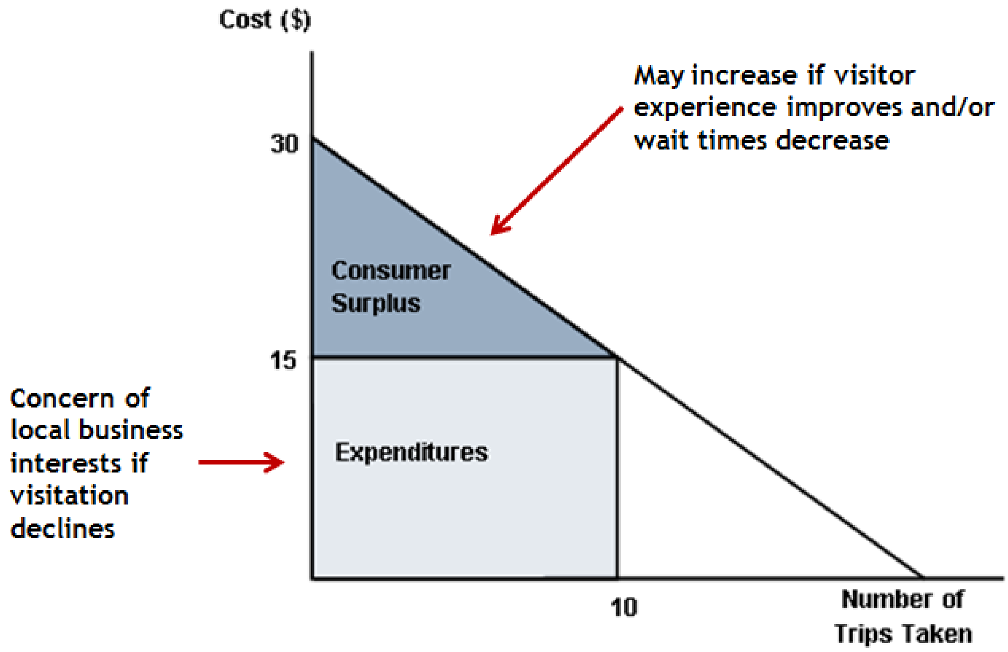
[1] Based on conversations with NPS I understand that on Memorial Day weekend this year the Park closed the entrance and turned cars away due to congestion conditions on Saturday and Sunday. Going forward this is a management action that the Park would likely need to implement more frequently as visitation grows.

[2] For example, see U.S. Environmental Protection Agency's Guidelines for Preparing Economic Analyses (2014), Office of Management and Budget's Guidance on Development of Regulatory Analysis (Circular A-4, 2003), and U.S. Department of the Interior Natural Resource Damage Assessment Regulations (43 CFR Part 11).

individual is willing to pay. The individual's total expenditures for these 10 trips is equal to the area of the rectangle labeled "Expenditures," or $150 ($15×10). For each trip leading up to 10, the individual's willingness to pay exceeds the cost per trip. The area of this triangle, labeled "Consumer Surplus," represents surplus value that accrues to the consumer, in this case $75 [½×10×(30-15)].

EXHIBIT 1. DEMAND FOR TRIPS TO A NATIONAL PARK (ILLUSTRATIVE ONLY)



If the quality of a park trip increases, in this case due to reduced congestion and perhaps reduced wait times at the Park entrance, the amount that visitors would be willing to pay for trips may increase, and in turn the value of those trips.

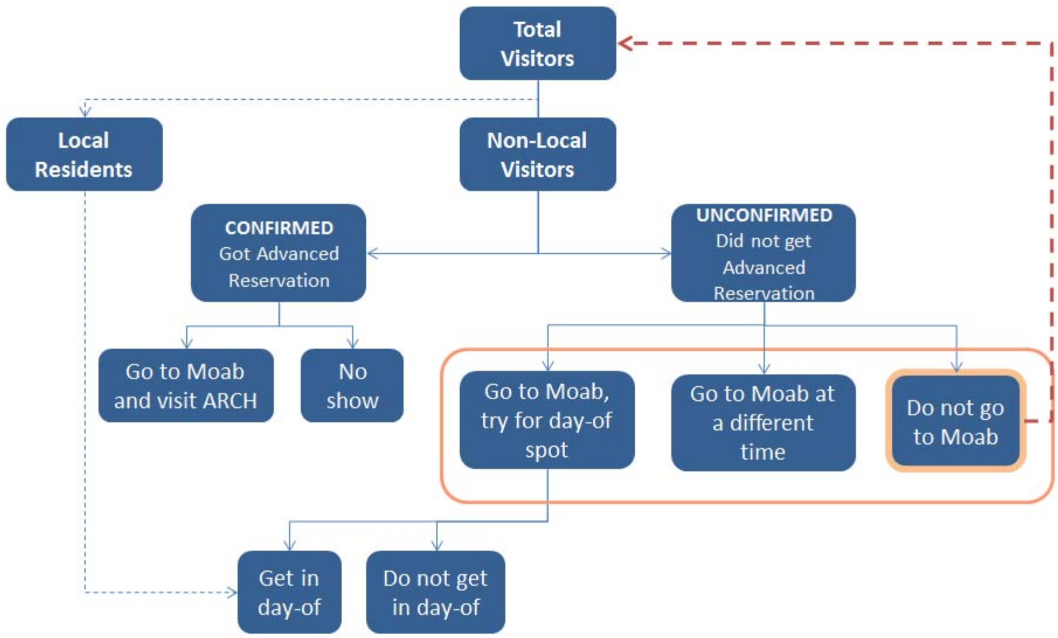
If potential Moab visitors are discouraged by the system, these individuals may not change their spending behavior. Expenditures may simply be diverted to alternative areas or activities. In this manner, changes in consumer surplus represent a net change, while changes in expenditures are typically considered a redistribution. However, within a regional economy (in this case the City of Moab and Grand County), the level of expenditures affects revenues, employment, and tax receipts, all of which are of concern to proprietors, residents and local officials.

To estimate potential regional economic impacts associated with a change in ARCH visitation we conduct a variety of statistical analyses to examine the impact of changes in NPS unit access and management. Based on these I provide an estimated range of changes in visitation, and in turn, reductions in visitor spending within the Moab region.

Exhibit 2 below provides a conceptual model of the distribution of ARCH visitors and the particular segment of interest for our analysis.

For purposes of this economic analysis, we are not directly concerned about local residents. While local residents' access to ARCH will be affected by the system, they are best positioned to adjust their use of the Park and/or take advantage of the set aside day of/before reservation slots. More importantly, local residents will continue to make purchases of goods and services within the Moab area regardless of whether the system is implemented or not.

EXHIBIT 2. ARCH VISITOR CLASSIFICATION



Of the non-local visitors we are most concerned with those that do not access the reservation system in advance and do not visit Moab. These represent individuals from outside the local economy that would otherwise be contributing through expenditures on food, lodging, and other tourism-related activities. It is also possible that some decreased visitation would be attributable to potential visitors that utilize the system and reserve multiple slots to provide flexibility in travel plans but ultimately only visit once (or something less than the number of reserved slots), thereby holding a slot that otherwise could have been filled by a different visitor.[3]

IV. FUTURE VISITATION WITHOUT A RESERVATION SYSTEM

Prior to considering how the system may affect visitation, it is necessary to estimate what ARCH visitation would be in the future absent the system. This is what is referred to in policy analysis as the "baseline" and may be thought of as the "but-for" or "business as usual" scenario. To estimate ARCH visitation in 2018 and 2019 we project growth

[3] Based on conversations with NPS I understand that the Park intends to track 'no-shows' and may adjust the number of day of/before reservations based on the initial rates, thereby mitigating some of these potential impacts.

according to the average monthly growth between 2013 and 2015, taking into account constraints imposed by Park carrying capacity (our carrying capacity analysis and results are described in Appendix B). We exclude 2016 because that was the NPS Centennial and there was a variety of publicity and special programming that may have encouraged visitation above what would otherwise be expected.[4] Similarly, we do not include 2017 because that was the year of the re-paving project throughout the Park that involved nighttime closures. Utilizing these assumptions our predicted 2018 non-local visitation is 676,249 vehicle entrances (a 6.7% annual increase) and our predicted 2019 visitation is 705,535 vehicle entrances (a 4.3% annual increase over 2018).[5]

V. CONNECTION BETWEEN ARCH AND MOAB VISITATION

Many stakeholders in Moab believe that ARCH is the principal reason that visitors come to the area. Alternatively, others point out that Moab offers draws that are unrelated to the Park, such as extensive mountain biking and off-road vehicle recreational opportunities. In this section we present several basic analyses to investigate the relationship between visitation to ARCH and visitation to the Moab area in general.

First, it is natural to ask what the correlation is between ARCH visitation, visitation to other area recreational sites, and a measure of visitor activity in the City. Correlations measure the degree of association between two variables. A correlation of “1” means that the two variables move in lockstep. In the correlation matrix below in Exhibit 3 the off-diagonal elements indicate the correlation between monthly ARCH visitation, visitation to BLM recreational areas, Canyonlands National Park (CANY) visitation, Dead Horse Point State Park visitation, and finally “hotel demand”. Hotel demand reflects the number of room-nights sold in a month at all lodging in the Moab area.

EXHIBIT 3. CORRELATIONS WITH ARCH VISITATION

	ARCH	BLM	CANY	DEAD HORSE POINT	HOTEL DEMAND
ARCH	1				
BLM	0.9716	1			
CANY	0.9781	0.9567	1		
DEAD HORSE POINT	0.9364	0.9629	0.9057	1	
HOTEL DEMAND	0.9529	0.9239	0.8934	0.8933	1

[4] https://www.nps.gov/subjects/centennial/nps-centennial-programs.htm

[5] Annual vehicle visitation accounts for non-Moab residents only. According to the 2003 ARCH Visitor Survey, Moab residents constitute one percent of ARCH visitors (Meldrum et al. 2004).

Not surprisingly, all of these correlations are quite high. For example, the correlation between ARCH visitation and CANY visitation is 98%, and the correlation between ARCH visitation and hotel demand is 95%. These figures indicate that in months when visitation is higher at ARCH, it is also higher at the other sites, and there is more demand for hotel rooms. However, these figures do not imply causality. That is, we are particularly concerned with the effect of ARCH visitation on hotel demand, for example. In order to identify a causal relationship, a directional model such as an ordinary least squares (OLS) regression must be estimated. A very simple model would be to estimate hotel demand as a function of ARCH visitation. However, that model suffers from a form of endogeneity because the causality could go in either direction. Instead, some additional control or treatment is required. In the case of ARCH there are two events that can be leveraged to establish a relationship between visitation and lodging demand: 1) the October 2013 Federal Government shutdown; and, 2) the 2017 resurfacing, restoration and rehabilitation (3R) project. In the case of the former, the Park was closed from October 1st to the 10th. For the latter, the Park was closed from 7pm to 7am on weekdays between the months of March and November.

We developed four regression models to investigate the relationship between the shutdown and 3R and hotel demand and occupancy.[6] Hotel occupancy is the percent of total Moab-area rooms filled. Ten years of monthly data were used to specify a model where occupancy is a function of an annual time trend, weather (the monthly average of daily deviations from average temperature), binary variables to capture monthly (seasonal) variation in visitation, and a binary variable for October 2013 when the shutdown occurred. Estimation results for all models in the report are presented sequentially in Appendix C.

This first model suggests that occupancy in Moab was approximately three percent less than what otherwise would be expected during the shutdown month.[7] That estimate is statistically significant at the .01% level. A similar model was estimated using the natural log of hotel demand on the left-hand side.[8] Again, hotel demand reflects the number of room-nights sold in a month at all lodging in the Moab area. This model also indicates a statistically-significant, negative effect during the shutdown month, in this case on the order of seven percent.[9] In both models all other coefficients are significant and of the expected sign- the time trend is positive, the temperature deviation coefficient is positive (warmer than average shoulder or winter months increase visitation), and visitation is

[6] All models were estimated using the STATA v.12 statistical package. All models rely on time series (monthly or daily) data on visitation and/or lodging demand and therefore are likely to exhibit serial correlation, which alters the standard errors of coefficients, potentially leading to incorrect inferences. As such, all models are estimated using Newey-West standard errors that are robust to serial correlation (Wooldridge 1999).

[7] See Appendix C-1 for Hotel Occupancy and Government Shutdown model results.

[8] See Appendix C-2 for Hotel Demand and Government Shutdown model results.

[9] In this and all subsequent models where the dependent variable is a natural log, coefficients may be interpreted as the approximate percentage change in the dependent variable for a unit change in the independent variable. The exact change is given by: $\%\Delta = 100\ [e - 1]$ (Wooldridge 1999).

higher (lower) in the peak (off-peak) season. While these results are suggestive of a relationship between ARCH and Moab visitation, they are not conclusive, as other area sites like CANY and BLM campgrounds were also closed during some portion of the shutdown.

A more direct model investigates the relationship between the 3R period, which is unique to ARCH, and hotel occupancy and demand.[10] These models were estimated using the same data and specification, here including a second set of monthly binary variables to denote the 3R period. In the hotel occupancy model there are positive and significant coefficients on the 3R months of March, April, October and November on the order of three to four percent (the intuition behind this positive impact will be discussed in Section VII). There are negative coefficients on the 3R months of June, July and August, though only the July coefficient is statistically significant and is small numerically (~ 2%). The corresponding hotel demand model exhibits a similar pattern of signs and significance. In this model the 3R July coefficient is also the only negative coefficient significant at conventional levels, and is approximately four percent in magnitude. The interpretation of these coefficients is: controlling for other factors, how was monthly visitation different during 3R relative to those same months in the past? An interpretation of the negative effect is that, regardless of whether the 3R restrictions would actually affect a given visitor, a small percentage of visitors avoided the Park during those months anticipating some potential impact on their trip.

Taken together, these analyses not surprisingly indicate a connection between ARCH visitation and measures of demand/activity in Moab. However, none are sufficient to support a specific estimate of exactly how much less activity would occur if ARCH alone was for some reason inaccessible for a period of time.

VI. PROPOSED SYSTEM AND UNCERTAINTY

From my in-person discussions and subsequent interviews/calls, I understand that there is a diversity of perspectives on the potential impact of the system. These range from concerns that it will reduce ARCH visitation to such an extent that Moab will be fiscally bankrupt, to beliefs that any effect on visitation will be negligible.

To my knowledge, the only quantitative assessment of potential impacts appears in the EA. This approach takes the perspective of "what might happen if the system was in place and visitation was identical to 2016?" Looking at that pattern relative to the proposed quotas, the EA concludes that only 3.2 percent of total vehicle entrances would be displaced (p.30). The difficulty with this approach is that it implicitly assumes that potential visitors would behave similarly whether a system was in place or not. In reality, the system alters the ways that potential visitors may plan, organize and execute their travel/trips.

[10] See Appendix C-3 and C-4 for Hotel Occupancy/Demand and 3R model results.

The planning process, proposals, and speculation regarding a reservation system may be thought of as creating *uncertainty*. Broadly speaking, the system is akin to a new regulation that has the potential to impact consumers (individual visitors) and producers (operators) alike. There is a substantial literature on the economic impacts of regulatory uncertainty. Policy uncertainty has been found to foreshadow macro-level declines in investment, employment, and growth (Baker et al. 2012, 2016). At the firm-level, Baker et al. (2016) found that policy uncertainty is responsible for stock price volatility, reductions in investments, and reductions in employment, particularly in policy-sensitive sectors. For example, Fabrizio (2012) demonstrates that regulatory uncertainty negatively impacts firms' investments in renewable energy assets. A study examining economic recovery after the 2009 recession demonstrates that policy uncertainty hampers economic recovery by reducing businesses' and individuals' spending, investment, and hiring (Baker et al. 2012). Uncertain environmental regulations are found to cause negative economic and environmental impacts- regulatory uncertainty regarding CO_2 emission regulations has resulted in elevated electricity costs and increased emissions (Patino-Escheverri 2008). Even uncertainty that is potentially beneficial can have a negative impact on economic indicators such as wages and employment (Lennon and Sobel 2017).

Regardless of whether the parameters of the system are designed to accept all potential visitors, it nonetheless creates uncertainty that may discourage some visitation by tour operators ("operators"), foreign tourists, and the general public for several reasons:

- Awareness and understanding- individuals and operators may not avail themselves of information about how the system works and why it is being implemented, and instead rely on second-hand interpretations that may be inaccurate.
- Proper functioning- operators in particular may not have confidence that the system will be implemented, managed and maintained properly.
- Financial risk- under consumer protection laws, operators that do not provide all elements of a given itinerary may be financially liable and as such, any risk of not gaining access to ARCH may be sufficient to alter traditional schedules.

VII. BASIS OF OPINION

Within the resource economics field there are well-established models used to estimate how visitation may change in response to changes in the attributes of a recreational site (e.g., see texts by Phaneuf and Requate 2017, Champ et al. 2017 and Freeman et al. 2014). These models rely upon data typically collected through mail, phone, or in-person surveys and require significant time and resources to develop. Very recently social scientists have begun to try to leverage mobile phones as an efficient means to collect data on consumer choices and behavior through the use of anonymous, opt-in applications. For example, Athey et al. (2018) use data on over 100,000 lunch visits collected in this manner to estimate how consumers respond when restaurants open or close in the San Francisco Bay Area.

As noted, my opinion is based on consideration of existing data and information. Ideally, one would look to a similar situation as a proxy for estimation of potential impacts at ARCH. However, a system of this nature has not been implemented at an NPS unit with similar attributes. In lieu of a natural analogy, I adopt a "weight of evidence" approach that involves three principal elements:

- Literature searches and a review of studies that have examined, generally, congestion management at National Parks;
- A suite of statistical analyses that examine the extent to which changes in access policies at other NPS units resulted in changes in visitation; and,
- Similar statistical analyses, including an example from ARCH, that investigate the extent to which visitors may alter the timing of their trips in response to changes in access policies.

Each of these is discussed in turn below.

LITERATURE REVIEW

A review of literature relevant to congestion at National Parks suggests that visitors are typically supportive of alternative transportation systems (ATS), particularly shuttle buses, but prefer personal vehicles for transportation within parks (Dilworth 2003, Pettebone et al. 2011, Taff et al. 2014, White et al. 2006, White 2013). Few studies examine visitor perceptions of reservation systems, and results generally indicate that visitors are not particularly supportive of day-use reservation systems for vehicles or timed park entry (RSG 2017, White 2013). Several authors suggest that crowding is a negative and subjective perception of use levels and that these perceptions can be used as a standard of quality in determining social carrying capacity of a park (Graefe et al. 1984, Gramann 2002, Manning et al. 1996, Manning et al. 2000, Manning 2001, Manning et al. 2014, Manning et al. 2017, Vaske and Shelby 2008). Further, some studies found evidence of displacement (when a visitor stops using a resource due to perceptions of crowding) at NPS units. In some cases, visitors are displaced to less-popular recreation sites; while in other cases, displaced visitors are replaced by more crowd-tolerant visitors (Graefe 1984, Gramann 2002). Overall, few studies have examined the impact of vehicle reservation systems on transportation and crowding management.

MODELS OF VISITATION AND ACCESS POLICY CHANGES

We identified every instance possible where an NPS unit, or other significant park, had implemented a change in access policy and maintained data suitable to support a before/after analysis of visitation. These included both shuttle and reservation systems, as summarized below:

- **ROMO-** Rocky Mountain National Park was the first park to introduce an ATS in the form of a shuttle bus in 1978. In 2001, the Park greatly expanded the shuttle system to include 10 buses and three routes along Bear Lake Road. The shuttle is free and voluntary, operating during the peak season from late May to early October (Pettebone et al. 2011, Rocky Mountain 2018).

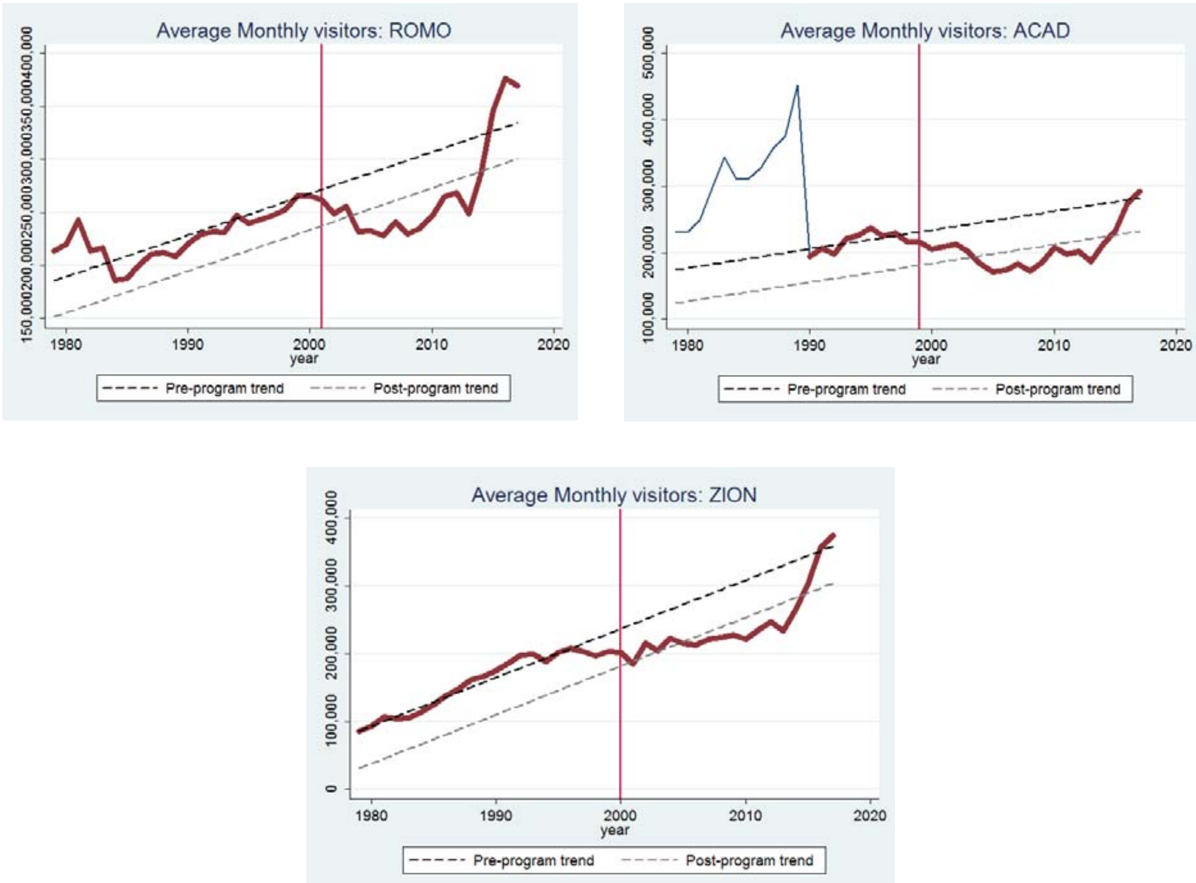
- **ACAD-** Acadia's Island Explorer Shuttle operates during the peak season from late June to early October each year. The shuttle service began in 1999 with six shuttles and has since expanded to 17 shuttles. The service is free and voluntary, delivering both park visitors and residents to park destinations, local communities, and the nearby airport (Acadia's Island Explorer Shuttle).
- **ZION-** Zion National Park implemented a shuttle bus system in 2000 to alleviate traffic congestion and parking issues, protect natural resources, and restore a sense of tranquility in the park. The shuttle is free and runs from March through October, during which Zion Canyon Scenic Drive is closed to private vehicles and can only be accessed by shuttle, bicycle, or foot (Zion 2018).
- **YOSE-** Yosemite National Park implemented a pilot day use parking reservation program for select summer weekends in 2016 and 2017. By only offering reservations for 150 parking spots in Yosemite Valley, the program was designed to guarantee parking for visitors who secure reservations while not affecting visitors entering the Park without a reservation. Reservations cost $1.50 each and were available only to cars, not RVs. Unreserved spots were available on a first-come, first-served basis, like all other parking spots in Yosemite Valley. In 2016, reservations were held until 11am, and in 2017, reservations were held until 4pm (Yosemite 2016, Yosemite 2017).
- **MUWO-** In January 2018, Muir Woods implemented a timed-entry reservation system requiring both personal and commercial vehicles entering the Park to obtain a reservation. For $8, individuals can reserve a parking space up to 90 days in advance. A limited number of spots are held for week-of reservations. Visitors may purchase same-day reservations if spots are available, but they must make the reservations on-line as reservations are not sold at the Park. Alternatively, visitors can reserve a spot on the Muir Woods Shuttle for $3. In addition to the reservation fee, visitors pay the entrance fee upon entry to the Park. Commercial carriers are also required to obtain reservations for designated commercial use parking spots (Golden Gate 2015, Muir Woods 2018)
- **ALCA-** To visit Alcatraz Island, visitors are required to secure ferry reservations. Reservations include a ferry ticket and park entry, costing between $38 and $90 depending on the tour. Reservations can be made up to 90 days in advance. Visitors may purchase same-day tickets in person at the pier if they are available, but no reservations are reserved for day-of purchase (Alcatraz Island 2017). A new concession contract in 2006 established these specific reservation requirements. We were unable to confirm the nature and extent of requirements under the previous contract, but assume for purposes of our analysis that the 2006 change is operative.
- **Baxter**- Since 2010, Baxter State Park has required day use parking reservations at the three trailheads used to access Mount Katahdin, the highest peak in the state of Maine (and the terminus of the Appalachian Trail, a NPS unit). Maine residents are permitted to reserve spots after April 1 for any day in the summer; non-Maine residents can reserve spots up to two weeks in advance. Each reservation costs $5,

and individuals are not permitted to make more than three reservations per month. Reservations are held until 7am, after which parking becomes first-come, first-served. Unreserved spots are filled on a first-come, first-served basis starting at 6am (Baxter State Park).

- **HALE-** Beginning in February 2017, Haleakalā National Park implemented a parking reservation system for sunrise viewing between 3am and 7am. Reservations are required for entry and cost $1.50 each. They can be made up to 60 days in advance, and a small portion is released two days before the day of the reservation. The reservation system caps visitation to 150 visitors per day. In addition to the reservation fee, visitors pay the entrance fee upon entry to the Park. Commercial vehicles are not required to obtain a reservation (Haleakalā 2018).
- **ARCH (Fiery Furnace)-** Visitors are required to obtain permits to hike the Fiery Furnace. Permits can be purchased for $6 up to a week in advance and are only available for purchase in person at the Visitor Center (Arches 2018). The original permit system in March 1995 limited the group size per permit to 25 people but did not limit the number of permits issued on each day. In March 1997, the park limited the number of permits issued each day to 75. While this example is specific to the Park, we note that there are limitations associated with available data that render this example less relevant. Importantly, data are expressed in numbers of permits, not visitors.

Beginning with the shuttle systems, graphs of these visitation data are provided in Exhibit 4 below. In each case these display the average monthly visitation by year (to minimize the influence of missing months of data) and the vertical line indicates when the system was implemented. In the case of ACAD only the post-1990 data are used (corresponding to the bolded segment) as there were dramatic fluctuations in visitation in the preceding decade that may correspond to changes in counting procedures.

EXHIBIT 4. VISITATION DATA FOR SHUTTLE SYSTEM ANALYSES



While visually these graphs may suggest some reduction in visitation in some years following establishment of the systems, a basic statistical analysis is necessary. For each case we estimate simple regression models similar to those described in Section V. Monthly visitation data are modeled as a function of an annual time trend, a binary variable that identifies the post-system period, and a binary variable for 2016 (the year of the NPS Centennial when visitation was likely higher than normal due to advertising, promotions and special programs). In the graphs in Exhibit 4 there are two trend lines added to assist in interpreting the model results. The “pre-program” line describes the trend in annual visitation before the management change and the “post-program” line captures the trend after the management change. The models estimate the percentage change in these lines.

In each of these models the post-system period coefficients are all negative, statistically significant, and imply average percentage reductions in visitation of approximately 21, 13 and 11 percent for ACAD, ROMO and ZION, respectively.[11]

[11] See Appendix C-5 and C-6 for ACAD, ROMO, and ZION model results.

For the reservation systems the ARCH, MUWO, Baxter State Park and ALCA models are all specified in the same manner as the shuttle system models.[12] Across these models the post-system coefficients suggest an almost 40 percent reduction in Fiery Furnace tours in ARCH and an 11 percent reduction in ALCA visitation- both are statistically significant. The post-system coefficient for MUWO is *positive* but insignificant, and that for Baxter is essentially zero and also insignificant. The former result is not surprising given that the MUWO system was only implemented earlier this year.

The YOSE models are slightly different in that these pilot programs were implemented on selected weekends in 2016 and 2017.[13] Thus, the system weekends are compared to those same sets of weekends in the 10 preceding years. Estimation results indicate an approximate 14 percent *increase* in Yosemite Valley visitation for the 2016 program, but a nearly 45 percent decrease for the 2017 program- both coefficients are statistically significant. The intuition behind these contrasting results is that in 2016 one of the two pilot weekends was the July 4 holiday, and likely more importantly, in 2017 the reservations were held until 4pm (versus 11am in 2016), thus occupying a much greater portion of the day when non-reservation visitors might otherwise capture those parking spots.

Finally, no analysis was conducted for HALE because historical visitation data are extremely erratic (e.g., over the 40-year period the mean is 1.2 million and the standard deviation is nearly 350,000) and it is not possible to reconstruct a history of events or changes in conditions that would support an appropriately specified model.

SUBSTITUTION AND ADAPTATION

The EA (p.30) suggests that implementation of the system would shift some visitation that would otherwise occur during peak season to off-peak months. As noted at the beginning of this section, there are standard approaches used to model how individuals make decisions regarding recreational site choices. These models are rooted in the random utility maximization (RUM) framework originally applied in transportation contexts (see McFadden 2001 for a review and summary based on his Nobel lecture) and are also used to examine how individuals make repeated decisions over time. Within the resource economics field, a handful of studies have investigated the notion of "intertemporal substitution." That is, the extent to which individuals may adjust their timing of trips to a site in response to changes in site conditions (e.g., Parsons and Stefanova 2011). Unfortunately these studies offer little insight into the potential for this to occur at ARCH as they consider different circumstances, such as outright closures of a given site.

However, given an extensive dataset on daily vehicle entrances provided by the Park, it is possible to investigate, if indirectly, how changes in access affected the temporal distribution of visitation in the past. As discussed in Section V, the 2017 3R project

[12] See Appendix C-7, C-8, C-9, and C-10 for ARCH, MUWO, Baxter State Park and ALCA model results.

[13] See Appendix C-11 for YOSE 2016 and 2017 model results.

restricted access to ARCH to some degree and was widely publicized.[14] Similar to the lodging analyses, we estimate a model where daily vehicle entrances are a function of an annual time trend, monthly binary variables, and monthly binary variables during the 3R period.[15] In this model there are negative and statistically-significant coefficients on the 3R months of May through September ranging in magnitude from roughly eight to 13 percent. In the 3R months of October and November, however, there are positive and equally significant coefficients that suggest visitation was approximately 30 percent higher than would otherwise have been expected.

I interpret this as direct evidence of some segment of ARCH visitors' temporal substitution of visits in response to an access constraint. In plain terms the intuition behind this result is that some visitors that planned a trip to ARCH in 2017 deliberately targeted the fall months to avoid the combined effect of peak season congestion and potential restrictions associated with the 3R project.[16]

VIII. ESTIMATED IMPACTS

Based on the analyses described in the preceding sections, and my professional judgment, it is my opinion that ARCH visitation may be reduced by five to ten percent in the first year under the system relative to the level that otherwise would be expected (based on past trends and estimated carrying capacity constraints). Given the projection described in Section IV, this implies a reduction in visitation of roughly 35,000 to 70,000 non-local vehicle entrances over the course of the year if the system were implemented in 2019. This is equivalent to an annual figure that lies between 2017 and estimated 2018 visitation.[17] Given the relevant estimate of ARCH trip-related expenditures of $119 (Cullinane and Koontz 2017), and an average party size of 2.6, this implies a potential reduction in revenues within the Moab area of $11 to $22 million relative to what otherwise would be expected. Through estimated multipliers, this in turn implies reductions in overall output, employment and wages.

Available information and data are insufficient to predict whether and to what extent impacts would occur in subsequent years. However, I expect that after a full year of implementation, commercial operators and individuals would better understand and adapt to the system, and that visitation would revert to what it would otherwise be (i.e., no further reductions due to uncertainty) under the system by year three. These projections (assuming that impacts in 2020 are reduced by one-half) are displayed in Exhibit 5 below.

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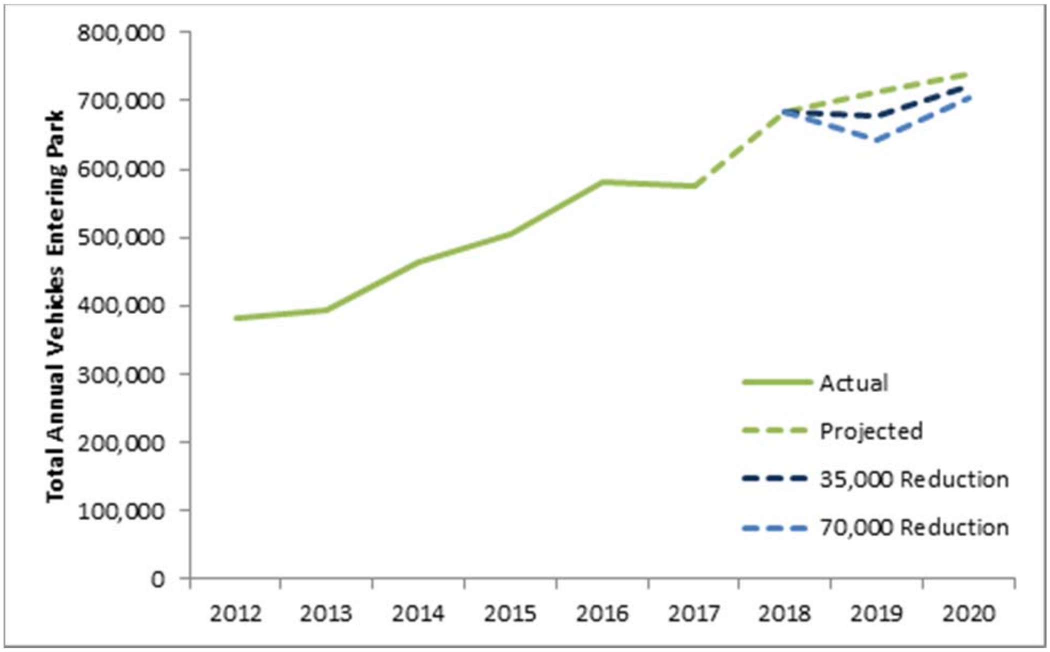
[14] http://moablog.com/wp-content/uploads/2017/04/ARCH-3R-QAs-022317.pdf

[15] See Appendix C-12 for 3R and ARCH visitation model results.

[16] A less relevant, but nonetheless interesting example of short-term substitution is provided by the advance reservation system implemented for Half Dome access in YOSE. In that case reservations could be made up to four months in advance for 400 available weekend and holiday slots. No reservations were required for weekdays, when use was historically low. When implemented, slots sold out very quickly (e.g., all weekends in May and June sold out in five minutes), but there was an approximate 25 percent 'no-show' rate. Of interest, there was a corresponding 75 percent increase in weekday visits.

[17] To be more precise, the figure falls roughly between our prediction of what 2017 visitation would have been without the 3R project (640,310 versus 557,316 actual), and our prediction of 2018 visitation (683,080).

EXHIBIT 5. PREDICTED REDUCTION IN VISITATION (VEHICLE ENTRANCES)



Additionally, I was asked by NPS to consider how my opinion and estimates may change if certain aspects of the system were altered, specifically:

- Having the system operative for six versus eight months;
- Reducing the reservation window from 11 to 9 hours; and,
- Adjusting the ratio of advance versus day of/before slots.

Other than to say that each of these potential modifications may mitigate any reduction in visitation to some extent, available information and data are insufficient to provide a specific estimate.

Finally, as noted, a concern of certain stakeholders is the potential for foreign visitors, and particularly foreign tour operators, to avoid visiting Moab due to the system. As I understand from the EA, the anticipated parameters are set such that nearly every commercial tour that historically accessed the Park would be admitted under the system. However, as described in Section VI, uncertainty and potential financial liability associated with the system may reduce visitation by these groups. In a conference call with members of the IITAB, I was told by two members that they were advising the vendors they work with to drop Moab from their itineraries in 2019 (which were actively being booked at the time).[18]

[18] These IITAB members suggested that there may be a 75 percent reduction in foreign bus tours in 2019. I have no external information to corroborate this estimate. However, if 50 percent of bus entrances are foreign tours, and, as assumed in Section IV that tours in 2019 would increase at the average monthly growth rate from 2013 to 2015, this could imply a reduction of roughly 600 entrances. If the average bus seats 50 individuals, then this implies an additional reduction in Moab visitors of approximately 30,000.

IX. CAVEATS AND UNCERTAINTIES

There are a number of important caveats and uncertainties associated with my opinions as summarized below:

- My analysis and conclusions are based on existing data and information. Because no substantially similar precedent exists, I consider a wide array of different situations and some signals from past events at ARCH itself. Recognizing the uncertainty inherent in drawing conclusions from this approach, I provide a range of potential visitation impacts.
- The reliability of conclusions based on the various statistical analyses presented is contingent upon the integrity of the underlying data sources.
- The estimate of a potential reduction in foreign bus tours is based on a representation from a party that may be adversely impacted by the system.
- Finally, my estimate of impacts is static in that it does not (and is unable to) account for any adaptation that may take place in the weeks or months after a system is implemented that may mitigate total impacts over the course of the season. Similarly, it does not assume that any additional effort is undertaken to reduce the 'uncertainty effect' through outreach and education.

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APPENDIX A: PATERSON RESUME

ROBERT W. PATERSON — PRINCIPAL

Overview

Mr. Paterson's academic training, research, and professional experience focuses on applied economics and econometrics, with an emphasis on environmental and natural resource applications. Mr. Paterson has worked with Industrial Economics, Incorporated for 20 years, providing expert technical support in natural resource damage assessments for state, federal and tribal trustees. In addition, he has led numerous other economic analyses for clients such as the U.S. Fish and Wildlife Service, the U.S. Department of Justice, the National Park Service, the National Oceanic and Atmospheric Administration, Health Canada, the U.S. Environmental Protection Agency, and several private law firms.

Education

Master of Science in Resource Economics and Policy, University of Maine, Orono

Bachelor of Arts, Economics, with Distinction, Colby College

Mr. Paterson is a member of the American Economic Association and the Association of Environmental and Resource Economists.

Selected Project Experience

For the **NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**, leading the final development, implementation and analysis phases of a national stated-preference study designed to estimate the value of ecological and human use losses resulting from the 2010 Deepwater Horizon oil spill.

For the **NATIONAL PARK SERVICE**, designing and implementing a national stated-preference study to estimate the benefits of improved visibility at park units and Class I wilderness areas.

For state and federal trustees, estimated damages to recreational resources resulting from PCB contamination on Lake Hartwell, South Carolina/Georgia, negotiated settlement and developed a Restoration and Compensation Determination Plan.

For a group of private law firms representing the **STATE OF NEW JERSEY**, utilized valuation and equivalency methods to estimate damages associated with MTBE groundwater contamination at sites throughout the state.

For the **ILLINOIS ATTORNEY GENERAL'S OFFICE**, estimated the benefits of improved water quality in Chicago's urban waterway system to support a negotiated rulemaking regarding wastewater disinfection.

For state, federal and tribal trustees, estimated economic damages to recreational and tribal resources resulting from contamination on the lower St. Louis River, Minnesota, negotiated settlement and developed a Restoration Plan.

For the **NATIONAL PARK SERVICE**, estimated the value of recreational and ecological impacts expected to result from an upgraded transmission line traversing the Delaware Water Gap National Recreation Area and the Appalachian Trail.

For the **DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL**, directed a study to measure the value of coastal and inland wetland ecosystem services using integrated ecological and economic models.

Additional examples of Mr. Paterson's project experience include:

Natural Resource Damage Assessment & Environmental Valuation

For the **U.S. Fish and Wildlife Service**, estimated damages associated with fish consumption advisories and avoided stocking activities on the Sheboygan River in Wisconsin due to PCB contamination.

For the **State of New Jersey**, served as co-Principal Investigator for a statewide stated-preference groundwater valuation study.

For the **State of Arkansas**, developed a contingent behavior study to estimate recreational fishing damages resulting from the Mayflower oil spill.

For the **National Oceanic and Atmospheric Administration**, estimated recreational fishing damages associated with fish consumption advisories on the lower Delaware River.

For the **National Park Service**, developed a report describing the likely cultural, historical and recreational impacts associated with a new proposed transmission line traversing the James River adjacent to the Colonial National Historical Park, including a detailed plan for studies that could be conducted to quantify and monetize visitor experience impacts, as well as general population losses.

For the **U.S. Environmental Protection Agency, Office of the Chief Financial Officer**, estimated the recreational and ecological benefits of several American Recovery and Reinvestment Act funded water quality and land cleanup projects.

For the **National Park Service**, leading a stated-preference study designed to estimate the value of reducing noise pollution in park units.

For the **Wampanoag Tribe of Aquinnah**, estimated damages to subsistence and cultural resources associated with the Bouchard oil spill in Buzzards Bay, Massachusetts.

For a private law firm, developed models to estimate residential property value diminution along a dioxin-contaminated floodplain in Michigan.

For the **U.S. Environmental Protection Agency, National Center for Environmental Economics**, conducted parallel hedonic property value and stated-preference studies to estimate the benefits of preventing/remediating releases from underground storage tanks.

For a private law firm, estimated economic damages to commercial lobster fishermen arising from pesticide contamination in Long Island Sound, Connecticut and New York.

For the **National Oceanic and Atmospheric Administration**, led a cooperative process to evaluate recreational resource restoration projects on the Passaic River, New Jersey.

For a private law firm representing the **State of New Jersey**, provided expert support in estimating damages associated with ecological injuries at two large refinery sites.

Provided technical support in estimating economic damages suffered by a class of residential property owners adjacent to an industrial facility in Lakeland, Florida.

Provided technical support in estimating economic damages to property owners associated with emissions from an industrial-scale meat processing plant in Nebraska.

For the **United Nations Compensation Commission**, evaluated natural resource damage claims arising from Iraq's invasion and occupation of Kuwait in 1991.

For the **MISSOURI DEPARTMENT OF NATURAL RESOURCES**, developed a travel cost recreational demand model to estimate losses at a state park compromised by a reservoir breach.

For the **U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF AIR QUALITY PLANNING & STANDARDS**, conducting a hedonic study in 20 cities to estimate the property value effects of urban/residential visibility conditions.

For the **U.S. DEPARTMENT OF JUSTICE**, developed estimates of recreational fishing damages on a contaminated waterway in northeastern New Jersey.

For the **NATIONAL PARK SERVICE**, providing programmatic support to damage assessment efforts under the System Unit Resource Protection Act- including updating internal guidance; establishing best practice methods for valuation/restoration of vegetation injuries, injuries to cultural and historical resources, injuries to paleontological resources, and injuries to wildlife; and, recommending methods for recovery of response/restoration equipment costs.

Estimated economic damages suffered by a class of residential property owners in Brooklyn, New York arising from groundwater contamination and vapor intrusion.

For the **NATIONAL PARK SERVICE**, directed a study of ecosystem services associated with NPS management of the Hetch Hetchy watershed and reservoir.

For the **STATE OF MAINE**, conducted reviews of economic damage determination and proposed restoration actions at a former nuclear power facility and a Superfund site.

For the **STATES OF MASSACHUSETTS AND NEW JERSEY**, developed guidance on groundwater damage assessment.

For the **NATIONAL PARK SERVICE**, assisted in developing a claim for damages to historic landscapes and other park resources at Saratoga National Historical Park, New York resulting from PCB contamination of the Hudson River.

For the **STATE OF NEW MEXICO**, provided technical support in estimating groundwater damages from a Superfund site.

Provided technical support in estimating economic losses associated with groundwater contamination at two sites in the **U.S. VIRGIN ISLANDS**.

Provided technical support in estimating damages to a Rhode Island water district associated with municipal well contamination and closure.

For the **WASHINGTON SUBURBAN SANITARY COMMISSION** and the **NATIONAL PARK SERVICE,** estimated the value of recreational and ecological impacts expected to result from a new water intake project along the Chesapeake and Ohio Canal National Historical Park.

For the **U.S. FISH AND WILDLIFE SERVICE**, developed a comprehensive database of sportfishing valuation literature and conducted meta-analyses of estimated values.

Provided technical support in estimating economic damages suffered by a class of residential property owners in Lisle, Illinois associated with groundwater contamination.

For the **U.S. DEPARTMENT OF JUSTICE** and other federal agencies, provided technical support in estimating groundwater damages at former military sites in Rhode Island, Ohio, Colorado and Minnesota.

Developed models to estimate economic damages to a class of private property owners adjacent to a refinery site in southwestern Illinois.

Developed preliminary estimates of damages to recreational resources at several additional sites, including the Shenandoah River, Virginia; TVA/Kingston plant, Tennessee; Southeast Lead Mining District, Missouri; Richland, Clear and Salt Creeks, Indiana; Oak Ridge Reservation, Tennessee; Jamaica Bay, New York; St. Lawrence River, New York; and the White River, Indiana.

Regulatory & Other Economic Analyses

For the **NATIONAL PARK SERVICE**, conducted a cost-benefit analysis of a proposed commercial fishing management plan at Biscayne National Park.

For the **OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT,** directed analyses of changes in stream water quality and other ecological services expected to result from a Stream Protection rule in support of the Regulatory Impact Analysis and Environmental Impact Statement.

For the **NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**, developed a spatial economic model to evaluate climate change threats to potential coastal restoration sites in the Puget Sound.

For the **NATIONAL FISH & WILDLIFE FOUNDATION**, collaborated with an expert fisheries economist to design an incentive program for vessel enrollment in a bycatch reduction program in the Gulf of Mexico pelagic longline fishery.

For the **U.S. FISH AND WILDLIFE SERVICE**, estimated costs and benefits associated with critical habitat designation under section 7 of the Endangered Species Act for several species in the southwest U.S., California and Florida.

For the **U.S. COAST GUARD**, developed a study plan for several potential primary valuation studies to estimate values for changes in risks of passenger vessel injury, maritime security threats, and oil spills.

For the **U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF POLICY ANALYSIS AND REVIEW**, provided technical support in estimating the benefits of improved residential visibility for the Section 812 Second Prospective analysis of the Clean Air Act Amendments.

For the **U.S. FISH AND WILDLIFE SERVICE**, designed and conducted research on the housing market impacts of critical habitat designations for endangered species.

For the **U.S. DEPARTMENT OF JUSTICE**, provided critiques of econometric analyses submitted in conjunction with a lawsuit brought against the U.S. Environmental Protection Agency regarding CERCLA.

For the **MINNESOTA FOREST RESOURCES COUNCIL**, advised on approaches to incorporating non-market benefits in riparian forest management policies.

For the **NATIONAL WILDLIFE FEDERATION**, conducted an economic analysis of recreational resources in the vicinity of a proposed underground mine site in northern Michigan.

For **HEALTH CANADA**, designed and implemented a national stated-preference study to evaluate increased efficacy of smoking cessation therapies.

For the **U.S. CITIZENSHIP AND IMMIGRATION SERVICE**, conducted an econometric analysis of the demand for immigration services and benefits.

For the **U.S. FISH AND WILDLIFE SERVICE**, conducted economic analyses of several existing and proposed National Wildlife Refuges (NWRs), including the Necedah NWR in Wisconsin, the Monomoy and Nantucket NWRs in Massachusetts and the proposed Aldo Leopold NWR in Wisconsin.

For the **NATIONAL PARKS CONSERVATION ASSOCIATION**, developed a report on the economic benefits of instream flows and lake levels in Colorado River watershed park units.

For the **NATIONAL PARK SERVICE**, developing a report on the potential economic implications of ocean acidification at marine units.

For the **U.S. FISH AND WILDLIFE SERVICE**, conducted a comprehensive economic analysis of migratory shorebird recovery activities on the Atlantic coast.

For the **U.S. CONSUMER PRODUCT SAFETY COMMISSION**, developed a study plan describing research options to improve estimates of the value of nonfatal injury risk reductions.

For **HEALTH & ENVIRONMENT CANADA**, designed and implemented a national stated-preference study to value elimination of certain harmful attributes of chemical substances in commerce.

For **HEALTH CANADA**, adapted and implemented a stated-preference study to value avoided children's health risks from lead paint exposure.

Selected Publications

Bishop, Richard C., Kevin J. Boyle, Richard T. Carson, David Chapman, W. Michael Hanemann, Barbara Kanninen, Raymond J. Kopp, Jon A. Krosnick, John List, Norman Meade, Robert Paterson, Stanley Presser, V. Kerry Smith, Roger Tourangeau, Michael Welsh and Jeffrey M. Wooldridge," Putting a Value on Injuries to Natural Assets: The BP Oil Spill," *Science*, 356(6335), April 2017.

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Huguenin, Michael T., Michael C. Donlan, Alexandra E. Van Geel and Robert W. Paterson, "Assessment and Valuation of Damage to the Environment," in Gulf War Reparations and the UN Compensation Commission, Oxford University Press, 2011.

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Nguyen, To N., W. Douglass Shaw, Richard T. Woodward, Robert W. Paterson and Kevin J. Boyle, "An Empirical Study of Option Prices for Hunting Permits," *Ecological Economics* 63(2-3), August 2007.

Moeltner, Klaus, Kevin J. Boyle and Robert W. Paterson, "Meta-Analysis and Benefit Transfer for Resource Valuation- Addressing Classical Challenges with Bayesian Modeling," *Journal of Environmental Economics and Management* 53(2), March 2007.

Zabel, Jeffrey E. and Robert W. Paterson, "The Effects of Critical Habitat Designation on Housing Supply: An Analysis of California Housing Construction Activity," *Journal of Regional Science* 46(1), February 2006.

Paterson, Robert W., Kevin J. Boyle, Mary Ahearn, Anna Alberini, John Bergstrom, Larry Libby and Michael P. Welsh, "Public Preferences for Farmland Attributes in Conservation Easement Programs," in Land Use Problems and Conflicts, Routledge Publishers, 2005.

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APPENDIX B: CARRYING CAPACITY

Carrying capacity in national parks refers to the amount of visitor use a park can sustain while also preserving natural resources and maintaining a positive visitor experience. A variety of factors influence a park's carrying capacity, including physical space (i.e. number of parking spaces or miles of trail), site location, social norms and perceptions of crowding, type of recreational activities offered, and the type and intensity of management (Graefe et al. 1984, Manning 2001, Manning et al. 2014, Manning et al. 2017, Vaske and Shelby 2008). According to Hallo and Manning (2014), the physical and managerial aspects of carrying capacity lend themselves to more straight-forward quantification than the environmental and social aspects of carrying capacity because they align more closely with existing methods used to define carrying capacity of a space, such as the Highway Capacity Manual, a widely-used guide in determining the number of cars a road can support. However, Hallo and Manning (2014) further suggest that considering only physical carrying capacity may not be the best approach for determining park road carrying capacity because the social and environmental aspects of carrying capacity are particularly relevant at parks. A common method for quantifying social carrying capacity is the visual approach method, in which visitors rate on a scale ranging from unacceptable to acceptable a series of photographs depicting various amounts of people at a site, on a road, or on a trail. Manning et al. (1996) utilize this method to determine a specific social carrying capacity for Delicate Arch. Social carrying capacity values can be used in conjunction with other physical, environmental, and managerial factors to determine an overall carrying capacity for the site.

To better understand how visitation to ARCH may evolve in future years if a system is not implemented, we conducted a simple carrying capacity analysis. Due to the nature of available data, our analysis considers only physical and managerial carrying capacity, and is therefore not a comprehensive review of the Park's capacity. The analysis involved: (1) calculating a physical carrying capacity at ARCH based on parking spaces; (2) using historical visitation data to project near-term future visitation; and, (3) examining if projected future visitation exceeds physical carrying capacity. Overall, the analysis suggests that, at current visitation growth rates, peak season months at the Park are likely to meet physical carrying capacity in a few years.

The 1989 ARCH General Management Plan (GMP) calculates theoretical daily vehicle carrying capacity by multiplying maximum people at one time (PAOT) and visitor turnover rate (NPS 1989, NPS 2017).[19] Although carrying capacity of a park is inherently physical, environmental, social, and managerial, the 1989 GMP calculation of daily vehicle carrying capacity at ARCH considers only the physical and managerial components of carrying capacity. The equation used to calculate a daily carrying capacity at ARCH is presented below.

[19] Maximum PAOT, total number of parking spaces, and average number of people per car have been updated to reflect 2017 values presented in the Arches National Park Traffic Congestion Management Plan Environmental Assessment (NPS 2017).

To calculate the monthly carrying capacity, we multiply the daily carrying capacity by the number of days in the month:

$$Carrying\ Capcity = (Maximum\ PAOT) * (Turnover\ Rate)$$

where:

$$Maximum\ PAOT = (total\ number\ parking\ spaces) * (average\ people\ per\ car)$$

and:

$$Turnover\ Rate = (12\ hour\ day)/(average\ length\ of\ stay)$$

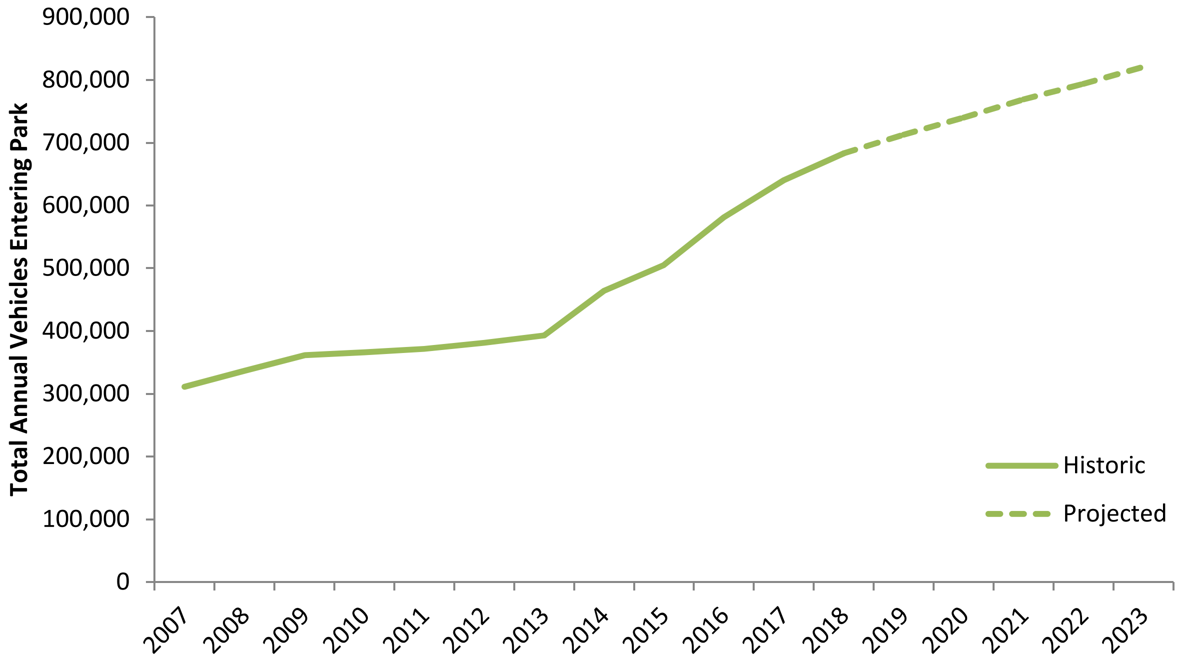
Using values from the October 2017 Arches National Park Traffic Congestion Management Plan Environmental Assessment:

$$Carrying\ Capacity\ at\ Arches\ = (857) * (2.6) * (12/4) = 6{,}685\ people\ or\ 2{,}571\ cars$$

To estimate future visitation at ARCH, we project the average monthly growth in ARCH visitation between 2013 and 2015. We exclude 2016 because that was the NPS Centennial and there was a variety of publicity and special programming that may have encouraged visitation above what would otherwise be expected.[20] Similarly, we do not include 2017 because that was the year of the 3R re-paving project throughout the Park that involved nighttime closures. Exhibit B-1 depicts historic and projected annual vehicle visitation at ARCH from 2007 to 2023.

[20] https://www.nps.gov/subjects/centennial/nps-centennial-programs.htm

EXHIBIT B-1. HISTORIC AND PROJECTED ANNUAL ARCH VISITATION, 2007-2023



According to the carrying capacity calculation and growth projections, some months are on track to surpass park carrying capacity by 2018. By 2021, the entire peak season is projected to exceed park carrying capacity. Exhibit B-2 depicts monthly visitation at ARCH, highlighting future months that are projected to reach park carry capacity. As previously stated, visitation projections begin in 2017 and growth is calculated using 2013-2015 monthly growth averages.

The physical carrying capacity value presented in this analysis represents an *estimate* of the physical limitations to visitation that ARCH can sustain. There are a number of important caveats associated with the carrying capacity analysis. First, the carrying capacity calculation assumes that every parking space in the Park is utilized for the entire 12-hour day. Furthermore, when using monthly carrying capacity to consider limits to future growth projections, we assume that every day in the month reaches daily carrying capacity and that visitation is spread out equally throughout the week, ignoring weekday and weekend variations in visitation. Finally, the analysis assumes that visitor behavior remains the same with increasingly crowded conditions, which is unlikely according to existing research on visitor behavior and crowding at national parks (Graefe 1984, Gramann 2002).

The purpose of the carrying capacity analysis is to expand our understanding of limits to growth in Park visitation without a reservation system. The results of this analysis are not relied upon in any estimates of how the system may impact park visitation. Overall, the analysis suggests that current growth rates may exceed the Park's physical carrying capacity in the near future.

EXHIBIT B-2. MONTHLY HISTORIC AND PROJECTED ARCH VEHICLE VISITATION, 2007-2022

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2007	4,362	6,347	23,338	32,657	39,837	38,419	39,472	36,840	41,417	30,790	12,552	5,197
2008	3,774	5,565	24,414	32,667	46,821	43,908	42,694	45,206	42,400	31,536	12,080	5,478
2009	4,844	6,421	24,486	32,857	49,325	49,771	47,830	47,253	45,615	34,475	13,016	5,445
2010	3,597	4,915	20,990	34,256	50,642	52,594	50,961	48,715	47,030	35,211	11,895	5,220
2011	4,226	5,364	22,808	35,204	49,726	53,715	51,407	48,011	46,235	35,985	12,660	6,251
2012	6,189	7,413	26,585	37,597	49,131	49,073	50,585	46,989	47,287	37,977	14,978	7,422
2013	4,576	6,710	27,028	39,475	52,918	53,925	54,434	51,013	53,607	22,859	17,938	8,473
2014	7,056	9,270	32,968	44,563	58,739	59,809	59,505	59,788	56,304	46,266	19,203	10,667
2015	8,533	14,200	37,963	50,638	63,771	66,293	68,489	60,152	58,014	45,639	20,164	11,224
2016	8,439	13,788	43,906	55,570	72,014	74,575	74,352	66,669	70,614	58,893	28,693	13,657
2017	*9,819*	*17,550*	*49,584*	*61,408*	*78,561*	*77,130*	*79,701*	*72,530*	*75,659*	*70,914*	*31,736*	*15,718*
2018	11,425	22,338	55,996	67,859	79,701	77,130	79,701	78,906	77,130	79,701	35,102	18,090
2019	13,294	28,433	63,237	74,988	79,701	77,130	79,701	79,701	77,130	79,701	38,825	20,821
2020	15,468	36,190	71,414	77,130	79,701	77,130	79,701	79,701	77,130	79,701	42,943	23,963
2021	17,998	46,064	79,701	77,130	79,701	77,130	79,701	79,701	77,130	79,701	47,498	27,579
2022	20,942	58,632	79,701	77,130	79,701	77,130	79,701	79,701	77,130	79,701	52,536	31,742

APPENDIX C: MODEL RESULTS

HOTEL OCCUPANCY AND GOVERNMENT SHUTDOWN MODEL

```
.         newey occupancy year ib10.month shutdown tdev, lag(1)

Regression with Newey-West standard errors          Number of obs  =       123
maximum lag: 1                                      F( 14,    108)  =   1155.89
                                                    Prob > F        =    0.0000
```

occupancy	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.6354965	.1425087	4.46	0.000	.3530195	.9179736
month						
1	-43.86006	1.089424	-40.26	0.000	-46.01949	-41.70063
2	-35.51568	.9569831	-37.11	0.000	-37.41258	-33.61877
3	-12.20136	1.28272	-9.51	0.000	-14.74393	-9.658784
4	-2.188717	1.137427	-1.92	0.057	-4.443296	.0658608
5	7.890592	1.365998	5.78	0.000	5.182947	10.59824
6	11.11236	1.057991	10.50	0.000	9.015238	13.20948
7	10.06185	1.163235	8.65	0.000	7.756116	12.36758
8	7.89656	1.44375	5.47	0.000	5.034798	10.75832
9	12.4489	.908817	13.70	0.000	10.64747	14.25033
11	-25.33297	1.186884	-21.34	0.000	-27.68558	-22.98036
12	-40.21078	1.018964	-39.46	0.000	-42.23054	-38.19102
shutdown	-3.600116	.8325129	-4.32	0.000	-5.250301	-1.949931
tdev	.189775	.0568762	3.34	0.001	.0770365	.3025136
_cons	-1207.614	286.866	-4.21	0.000	-1776.232	-638.9957

HOTEL DEMAND AND GOVERNMENT SHUTDOWN MODEL

```
.         newey lndemand year ib10.month shutdown tdev, lag(1)

Regression with Newey-West standard errors          Number of obs  =       123
maximum lag: 1                                      F( 14,    108) =    453.35
                                                    Prob > F       =    0.0000
```

lndemand	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.0351302	.0033078	10.62	0.000	.0285735	.0416869
month						
1	-.9930295	.0221421	-44.85	0.000	-1.036919	-.9491399
2	-.8221836	.0280994	-29.26	0.000	-.8778815	-.7664857
3	-.2053945	.0248519	-8.26	0.000	-.2546552	-.1561338
4	-.0838752	.0217055	-3.86	0.000	-.1268992	-.0408511
5	.0878737	.0236293	3.72	0.000	.0410364	.134711
6	.0994627	.0213978	4.65	0.000	.0570485	.1418769
7	.122675	.0195734	6.27	0.000	.0838771	.1614728
8	.095557	.0240472	3.97	0.000	.0478912	.1432227
9	.1223028	.0143866	8.50	0.000	.093786	.1508195
11	-.4713166	.0304932	-15.46	0.000	-.5317594	-.4108738
12	-.8382585	.0332705	-25.20	0.000	-.9042065	-.7723105
shutdown	-.0811281	.0132312	-6.13	0.000	-.1073546	-.0549016
tdev	.007412	.0016508	4.49	0.000	.0041399	.0106841
_cons	-60.01367	6.657681	-9.01	0.000	-73.21035	-46.81699

HOTEL OCCUPANCY AND 3R MODEL

```
.         newey occupancy year i.month R3_* tdev, lag(1)
note: R3_1 omitted because of collinearity
note: R3_2 omitted because of collinearity
note: R3_12 omitted because of collinearity

Regression with Newey-West standard errors          Number of obs  =       123
maximum lag: 1                                      F( 14,    100) =   1618.01
                                                    Prob > F       =    0.0000
```

occupancy	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.5848826	.1590891	3.68	0.000	.2692544	.9005109
month						
2	8.345628	1.014177	8.23	0.000	6.33353	10.35773
3	31.36548	1.347972	23.27	0.000	28.69114	34.03982
4	41.28244	1.093646	37.75	0.000	39.11267	43.4522
5	51.71798	1.419209	36.44	0.000	48.90231	54.53365
6	54.98993	1.047681	52.49	0.000	52.91136	57.0685
7	54.08926	1.152106	46.95	0.000	51.80352	56.37501
8	51.92096	1.476487	35.17	0.000	48.99166	54.85027
9	56.26406	1.054838	53.34	0.000	54.17129	58.35683
10	43.08373	1.105209	38.98	0.000	40.89103	45.27644
11	18.08656	1.535043	11.78	0.000	15.04108	21.13204
12	3.622676	1.129401	3.21	0.002	1.381977	5.863376
R3_1	0	(omitted)				
R3_2	0	(omitted)				
R3_3	3.21811	1.234984	2.61	0.011	.767937	5.668283
R3_4	3.666153	.9793488	3.74	0.000	1.723152	5.609153
R3_5	.0757158	1.160733	0.07	0.948	-2.227146	2.378578
R3_6	-.4396875	.8804592	-0.50	0.619	-2.186494	1.307119
R3_7	-1.91865	1.006827	-1.91	0.060	-3.916167	.0788664
R3_8	-1.887585	1.280224	-1.47	0.144	-4.427512	.6523423
R3_9	.1872199	.9174882	0.20	0.839	-1.633051	2.00749
R3_10	3.891114	1.100967	3.53	0.001	1.706826	6.075402
R3_11	4.144742	1.549643	2.67	0.009	1.070294	7.21919
R3_12	0	(omitted)				
tdev	.1981958	.0602553	3.29	0.001	.0786509	.3177406
_cons	-1149.587	320.2101	-3.59	0.001	-1784.875	-514.2996

HOTEL DEMAND AND 3R MODEL

```
.          newey lndemand year ib10.month R3_* tdev, lag(1)
note: R3_1 omitted because of collinearity
note: R3_2 omitted because of collinearity
note: R3_12 omitted because of collinearity

Regression with Newey-West standard errors          Number of obs  =       123
maximum lag: 1                                      F( 14,    100) =    532.61
                                                    Prob > F       =    0.0000
```

lndemand	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.0342097	.0037986	9.01	0.000	.0266734	.0417459
month						
1	-.9788663	.0239264	-40.91	0.000	-1.026336	-.9313969
2	-.8080243	.0300463	-26.89	0.000	-.8676354	-.7484133
3	-.1949229	.0287535	-6.78	0.000	-.2519689	-.1378768
4	-.0753482	.0259999	-2.90	0.005	-.1269313	-.0237651
5	.1020611	.0271462	3.76	0.000	.0482039	.1559183
6	.1162246	.0241642	4.81	0.000	.0682834	.1641657
7	.1403096	.0220069	6.38	0.000	.0966486	.1839706
8	.1132263	.0270683	4.18	0.000	.0595236	.166929
9	.1367053	.0164227	8.32	0.000	.1041232	.1692873
11	-.4734004	.0319348	-14.82	0.000	-.536758	-.4100427
12	-.8248414	.0356938	-23.11	0.000	-.8956568	-.754026
R3_1	0	(omitted)				
R3_2	0	(omitted)				
R3_3	.0406304	.0306208	1.33	0.188	-.0201205	.1013812
R3_4	.0538778	.0244501	2.20	0.030	.0053694	.1023861
R3_5	-.0048511	.0248882	-0.19	0.846	-.0542285	.0445263
R3_6	-.0305529	.0243433	-1.26	0.212	-.0788494	.0177436
R3_7	-.0393419	.0226887	-1.73	0.086	-.0843555	.0056717
R3_8	-.0396917	.0255383	-1.55	0.123	-.090359	.0109757
R3_9	-.0069679	.0218363	-0.32	0.750	-.0502906	.0363547
R3_10	.0490447	.0237608	2.06	0.042	.0019039	.0961854
R3_11	.1588276	.0365656	4.34	0.000	.0862825	.2313727
R3_12	0	(omitted)				
tdev	.0073853	.0018334	4.03	0.000	.0037479	.0110228
_cons	-58.17475	7.643573	-7.61	0.000	-73.33938	-43.01012

ACAD SHUTTLE BUS MODEL

```
.         newey lnvisits year post, lag(1)

Regression with Newey-West standard errors          Number of obs  =        24
maximum lag: 1                                      F(  2,     21)  =      5.45
                                                    Prob > F        =    0.0124
```

lnvisits	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.0003809	.0048765	0.08	0.938	-.0097603	.0105221
post	-.1249922	.0730712	-1.71	0.102	-.2769522	.0269678
_cons	14.01229	9.732702	1.44	0.165	-6.227967	34.25256

ROMO SHUTTLE BUS MODEL

```
.         newey lnvisits year post, lag(1)

Regression with Newey-West standard errors          Number of obs  =        34
maximum lag: 1                                      F(  2,     31)  =      8.22
                                                    Prob > F        =    0.0014
```

lnvisits	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.0108273	.0027585	3.93	0.000	.0052013	.0164532
post	-.1137239	.0429617	-2.65	0.013	-.2013449	-.0261028
_cons	-6.728016	5.502314	-1.22	0.231	-17.95006	4.494026

ZION SHUTTLE BUS MODEL

```
.        newey lnvisits year post cent, lag(1)

Regression with Newey-West standard errors          Number of obs  =        19
maximum lag: 1                                      F(  3,     15) =   1151.15
                                                    Prob > F       =    0.0000
```

lnvisits	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.0291381	.0071149	4.10	0.001	.0139731	.044303
post	-.1189154	.0537006	-2.21	0.043	-.2333756	-.0044552
cent	.2032153	.0718236	2.83	0.013	.0501269	.3563037
_cons	-43.55362	14.22652	-3.06	0.008	-73.87674	-13.2305

ARCH FIERY FURNACE RESERVATION SYSTEM MODELS

```
. regress lnvisit post year if peak & year < 2008
```

Source	SS	df	MS		
Model	.093259074	2	.046629537	Number of obs =	12
Residual	.033083486	9	.003675943	F(2, 9) =	12.69
Total	.12634256	11	.011485687	Prob > F =	0.0024
				R-squared =	0.7381
				Adj R-squared =	0.6800
				Root MSE =	.06063

lnvisits	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
post	-.3585277	.0722022	-4.97	0.001	-.5218604	-.195195
year	.0095088	.0057808	1.64	0.134	-.0035683	.0225859
_cons	-12.15428	11.53864	-1.05	0.320	-38.2565	13.94793

```
. regress lnvisit post year if !peak & year < 2008
```

Source	SS	df	MS		
Model	.105324171	2	.052662085	Number of obs =	12
Residual	.268966157	9	.029885129	F(2, 9) =	1.76
Total	.374290328	11	.034026393	Prob > F =	0.2260
				R-squared =	0.2814
				Adj R-squared =	0.1217
				Root MSE =	.17287

lnvisits	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
post	.2960203	.2058702	1.44	0.184	-.1696905	.7617311
year	-.0288337	.0164828	-1.75	0.114	-.0661204	.008453
_cons	62.90147	32.90014	1.91	0.088	-11.52382	137.3268

MUWO RESERVATION SYSTEM MODEL

```
.        regress lnvisits year post cent

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  3,     16) =    9.55
       Model |  .387475837     3  .129158612           Prob > F      =  0.0007
    Residual |  .216339771    16  .013521236           R-squared     =  0.6417
-------------+------------------------------           Adj R-squared =  0.5745
       Total |  .603815608    19  .031779769           Root MSE      =  .11628

------------------------------------------------------------------------------
    lnvisits |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        year |   .0192592   .0051876     3.71   0.002      .008262    .0302564
        post |   .1407303   .1311794     1.07   0.299    -.1373576    .4188182
        cent |    .163802   .1272454     1.29   0.216    -.1059462    .4335503
       _cons |  -26.78537   10.41438    -2.57   0.020    -48.86286    -4.70788
------------------------------------------------------------------------------
```

BAXTER STATE PARK RESERVATION SYSTEM MODEL

```
.        regress lnvisitors year  i.post if year >=2005

      Source |       SS           df       MS      Number of obs   =        13
-------------+----------------------------------   F(2, 10)        =     18.12
       Model |  .061159846         2  .030579923   Prob > F        =    0.0005
    Residual |  .016875862        10  .001687586   R-squared       =    0.7837
-------------+----------------------------------   Adj R-squared   =    0.7405
       Total |  .078035708        12  .006502976   Root MSE        =    .04108

------------------------------------------------------------------------------
  lnvisitors |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        year |   .0186235   .0056968     3.27   0.008     .0059302    .0313167
      1.post |  -.0026655   .0438136    -0.06   0.953    -.1002882    .0949572
       _cons |  -26.40796    11.4335    -2.31   0.044    -51.88339   -.9325297
------------------------------------------------------------------------------

.        estimates store baxter, title(Baxter State Park)

.        estat dwatson

Durbin-Watson d-statistic(  3,    13) =  2.204737
```

ALCA RESERVATION SYSTEM MODEL

```
.         newey lnvisits year post x2008 cent, lag(1)

Regression with Newey-West standard errors          Number of obs  =        22
maximum lag: 1                                      F(  3,     17) =    603.20
                                                    Prob > F       =    0.0000
```

lnvisits	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.0254924	.0037091	6.87	0.000	.0176668	.033318
post	-.1190732	.0471064	-2.53	0.022	-.2184591	-.0196873
x2008	-.2809726	.0186105	-15.10	0.000	-.3202373	-.2417078
cent	.0342315	.0197551	1.73	0.101	-.0074482	.0759112
_cons	-36.96827	7.419171	-4.98	0.000	-52.62135	-21.31518

YOSE RESERVATION SYSTEM MODELS

```
.         regress lnentries year pil_16 if pil_16_comparison & year != 2009

      Source |       SS       df       MS              Number of obs =      21
-------------+------------------------------           F(  2,    18) =   10.65
       Model |  .148561572     2  .074280786           Prob > F      =  0.0009
    Residual |  .125596052    18  .006977558           R-squared     =  0.5419
-------------+------------------------------           Adj R-squared =  0.4910
       Total |  .274157624    20  .013707881           Root MSE      =  .08353

------------------------------------------------------------------------------
   lnentries |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        year |   .0178659   .0059363     3.01   0.008      .0053941    .0303377
      pil_16 |   .1278653    .068826     1.86   0.080     -.0167328    .2724635
       _cons |  -27.24331   11.93801    -2.28   0.035     -52.32413   -2.162493
------------------------------------------------------------------------------

.         regress lnentries year pil_17 if pil_17_comparison & year != 2016

      Source |       SS       df       MS              Number of obs =      98
-------------+------------------------------           F(  2,    95) =    7.11
       Model |  2.31002134     2  1.15501067           Prob > F      =  0.0013
    Residual |  15.4241812    95  .162359802           R-squared     =  0.1303
-------------+------------------------------           Adj R-squared =  0.1119
       Total |  17.7342026    97   .18282683           Root MSE      =  .40294

------------------------------------------------------------------------------
   lnentries |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        year |   .0055669   .0147389     0.38   0.706     -.0236935    .0348274
      pil_17 |  -.5934796   .1759719    -3.37   0.001     -.9428279   -.2441313
       _cons |  -2.562915   29.63429    -0.09   0.931     -61.39441    56.26858
------------------------------------------------------------------------------
```

3R AND ARCH VISITATION MODEL

```
.         newey lncars year i.month R3_* tdev, lag(1)
note: R3_1 omitted because of collinearity
note: R3_2 omitted because of collinearity
note: R3_12 omitted because of collinearity

Regression with Newey-West standard errors          Number of obs  =      3987
maximum lag: 1                                      F( 22,  3964)  =    737.23
                                                    Prob > F       =    0.0000
```

lncars	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
year	.0663142	.0031084	21.33	0.000	.06022	.0724083
month						
2	.3854916	.0459456	8.39	0.000	.2954124	.4755708
3	1.573149	.0492966	31.91	0.000	1.4765	1.669798
4	2.053829	.0309734	66.31	0.000	1.993104	2.114555
5	2.325037	.0301097	77.22	0.000	2.266005	2.384069
6	2.386012	.0283286	84.23	0.000	2.330472	2.441552
7	2.347621	.0275234	85.30	0.000	2.29366	2.401583
8	2.283678	.0306296	74.56	0.000	2.223627	2.343729
9	2.320153	.0288505	80.42	0.000	2.26359	2.376716
10	1.748117	.1070446	16.33	0.000	1.53825	1.957985
11	1.075558	.0428295	25.11	0.000	.991588	1.159528
12	.2445132	.050041	4.89	0.000	.1464048	.3426216
R3_1	0	(omitted)				
R3_2	0	(omitted)				
R3_3	.1785825	.1091194	1.64	0.102	-.035353	.3925179
R3_4	.0326657	.0410538	0.80	0.426	-.0478229	.1131542
R3_5	-.0938857	.0410078	-2.29	0.022	-.1742841	-.0134873
R3_6	-.1105758	.0283715	-3.90	0.000	-.1662	-.0549516
R3_7	-.0864497	.029077	-2.97	0.003	-.143457	-.0294425
R3_8	-.1361101	.049773	-2.73	0.006	-.2336933	-.038527
R3_9	-.0823424	.0392298	-2.10	0.036	-.1592548	-.00543
R3_10	.2574406	.1266584	2.03	0.042	.0091189	.5057623
R3_11	.2609849	.1075049	2.43	0.015	.0502147	.471755
R3_12	0	(omitted)				
tdev	.0069855	.00138	5.06	0.000	.00428	.0096911
_cons	-128.2945	6.252587	-20.52	0.000	-140.5531	-116.0359