# Demand for Visits to Southwestern National Parks: Efficient Estimation with Time-Invariant and Rarely Changing Variables and Park-Specific Fixed Effects

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## Abstract

This study estimates factors affecting annual visits to national parks in the Southwestern United States from 1980-2003. The time-series cross section data includes national parks, historical parks, monuments, and recreation areas in Arizona, New Mexico, and southern Utah, Nevada, and California. The study applies a fixed-effects vector decomposition (FEVD) estimator – a three-stage estimator – that separates effects of time-invariant or rarely changing variables, while including fixed effects. Estimation results suggest (a) parks exhibit spatial complementarity (i.e. being closer to other parks encourages visits); (b) the elasticity of visits with respect to gas price is -0.23; (c) climate variables are important predictors of park visits; (d) changes in designation from national monument to park significantly increases visits; (e) falling reservoir levels are among the most important factors affecting total park visits to the entire region; and (f) the effects of regional population growth dominate effects of economic and environmental changes.

Key words: national parks, drought, climate change, time series-cross section data, input-output models

JEL Codes: Q250; Q260; Q510; Q540

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**Demand for Visits to Southwestern National Parks: Efficient Estimation with Time-Invariant and Rarely Changing Variables and Park-Specific Fixed Effects**

National parks in the U.S Southwest are areas of spectacular beauty, rich in unique biological, cultural, scientific, and historic significance. Here, we mean "national park" generically for sites in the National Park System, including national parks, monuments, recreation areas, historic sites, etc. National parks also make important contributions to local rural economies. In 2007, Southwest national parks received more than 28 million recreation visits. Visitors spent roughly $1.5 billion in local gateway communities, supporting more than 32,000 jobs (calculated from Stynes, 2008).

There have been growing concerns, however, that rapid population growth, drought, climate change, and other environmental stressors may place park resources at risk (Wall, 1998; Burns et al., 2003; Saunders et al., 2006; Mitchell, 2006; NPCA, 2007; Uscher, 2008). Surprisingly, there has been relatively little research examining the potential impacts of climate change on outdoor recreation in general (Cline, 1992; Mendelsohn and Markowski, 1999; Loomis and Crespi, 1999) and national park visitation in particular (Weiler et al., 2002; Richardson and Loomis, 2004; Loomis and Richardson, 2006; Jones and Scott, 2006; Scott, et al., 2007). There has been extensive work considering the economic *impacts* of national park visitation on local economies (e.g. Stynes, et al., 2000; Stynes, 2008). With a few exceptions, however (Johnson and Suits, 1984; Wicks et al., 1994; Hanink and White, 1999; Hanink and Stutts, 2002; Weiler and Seidl, 2004; Weiler, 20006; Pergams and Zaradic, 2006), there has been little estimation of factors affecting demand for visits in the first place.

## Aims and scope

This study uses multivariate regression to estimate factors affecting annual visitation to Southwest national parks (parks in New Mexico, Arizona, and southern parts of California, Nevada, and Utah). Demand for park visits is modeled as a function of spatial demand factors, park attributes, climate, and water availability. It then uses input-output analysis to map changes in visits to changes in visitor spending, then to changes in local sales, personal income and employment. This study contributes to the economic literature in four areas. First, it extends previous literature on demand for national park visitation. Second, it adds to the literature on the impacts of climate change on outdoor recreation. Third, we consider the impact of climate mitigation policy on visitation. We estimate an elasticity of visits with respect to gasoline price of -0.23. Thus, we examine how different carbon taxes or pricing policies might affect visits via changes in gasoline prices. Fourth, we apply a new approach to estimate time series-cross section data, fixed effects vector decomposition (FEVD) estimation. Standard fixed effects estimation does not permit estimation of time-invariant variables (such as fixed park attributes) and provides highly inefficient parameter estimates for variables that change slowly over time. FEVD overcomes these limitations of fixed effects modeling.

Previous research suggests climate change would have a net positive effect on outdoor recreation (Mendelsohn and Markowski; Loomis and Crespi) and park visitation (Weiler et al., 2002; Richardson and Loomis, 2004; Loomis and Richardson, 2006; Jones and Scott, 2006; Scott, et al., 2007). This research has involved (a) using visitation regression results to conduct comparative static exercises, simulating response to some hypothesized change in climate; (b) conducting visitor surveys to elicit contingent responses to climate change; or (c) combining and comparing both methods. The pure effect of higher temperatures appears to be positive (at least if temperature increases are not too extreme; see Richardson and Loomis). Reduced snowfall discourages skiing (Cline; Mendelsohn and Markowski), but warmer temperatures appear to contribute to a net increase in total recreation and park visitation.

Changes in temperature (and precipitation) will not be the only impacts of climate change. The ecology and resources of parks will change. The number and types of plant and animal life will changes. Streamflows and lake levels will also change, affecting fishing and water-based recreation. Visitor response to park ecology and hydrology is more difficult to measure than responses to climate variables. Changes in ecology and hydrology are also more difficult to predict.

A few studies have attempted to consider both temperature / precipitation changes and resource quality changes. Even accounting for changes in resource quality, the effects of climate change appear to be positive, up to a point (Scott et al.; Richardson and Loomis). Scott et al. found visitor responses to ecological changes were slightly positive for small changes associated with near-term climate change, but grew increasingly negative with extreme changes associated with more distant climate change. Examining demand for reservoir recreation, Loomis and Crespi considered the positive effect of higher temperature together with the negative effect of reduced lake surface areas. They found the net effect on reservoir recreation was positive.

In this study, we conducted comparative static exercises examining the impacts of long-term average temperature increases of 2°F for July and 1°F for January. These changes were considered alone and (where relevant) in combination with reductions in lake surface areas. Our results are generally consistent with previous research. Overall, warmer temperatures increase total regional visits and visitor spending rises by $80.9 million. Visits to reservoirs increase with warmer temperatures, but decrease as the surface area of lakes declines. Because of recent droughts, the surface areas of Lake Powell and Mead fell 29% and 24% from 1998 to 2003. Declining reservoir levels accounted for a loss of more than 700 jobs in addition to $29.4 million in lost sales and $10.4 million in lost personal income.

The effects of warming are not positive for all parks. Visits to eight parks at lower elevations and latitudes declined, with visitor spending losses of $3.7 million. For example, low desert parks, such as Saguaro National Park in the Sonoran Desert or Joshua Tree National Park in the Mojave Desert lose visitors. While cooler parks may benefit from extended seasons (from warmer winters, earlier springs, later falls), low desert parks are already quite warm in winter. Beyond a threshold, greater heat only discourages visits. These findings are consistent with Richardson and Loomis that found negative visitor responses to an "extreme heat" scenario.

Second, it is less clear that the net effect of warmer temperatures and lower lake elevations is positive, at least with warming trends over the next 30 years. These results differ from those of Loomis and Crespi. Assessing the effects of climate change on reservoir recreation is complicated because (a) there is a high degree of uncertainty about climate change impacts on water runoff and reservoir inflows and (b) reservoirs are managed systems that depend on human reactions to water shortages. Nevertheless, some reservoir system modeling (e.g. Christensen et al. 2004; Christensen and Lettenmaier 2006; Barnett and Pierce, 2009) suggests that levels at Lakes Mead and Powell could fall sufficiently so that the net effect of warming and water shortages is negative in some years. Because visits to Lakes Powell and Mead account for such a large share of regional park system visits (36%), results suggest falling lake levels could substantially reduce, if not negate, the net regional gains from warmer temperatures.

**Fixed-Effect Vector Decomposition (FEVD) Estimation**

Data in this study come from 42 national parks for 25 years, from 1979 to 2003. This provides 1,050 observations of time series-cross section (TSCS) data. While TSCS data allows for richer analysis than either time series or cross section data, it has its own problems. First, the standard Gauss-Markov assumptions about the error term $\varepsilon_{it}$ ($i$ for units and $t$ time points) rarely hold.

Therefore, ordinary least squares (OLS) regression often will not yield unbiased, efficient parameter estimates. TSCS data often deviates from the Gauss-Markov assumptions because of (i) panel heteroskedasticity, (ii) contemporaneous correlation of the errors and (iii) serially correlated errors (Beck, 2001).

Various techniques have been applied to handling these three problems simultaneously. Among the first is the Feasible Generalized least squares (FGLS) method (Parks, 1967). However, Beck and Katz (1995) have demonstrated that there can be serious problems with FGLS. Problems arise because FGLS relies on an estimate of the unknown error process, yet the standard errors are calculated assuming that error process is known (not estimated). Because of this, the estimated standard errors of the regression coefficients can be seriously biased downward. Based on Monte Carlo simulations, Beck and Katz report true variability of parameter estimates can be under-estimated by 50% to 300%! This can lead to serious overconfidence in parameter estimates. Beck and Katz recommend using panel corrected standard errors (PCSE) to address heteroskedasticity and contemporaneous correlation of errors and an AR(1) correction for autocorrelation. They also recommend using a single autocorrelation (ρ) parameter instead of attempting to estimate separate parameters for each unit (a) because it is difficult to estimate multiple ρ parameters efficiently and (b) the single parameter performs well in general. Their Monte Carlo simulation results suggest PCSE estimation yields far more reliable estimates than FGLS.

Another problem with TSCS estimation is the presence of unobserved unit-specific fixed effects. Failure to account for fixed effects can lead to omitted variables bias in regressions of TSCS data. The simplest way to allow for unit-specific heterogeneity is to estimate a fixed effects (FE) model where each unit has its own intercept. Yet the use of fixed effects models come with costs too. Beck (2001) notes, “Fixed effects are clearly collinear with any independent variables that are unchanging attributes of the units, so they force us to drop such unchanging variables from the specification." However, time-invariant variables are often of special interest. In our particular case, we may be interested in how fixed park attributes affect visitation.

Applied econometricians appear to face a trade-off between avoiding omitted variables bias (by ignoring fixed effects) and ignoring the role of time-invariant variables. Hanink and Stutts apply stepwise regression in their analysis of demand for visits to National Battlefield parks. The authors do not present their full regression results, but it appears they include some, but not all, park-specific fixed effects. This allows for inclusion of time-invariant variables, while accounting for some, but not all, fixed effects. This begs the question of why some parks have fixed effects but others do not (or why a group of parks have identical fixed effects). Stepwise regression also leads to confidence intervals of coefficient and predicted values that are too narrow (Altman and Anderson, 1989) and parameter estimates that are biased (Tibshirani, 1996).

An alternative to OLS and stepwise regression is to estimate a random effects (RE) model, where unit effects are treated as random variables. However, the RE model assumes the regressors are independent of the random effects and of the error term. If these assumptions are violated, parameter estimates will be inconsistent and likely biased (Plumper and Troeger, 2004). Even if these assumptions hold, \ the RE model has poor small sample properties and will likely yield biased and inefficient parameter estimates when used on typical TSCS datasets. The Hausman-Taylor (1981) model attempts to overcome this problem by using instruments for variables correlated with random effects. Practically speaking, however, applied researchers do not know which variables are endogenous and which are exogenous. So, choice of appropriate instruments and division of variables into endogenous and exogenous groups can be arbitrary.

As an alternative to pooled OLS (without fixed effects), a fixed effects (FE) model (without time invariant variables), an RE model, or a Hausman-Taylor model, Plumper and Troeger (2004; 2007) developed a Fixed Effects Vector Decomposition technique (FEVD) to estimate both fixed effects and time invariant variables. This technique consists of three stages. The first stage runs a fixed-effects model without time-invariant variables. This yields estimates of individual fixed effects. In the second stage, the estimated fixed effects become the dependent variable, while time-invariant (and / or rarely changing) variables are regressors. This second stage decomposes the unit-effects vector into a part explained by the time-invariant (or rarely changing) variables and an error term. In the third stage, the first stage model is re-estimated without fixed effects, but including the time invariant variables plus the error term of stage 2.

Mathematically, the three steps are as follows. The first-stage equation is

(1)
$$Y_{it} = \alpha + \sum_{k=1}^{K} \beta_k X_{kit} + \sum_{m=1}^{M} \gamma_m Z_{mi} + \mu_i + \varepsilon_{it}$$

where $Y$ is the dependent variable; $X$ is a vector of $k$ time-varying explanatory variables; $Z$ is a vector of $m$ time-invariant variables, $\alpha$ is the intercept; $\beta$ and $\gamma$ terms are coefficients to be estimated; $i$ denotes specific units; $t$ represents time periods; $\mu$ represents the fixed effect for a specific unit $i$; $\varepsilon_{it}$ is the error term.

In the first step, equation (1) is averaged over the observed period $T$

(2)
$$\bar{Y}_i = \alpha + \sum_{k=1}^{K} \beta_k \bar{X}_{ki} + \sum_{m=1}^{M} \gamma_m Z_{mi} + \mu_i + \bar{\varepsilon}_i$$

$$\bar{Y}_i = \frac{1}{T}\sum_{t=1}^{T} Y_{it}\ ,\ \bar{X}_i = \frac{1}{T}\sum_{t=1}^{T} X_{it} \text{ and } \bar{\varepsilon}_i = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_{it}$$

Subtracting (2) from (1) yields

(3) $$Y_{it} - \overline{Y}_i = \alpha - \alpha + \sum_{k=1}^{K} \beta_k (X_{kit} - \overline{X}_{ki}) + \sum_{m=1}^{M} \gamma_m (Z_{mi} - Z_{mi}) + \mu_i - \mu_i + \varepsilon_{it} - \overline{\varepsilon}_i$$

$$\equiv \ddot{Y}_{it} = \sum_{k=1}^{K} \beta_k \ddot{X}_{kit} + \ddot{\varepsilon}_{it}$$

where $\ddot{Y}_{it} = Y_{it} - \overline{Y}_i$, $\ddot{X}_{kit} = X_{kit} - \overline{X}_{ki}$ and $\ddot{\varepsilon}_{it} = \varepsilon_{it} - \overline{\varepsilon}_i$. By regressing $\ddot{Y}$ on $\ddot{X}$, we can get $\hat{\beta}_k^{FE}$. The estimated fixed effects are $\hat{\mu}_i = \overline{Y}_i - \sum_{k=1}^{K} \hat{\beta}_k^{FE} \overline{X}_{ki}$. In the second stage, it is assumed $\hat{\mu}_i$ can be explained (in part) by time-invariant variables $Z_{mi}$

(4) $$\hat{\mu}_i = \omega + \sum_{m=1}^{M} \gamma_m Z_{mi} + \eta_i$$

where error term $\eta_i$ is the unexplained portion of each unit's fixed effect, while $\omega$ and $\gamma_m$ jointly explain the common part of each unit's fixed effect.

This specification has a certain intuitive appeal. What makes the Grand Canyon grand? It is unlikely we can capture the Grand Canyon's fixed effect (i.e. what makes it unique or special) with a simple vector of attributes. Some factors (size, age, amenities, or other quantifiable features) go into *Z*, while other factors are unobservable (or immeasurable). National park sites are often chosen precisely because of unique features, so that a common set of quality variables may only explain part of a park's fixed effect.

The second stage regresses $\hat{\mu}_i$ on $Z_{mi}$ to obtain $\hat{\omega}$ and $\hat{\gamma}_m$. We then calculate

(5) $$\hat{\eta}_i = \hat{\mu}_i - \hat{\omega} - \sum_{m=1}^{M} \hat{\gamma}_m Z_{mi} .$$

In the last stage, $\hat{\eta}$ is placed back into the pooled regression model to estimate

(6) $$Y_{it} = \alpha + \sum_{k=1}^{K} \beta_k X_{kit} + \sum_{m=1}^{M} \gamma_m Z_{mi} + \delta \hat{\eta}_i + \varepsilon_{it}$$

Estimating (6) yields coefficients for time-varying and time-invariant variables. An adjustment in the degrees of freedom is needed when calculating standard errors (to account for the unit effects), else the standard errors would be underestimated (Plumper and Troeger, 2004; 2007). The coefficient of $\hat{\eta}$ should approximately equal one because $\hat{\eta}$ attempts to account for the unexplained part of each unit's fixed effect. In this last stage the model can be estimated with PCSE and AR(1) correction.

To test the validity of FEVD, Plumper and Troeger (2004; 2007) conducted Monte Carlo simulations, comparing their method with pooled-OLS, the random effects model (RE), and the Hausman-Taylor model (HT). They report that when unit effects are correlated with both time-varying and time-invariant variables, FEVD outperforms OLS, HT and RE estimators in terms of bias, efficiency, or both.

Plumper and Troeger compared the FEVD to standard FE model in Monte Carlo experiments. When comparing FEVD and FE, "the FE model performs best if the within variance of all regressors of interest is sufficiently large in comparison to their between variance. Otherwise, the efficiency of the FEVD model becomes more important than the unbiasedness of the FE model." In addition, the FE model is unable to capture effects of time-invariant variables.

Plumper and Troeger (2004; 2007) recommend treating rarely changing variables as time invariant in the FEVD estimation procedure. They point out that in the FE model, the variance of parameter estimates has a denominator that depends on the within variance of the explanatory variable. For rarely changing variables, this within variance can approach zero and so the variance of the parameter estimate can approach infinity. Thus, they suggest that the ratio of the between to within standard deviation should inform decisions about whether to treat the variable as time invariant or not. Based on Monte Carlo results, they suggest that if the ratio of between to within standard deviations is greater than 2.8, it is likely better to treat the variable as time-invariant. The exact cut-off rate depends on the correlation between the rarely changing variable and the unobserved unit effects. In their experiments, the cut-off ratio ranged from a low of 1.7 up to 3.8.

**Data and Variables**

Data on annual park visitation come from the National Park Service Public Use Statistics Office (http://www.nature.nps.gov/stats/index.cfm). Data were used from 42 sites in the U.S. National Park System in the Southwestern United States, from 1979 to 2003. Thus, 1,050 observations are available for regression analysis. The units are comprised of 24 National Monuments, 10 National Parks NPS Designated, three National Historical Parks, two National Historic Sites, two National Recreation Areas and one National Memorial (Table 1). The top ten parks account for 80% of annual recreation visits in 2003, while the top five account for nearly two-thirds of visits. The two sites with Lakes, Lake Mead National Recreation Area (NRA), and Glen Canyon NRA (home of Lake Powell) alone account for 36% of visits, illustrating the importance of water-based recreation.

**[ Table 1 here ]**

One can group explanatory variables used in the regression analysis into three categories: demand factors, park attributes, and climate / environmental variables. Demand factors include variables for the regional price of gasoline, the exchange rate, and regional population as well as a competing destination index and a market potential index. The variable *lnGas* is the (log of) U.S. average price of gasoline taken from various years of the *Short Term Energy Outlook* published by the Department of Energy's Energy Information Administration. Prices were deflated using the consumer price index for urban consumers in the Western Region from the Bureau of

Labor Statistics. Previous research has found fuel prices to be significantly and negatively associated with national park visits (Johnson and Suits, 1983; Pergams and Zaradic, 2006).

The variable *lnXRate* is the (log of) the real exchange rate weighted by airline passenger fares, published by the Board of Governors of the Federal Reserve System (Goldberg, 2004). This variable is meant to capture relative price effects on foreign versus domestic travel. Tourism demand studies usually include some measure of exchange rates between source and competing target destinations (Witt and Witt). Exchange rate fluctuations affect the costs of traveling to the United States. For example, a weak dollar may reduce the costs of a U.S. vacation by European or Japanese visitors. If the dollar depreciates, this means that domestic travel (to U.S. national parks) is less expensive relative. Conversely, a strong dollar, relative to the peso, for example, may encourage trips to Mexico. An exchange rate weighted by aggregate trade may not accurately reflect differences in travel-related exchange rates because such an aggregate weight would emphasize manufacturing as opposed to travel purchases. This index is a real index, adjusted for inflation in the U.S. and among trading partners (Goldberg, 2004).

Hanink and White (1999) and Hanink and Stutts (2002) examined spatial aspects of demand for national park visits. They applied two types of indexes: a competing destination index (*CDIndex*) and a market potential index (*MPIndex*). The *CDIndex* measures a park's spatial relationship to other parks, expressed as

(7) $$CDIndex_i = \sum_{j=1}^{n} 1 / D_{ij}$$

where $D_{ij}$ is the distance of park $i$ from park $j$. The closer a park is to other parks in the area considered, the greater the *CDindex* will be. Isolated parks will have a low *CDindex*. Hanink and associates argued that if visits to parks were complementary, the regression coefficient for *CDindex* would be positive. A negative coefficient would imply that visits to individual parks substituted for each other. Both Hanink and White (1999) and Hanink and Stutts (2002) found negative coefficients for *CDindex*, implying that parks substitute for each other. Hanink and Stutts confined their study to Civil War national battlefield parks, while Hanink and White on focused on major, high-volume parks with facilities for overnight stays. They did not examine possible complementarities between these high-volume parks and other, nearby parks. The *CDindex* was constructed by Ponnaluru (2005) who calculated the index using distances between all Southwest parks in the study from online driving distance calculations provided by the web tool of the American Automobile Association (AAA).

The market potential index (*MPIndex*) measures a place's location relative to areas of potential market demand

$$MPIndex_i = \sum_{j=1}^{n} Y_j / D_{ij} \tag{8}$$

where $Y_j$ is real personal income in a metropolitan or micropolitan statistical area and where $D_{ij}$ is the distance from that area and park $i$. Thus, *MPIndex* measures a park's location in relationship to sources of demand for visits. Hanink and White (1999) and Hanink and Stutts (2002) use population instead of income to capture demand. Here, personal income is used to capture both the effects of population and income on demand for visits. One would expect that both would be important. Wicks, et al. (1994) found personal income to be important in explaining visits to Everglades National Park. Again, we rely on Ponnaluru (1995) who constructed an *MPIndex* for Southwest Parks using the AAA driving distance data combined with data from Regional Economic Information System of the Bureau of Economic Analysis on personal income for all metropolitan and micropolitan regions of the Southwest.

We also account for the effects of population growth separately by including the log of regional population (*lnPop*) as an explanatory variable. Data come from the U.S. Bureau of Census and includes populations of Arizona, New Mexico as well as southern counties in Utah, Nevada, and California.

Different attributes of parks will also affect visitor demand. Previous studies have found park area (in square miles) to be significantly and positively associated with visits (Hanink and White, 1999; Weiler and Seidl, 2004; Weiler, 2006). Data on park area are available from Acreage Reports (various years) (http://www.nature.nps.gov/stats/acreagemenu.cfm) of the National Park Service Public Use Statistics Office. Both park area (*Area)* and its squared term (*AreaSq*) were used in the regressions

Hanink and White (1999) and Hanink and Stutts (2002) have used park age as an indicator of the quality or uniqueness of park attributes. They argued that many of the most spectacular parks in the United States (e.g. Yosemite, Grand Canyon, or Yellowstone) were established first. They included park age as an explanatory variable and it had a positive and significant effect in both studies. Rather than use age, we designate the year a park was first established. If one follows the argument that year of establishment relative to other parks is a signal of quality, then one might expect the relative age of parks matters, not their absolute age. Data on year of park establishment were obtained from the National Park Service (http://www.nps.gov/history/history/hisnps/NPSHistory/birthdays.htm).

A variable was included to account for the effects of the aftermath of the 9/11 attacks in the United States. Weiler (2006) notes that this affect could alter visitation and our on conversations with National Park System managers suggested a post-9/11 effect. The variable took on a value of 0.306 if the year is 2001 (to account for the number of days from 9/11/2001 to 12/31/2001), 1 if the year is 2002, and zero otherwise.

The variable *TopoVar* is an index measuring topographical variation. Developed by McGranahan (1999), the variable is an index measuring diversity of landforms in each U.S. county. Each park was assigned a *TopoVar* value based the county where it was located (or principally located). McGranahan found that topographical diversity helped explain in-migration to rural counties, arguing that greater diversity was a desirable natural feature. We include it here as a potentially important, positive park attribute. Puustinen et al. (2009) found topographical features to be important predictor of visits to national parks in Finland.

The variable *Lodging* is a dummy variable indicating whether a park has concessional lodging within its borders. Lodging within a park is likely an attractive feature. It may also be a signal of quality. The National Park Service and concessionaires may desire to build lodging in attractive parks with high visitor demand. This raises a question about whether the variable might be endogenous. However, construction of concessional lodging predates our survey data, often by several decades, so it is a strongly pre-determined.

Weiler and Seidl (2004) and Weiler (2006) have examined the effect of National Park System designation on annual visitation. The National Park Service has 16 different designations for sites (e.g. national monument, national park, national historical park, etc.).They estimated time series-cross section regressions for eight parks that changed designations between 1979 and 2000, treating re-designation from national monument to national park as a natural experiment. National Park designation, they argue, may be an important signal of quality to potential visitors, particularly out-of-state or foreign visitors. Their results are consistent with this argument, finding that, controlling for other factors, national park designation significantly increased the number of visits.

In our analysis, we include dummy variables for national park status (*NP*), national historical park (*NHP*) and national historic site (*NHS*) status to distinguish sites from national monuments and the one national memorial in the sample. While some sites change designation, most do not. So, the impact of a change in designation is mixed with any long-term differences that site designation might imply. The NPS designates system sites with lakes as national recreation areas. Instead of a single static variable, we include measures of lake surface area (discussed below).

The last group of dummy variables account for park anomalies. *Tonto* indicates the year 1990, when the Dude Fire occurred in Tonto National Forest surrounding Tonto National Monument. *Cerro* indicates the year when the Cerro Grande Fire took place in Bandelier National Monument. The variables *Petrified*, *Sunset* and *Casa* mark years when structural changes in visitor counting methods and protocols were put in place and Petrified Forest National Park, Sunset Crater Volcano National Monument, and Casa Grande Ruins National Monument.

The third category of variables used in the regression was climate/environmental variables. Following Mendelsohn and Markowski (1999) and Jones and Scott (2006), long-term winter and summer temperature averages were used to capture long-run adjustments to climate. These included average January temperature and temperature squared (*JanTemp*, *JanTempSq*) and July temperature and temperature squared (*JulTemp*, *JulTempSq*). Data for these variables come from the Western Regional Climate Center (WRCC). WRCC reports 1971-2000 average monthly temperatures for its sites. NPS sites usually have WRCC weather monitoring sites within their boundaries. When this was not the case, the nearest site to the park visitor center was chosen.

McGranahan reported measures of natural amenities that were also included in the regressions. These include the average number of hours of sunshine in January, the relative humidity in July, and their squared terms (*JanSun*, *JanSunSq*, *JulHum*, *JulHumSq*). We also experimented with different variables to capture the possible effects of drought or dryness on park restrictions to curb fire risk. None of the variables tried were statistically significant. One variable *Dry* was included in the final regression. This was a variable based on the December 12-month Standardized Precipitation Index (SPI) reported by the National Oceanic and Atmospheric Administration (NOAA). The SPI measures precipitation in an area in relation to historical averages and is standardized to range -4 to 4, with 0 as a normal year. When SPI < -2, the year is designated as "extremely dry." *Dry* equals one if the SPI < -2 and equals zero otherwise.

Lake Mead National Recreation Area (NRA) and Glen Canyon NRA, home of Lake Powell along with Grand Canyon NP and Zion NP are the four most visited National Park Service sites in the Southwest (Table 1). Following Loomis and Crespi (1999) and Ward et al. (1995), visits to these lakes are specified as a function of lake surface area. With declining surface area marinas and launches may be closed, there may be more hazards to boaters and skiers, and water based recreation can become more congested. Separate variables *LnPowell* and *LnLMNRA* were included in the regressions where *LnPowell* is the log of Lake Powell's surface area and *LnLMNRA* is the log of the combined surface areas of Lake Mead and Lake Mohave. Lake Mohave is also part of the Lake Mead National Recreation Area. When both lakes are at capacity, Lake Mohave's surface area is about 18% of Lake Mead's. In times of drought, however, it can rise to about 28% of Lake Mead's surface area because of Bureau of Reclamation management of reservoir levels. The hypothesis of a single surface area coefficient for Glen Canyon and Lake Mead NRAs was rejected using a log-likelihood test, so results with separate coefficients are reported.

Table 2 reports descriptive statistics for the dependent variable, log of annual visits, and the explanatory variables. Following the FEVD procedure, variables are categorized as time-varying, purely time invariant or rarely changing. In the FEVD procedure, rarely changing variables are treated as time invariant. The ratio of between to within standard deviations was greater than 4.0 for all these variables.

**[ Table 2 here ]**

**Regression Results**

Table 3 reports results of FEVD regression. The overall model fit as good ($R^2 > 0.98$). The hypothesis of panel homoskedasticity was rejected using a Lagrange multiplier test (Greene, 2003). The hypothesis of no contemporaneous correlation of the errors was rejected using a Breusch-Pagan Lagrange multiplier statistic, while the hypothesis of serially uncorrelated errors was rejected based on a Durbin-Watson test. Thus, the FEVD model was estimated using panel corrected standard errors and (Beck and Katz, 1995) and the Cochran-Orcutt procedure to correct for first order autocorrelation (AR(1)).

**[ Table 3 here ]**

The coefficient for *LnGas*, the elasticity of visits with respect to the price of gasoline, is -0.233, implying a 10% increase in the price of gas reduces visits 2.3%. The negative coefficient for *LnXrate* implies that a real appreciation of the dollar has a negative impact on park visits. The coefficient for *LnPop* is close to one, meaning visits increase at the same rate as regional population. This is an important result given the population of the study area is projected to grow by more than 45% from 2005 to 2030 and by more than 75% from 2005 to 2050. It suggests that the effect of population growth would likely swamp other economic or environmental effects.

The competing destination index, *CDIndex*, coefficient is positive, suggesting that there are complementarities between parks. This result differs from Hanink and White (1999) who found this coefficient to be negative. One possible reason for the difference is that their study only included major, high-volume parks and not clusters of parks situated more closely together. The market potential index (*MPIndex*) coefficient was positive suggesting proximity sources of market demand encourages visits. This index is personal income of metropolitan and micropolitan areas in the Southwest, weighted by their distance from a park. This index increases as personal incomes in the area increase. Thus, a positive coefficient appears to differ from Weiler (2006) who found park visits to be an inferior good, declining with rising national and state-level income or Wick et al (1994) who found it to be decreasing in regional income. The *MPIndex* shows small temporal variation relative to spatial variation. So, it might be better thought of as Hanink and White (1999) considered it, a measure of proximity to sources of demand. Topographical variation of the park and its environs (*TopoVar*) has a positive effect on visits as does having concessional lodging. The coefficient on concessional lodging (*Lodging*) is quite large and care should be taken interpreting it.  As noted earlier, years ago, decisions were made to build lodging within parks with more desirable attributes.  For this reason, we interpret the *Lodging* as capturing both the effects of facilities for overnight stays and unobserved aspects of quality.  Thus, although, the coefficient for *Lodging* is 1.6, one would not expect that constructing new lodging at a site where none previously existed would more than double visits.

National Park System designation also appears to matter as a signal of quality.  Weiler and Seidl (2004) and Weiler (2006) found a national park designation has a strong positive effect on visits.  We also found that compared to national monuments (the default) a national historical site or historical park had a negative impact.

Visits first increase then decrease in January temperature (based on *JanTemp* and *JanTempSq*). Warmer Januaries appear to encourage visits up to a point then begin to have negative impacts. The maximum is reached between 46°F and 47°F.  Visits decrease in July temperatures at a decreasing rate and decrease in January sunshine at a decreasing rate.  Visits are increasing then decreasing in July humidity. This may seem odd to many who would consider greater summer humidity unpleasant. However, the U.S. Southwest is extremely arid. The 75$^{th}$ percentile of observations was a relative humidity of 29%. As one moves from low elevation and altitude desert to forested area, humidity increases. Visits increase with humidity up to the point where relative humidity reaches 38 percent, then visits decline with humidity.

The elasticity of visits to Glen Canyon NRA with respect to Lake Powell surface area was than 0.116, while for Lake Mead NRA, the elasticity with respect to the combined surface areas of Lakes Mead and Mohave was just over 0.446. Loomis and Crespi estimated monthly visits to nine U.S. Army Corps of Engineers reservoirs in California and found an elasticity of reservoir recreation visits with respect to lake surface area of 0.39. In a study estimating visits to 115 Corps of Engineers sites, Ward et al. (1995) estimated reservoir-visit elasticity with respect to surface area of 0.47.

The coefficient for *Dry*, the variable indicating a year with a SPI < 2, was negative, but statistically insignificant. We experimented with different discrete and continuous variables based on the either the Standard Precipitation Index (SPI) or the Palmer Drought Severity Index. Although the coefficients of these variables were negative, indicating a negative association between drought and visits, none proved statistically significant.

Two dummy variables were included to account for impacts of wild fires. Tonto denotes the year of the Dude Fire near Tonto National Monument, while Cerro Grande denotes the Cerro Grande Fire that burned many acres within the Bandelier National Monument and surrounding areas. Both coefficients were negative, but only *Cerro* was statistically significant. Regression results suggest that controlling for other factors, the Cerro Grande Fire accounted for a 23% drop in visits in 2000. Since 1994, visits have been trending downward at Bandelier. Actual 2000 visits were 25% below 1999 levels and 21% 2001 levels.

**Comparative statics**

In this section, regression coefficients are used to map changes in January and July temperatures to percent changes in visits to each park. Visits are then mapped into party days, visitor spending, and local economic impacts using the Money Generation Model 2 (MGM2) developed by Stynes et al. (2000) for the National Park Service. MGM2 is an input-output model that translates visits into party days and spending for different visitor segments. Segments include local and non-local visitors on day trips, campers, and visitors using hotels. Different types of visitors have different spending patterns, so the share of visitors in each segment affects overall spending. Converting visits to party days is important because the latter measures the number of days (and nights) visitors are in the area (as opposed to the number of times parties enter a park). Visitor spending depends on the number of days a party spends in the area and the size of the party more than the number of times individuals enter a park. Visitor spending per party day estimates were derived directly from visitor surveys, from surveys of park managers, or based on spending patterns from similar parks.

Visitor spending overstates the amount of money visits inject into the local economy. Local sales include only local retail mark-ups (or wholesale markups, where appropriate). Multipliers are derived from input-output models such as IMPLAN or RIMS II (Rickman and Schwer). Local sales map into jobs supported by visitor spending and into personal income. The jobs measure includes all jobs, making no distinction between full-time jobs and part-time or seasonal jobs. Personal income includes wages, salaries and benefits as well as proprietor's income. MGM2 uses the more conservative IMPLAN Type SAM multipliers instead of Type II multipliers (Stynes et al., 2000; Alward and Lindall, 1996).

MGM2 reports both direct effects of visitor spending as well as multiplier effects. These latter may be divided into indirect effects – changes in sales, income, and jobs in backward linked industries – and induced effects – changes in sales, income, and jobs from changes in household income. Indirect effects include demand generated for inputs used to deliver goods and services to visitors. Induced effects are the multiplier effects from increased income from visitor related wages and profits. For example, more visitors can increase demand for hotel workers. Hotel workers in turn spend part of their incomes locally.

**Climate Change Scenario**

We conduct a comparative static exercise, simulating the effects of a 2°F increase in July temperature and a 1°F increase in January temperature on the percent-change in annual visits. These temperature increases are projected on to the observations at a 2003 baseline. Studies suggest warming of this magnitude over the next 20 years in the Southwest, with summer temperatures rising more quickly than winter temperatures (Hayhoe et al., 2004; NMOSE, 2006; Christensen and Hewitson, 2007; NMBGMR, 2007; Ray et al., 2008). Previous research has found warmer temperatures to have a net positive impact on outdoor recreation and park visitation (Mendelsohn and Markowski; Loomis and Crespi) and park visitation (Weiler et al., 2002; Richardson and Loomis, 2004; Loomis and Richardson, 2006; Jones and Scott, 2006; Scott, et al., 2007). Our simulation results are generally consistent with these previous findings, with an important exception. While the simulated temperature increases have a positive effect on visits to most parks, visits to low desert, low-elevation parks decline with the temperature increases (Table 4). While 34 parks experience gains in visitor spending totaling $84.6 million, eight parks experience losses totaling $3.7 million. Among parks with visitor spending gains, Grand Canyon NP, Lake Mead NRA and Glen Canyon NRA account for 52% of the increased visitor spending. Among parks with visitor losses, Saguaro NP and Joshua Tree NP account for two-thirds of the visitor spending losses. Seven parks account for 79% of visitor spending gains, while three parks account for 85% of spending losses. Future research on climate change and park-based recreation could capture much of the economic impact by focusing on a small sub-set of parks.

**[ Table 4 here ]**

Table 5 shows the direct and indirect effects of the changes in visitor spending for each park in the sample. The total effects of the temperature increases are an increase of $93 million in sales, $33.7 million in personal income and more than 2,000 jobs. Five parks, Grand Canyon, Glen Canyon, Lake Mead, Arches, and Bryce Canyon account for about 70% of the gains in sales, income and jobs among parks with gains.  Of park experiencing losses, three (Joshua Tree, Organ Pipe, and Saguaro) account for more than 83% of losses.

**[Table 5 here]**

**Lake Surface Area**

Because of recent droughts, the surface area of Lake Powell fell 29%, while the surface area of Lake Mead fell 24% from 1998 to 2003. Lake Mohave's surface area fell only 0.4%.  Table 6 simulates what visits to Glen Canyon NRA and Lake Mead NRA would have been in 2003 had lake surface areas been at 1998 levels. Table 6 thus captures some economic losses from declining lake levels. The total effect of the decline in reservoir levels was $29.4 million in sales, $10.4 million in personal income as well as a loss of more than 700 jobs. From 2003 to 2008, the surface area of Lake Mead decline further, for a 35% reduction from 1998 to 2008. The other lakes remained essentially unchanged. Extending the analysis to 2008, the total effects of declining lake levels from 1998 to 2008 was a loss of $42.4 million in sales, $15 million in personal income and a loss of more than 1,000 jobs (Table 6).

**[ Table 6 here ]**

Consistent with previous studies (Loomis and Crespi; Ward et al.) visits to the sites with lakes increase with higher temperatures. However, climate change will likely affect reservoir storage and lake surface area of Lakes Mead and Powell. Loomis and Crespi, to our knowledge, is the only study that attempts to estimate the combined effects of warmer temperatures and lower lake levels on reservoir-based recreation. They found the net effect of the positive effect of warming and negative effect of lower lake levels to be positive. Lake levels at Lakes Powell and Mead have fallen further than previously anticipated by the Bureau of Reclamation, who manages the reservoirs (Garrick et al., 2008) and studies suggest the possibility of significant reduction is lake levels in the Colorado River basin (Harding, et al, 1995; Christensen et al., 2004; Christensen and Lettenmaier, 2007; Barnett and Pierce, 2009). Given that Lake Mead NRA and Glen Canyon NRA accounted for 29% of the gain in park visitor spending from warming, how much might lower lake surface areas negate the projected positive impacts of warming?

In the late 1500s, the Colorado Basin was hit by a severe, multi-decade drought. Harding et al. (1995) examined how the region's hydrology would respond to the reoccurrence of a drought of that magnitude. Model simulations suggested that in the worst years of the drought, Lake Mead's elevation would fall to 1075 feet, while Lake Powell's elevation would fall to the dead pool levels, 3370 feet. Below the dead pool level, water can no longer be extracted from a reservoir via gravity. Christensen et al. (2004) conducted simulations of climate change on management of the Colorado River Basin reservoir system. They considered the likelihood that Lake Mead elevation falls below 1075 feet, triggering a level-one shortage declaration and below 1050 feet, triggering a level-two shortage. Under a level-one shortage, the Law of the River calls for reductions of deliveries to the Central Arizona Project (CAP) of 320,000 acre-feet and 13,000 to the Southern Nevada Water Authority (SNWA). Under a level two shortage, supplies to CAP and SNWA are reduced by 400,000 and 17,000 acre-feet. In simulations using 1950-1999 streamflows combined with 2000 demands, a level one shortage occurred in 60% of years. In simulations over the period 2006-2039, a level one shortage occurred 92% of years and level two shortages were declared 77% of years.  Using updated general circulation model (GCM) results, Christensen and Lettenmaier obtain more optimistic results. Nevertheless, simulations project that level one shortages would occur 21% of years from 2010-2039, while level three shortages would occur 10-11% of years. A level three shortage could be declared if Lake Mead elevations fell below 1025 feet.

Barnett and Pierce (2007) using probabalistic simulation modeling reported that there was a 50% chance that Lakes Mead and Powell would fall below their minimum power pool levels by 2017. Minimum power pool levels are the minimum lake elevations needed to generate hydroelectric power. This is 1050 feet for Lake Mead and 3490 for Lake Powell.  Assuming a climate-change induced 20% reduction in run-off, they found a 50% probability that both Lakes would reach their dead pool levels (3370 for Powell, 900 for Mead) by 2028. This article, titled "When Will Lake Mead Go Dry?" received considerable press coverage.  It has also received criticism from scientists (Barsulgi et al., 2009; Rajagopalan, 2009) and water managers, in part because of hydrologic modeling assumptions, but more importantly because of assumptions about how the Bureau of Reclamation (BOR), States, and other water management entities will respond to reduced water supplies. For example, the study did not include the BOR's Interim Guidelines for dealing with shortages on the Colorado River (USBR, 2007). Subsequent work by Rajagopalan et al. (2009) suggests that the probability of the lakes falling below dead pool elevations are less than 10% before 2026 and highlights the importance of pro-active management to reduce risks of shortages. After 2026, however, the authors find that the risk of lake "drying" could rise dramatically, depending on how climate change might affect runoff levels. More recently, Barnett and Pierce (2009), attempted to account for criticisms of their earlier work and consider reductions in deliveries needed to keep Lake Mead's elevations above 1,000 feet, the elevation needed to maintain water deliveries to Las Vegas. They still estimated that, given 20% reductions in runoff, shortage declarations (and reduced deliveries) would be common occurrences by 2030. They also estimated that deliveries would have to be curtailed sharply to maintain Lake Mead at 1,000 feet, even if Lake Powell was reduced to its dead pool elevation.

A key point about this literature is that the levels of Lakes Mead and Powell are not just functions of climate and hydrology. Rather, human management of the Colorado River and reservoir system is quite critical. Indeed, the BOR's Interim Guidelines illustrates how reservoir levels can vary depending on management options chosen. The Final EIS for the Guidelines reports estimates of the probabilities of lake levels falling below certain elevations that would create boating hazards or make marinas or launches inaccessible (USDI, BOR, 2007). The EIS, however, does not attempt to calculate the effects of these reduced elevations on visits and subsequent economic impacts. The results reported here could be used in future analyses of the economic consequences of different reservoir management options.

**Lake level and climate change scenarios**

Table 7 reports estimates of how changing lake elevations affect visitation to Lakes Powell and Mead. These results are used to construct three water shortage scenarios (Table 8). In the Level 1 Shortage scenario, Lake Powell's elevation drops from its 2003 elevation of 3,608 to 3,560 feet, while Lake Mead's drops from 1,145 to 1,075 feet. The 1,075 elevation would trigger a Level 1 shortage declaration on the Colorado River. At 3,560 feet, several launch facilities in Lake Powell could not be operated. In the Power Pool scenario, lake elevations fall further, from 2003 levels to their minimum power pool levels. The Powel Dead Pool scenario matches the case examined in Barnett and Pierce (2009) where Lake Powell's elevation falls to its dead pool level, while Lake Mead's falls to 1,000 feet, the minimum level needed to continue to transfer water to Las Vegas.

**[Table 7 here]**

The impacts of the three scenarios are increasingly negative. Party days fall by 0.29-0.76 million days, while visitor spending falls from $28-$70 million. Accounting for direct, indirect, and induced effects, sales fall $28-$72 million and personal income falls $10-$25 million, while job losses range from about 700 to over 1,700.

**[Table 8 here]**

Table 9 considers impacts of temperature change in combination with different changes in lake levels.  The baseline year values are from 2003. This comparative static exercise examines the effect of a temperature shock that may occur over the next 30 years in combination with the different lake level scenarios. It is not a forecast. It does not attempt to update population, income, or other variables. Our intent is to consider what types of lake level scenarios would have to obtain for the negative surface area effects to dominate the positive temperature effects on lake visitation. The pure effect of temperature increases alone (+2°F July, + 1°F January) is positive. However, the combined effect warmer temperatures and declining lakes grows increasingly negative with greater reductions in lake levels. Combining temperature with our Level 1 Shortage and Power Pool scenario leads to net economic losses (as measured by sales, incomes, and jobs). Positive net effects for Lake Powell are dominated by negative effects for Lake Mead.

Temperature change combined with the Dead Pool scenario implies net losses at both sites. A key question for future research is how climate change affects the probability of occurrence of the scenarios examined here. Christiansen et al.'s (2004) research suggests that lake levels of the Level 1 Shortage scenario would become the norm, while conditions corresponding to the Power Pool scenario would become frequent.

**[Table 9 here]**

Table 10 shows how the combined temperature and lake level scenarios affect regional visitation and economic activity. Even with declining lake levels, the net effect for the region as a whole remains positive. However, water shortages can have a dramatic effect on the estimates. With no lake level reductions, rising temperatures increase visits by 1.6 million and personal income by $33.7 million. Rising temperatures combined with the Dead Pool scenario reduces the gain in personal income to about $8 million, while total visits actually decline by 0.4 million. Party days still increase modestly. There are large reductions in visits to Lake Mead. However, in the MGM2 Model, 30% of Lake Mead visitors are visitors on local day trips, who have lower spending patterns than, say visitors to the Grand Canyon. Spending per party day for Lake Mead is $100, averaged over all visitor segments, while it is $211 per party day for Grand Canyon visitors.

**[Table 10 here]**

**Climate change mitigation policies**

We next consider the effects of carbon taxes on gasoline prices and subsequent impacts on park visitation. Nordhaus and Boyer (2000) and Nordhaus (2008) estimate an optimal global price for $CO_2$, rising from $9.5 / ton in 2015 to $23 / ton of carbon by 2050. Estimates of the marginal social costs of carbon emissions range widely with large outliers (Tol, 2005; 2007). Most studies report estimates below $75 / ton of carbon ($18 / ton of $CO_2$,) with most estimates from peerreviewed studies falling below \$50 / ton of carbon (\$12 / ton of $CO_2$) (Tol, 2007). Clarke et al. (2007) simulated carbon price trajectories needed to stabilize atmospheric CO2 concentrations at 450, 550, and 650 ppm. They estimate that by 2025 the price of CO2 emissions would need to rise to \$40–\$95 per ton of CO2 to reach the 450-ppm emission target, \$5–\$30 to reach the 550-ppm target, and \$1–\$10 to reach the 650-ppm target. After 2025, prices would have to continue to rise by 3-5% / year in real terms.

Table 11 estimates the impact of two carbon tax levels on the price of gasoline and the subsequent implications for park visits and local economic impacts. Conversion factors translating taxes rates on $CO_2$ to rates on carbon and gasoline prices are based on Aldy et al. (2008). The \$10 per ton of $CO_2$ tax increases the price of gasoline 8.8 cents. At 2003 prices, this represents a 5.5% price increase (although it would be considerably less at current gas prices). The tax reduces visitation with a total impact of 391 local jobs lost.

One way to counteract the negative employment effects would be to increase the level of park service employment in the region. Stynes (2007) estimates that for every two park service jobs, one additional (non-NPS) job is generated. The Public Lands Service Corps Act of 2009 (H.R. 1612) recently introduced in Congress would increase construction and employment in national parks and other public lands through creation of a service corp. This would be something similar to the old Civilian Conservation Corp (CCC) instituted during the New Deal. Table 11 suggests that a relatively small increase in jobs under this proposed program would suffice to counteract the negative effects of the \$10 ton $CO_2$ tax.

## Conclusions

To summarize, this study applies a relatively new statistical technique – fixed effect vector decomposition (FEVD) – to estimate time series-cross section data on Southwest national park visitation. Unlike standard fixed effects estimation, FEVD allows estimation of effects of time-invariant park attributes. It also allows for more efficient estimation of effects of rarely changing variables. Econometric results are then used as inputs for input-analysis to examine impacts of climate change, water shortages, and carbon taxes on sales, personal and employment in gateway communities to national parks.

Results suggest that warming (by itself) has a positive impact overall on regional visits. The type and timing of warming matter, however. Winter warming (up to a point) has more positive effects than summer warming. Projected warming reduces visits in low desert parks, but increases visits elsewhere. Increased visits have positive local economic impacts, but could also place extra pressure on park resources. Warming increases demand for reservoir recreation visits, but declining lake levels discourage visits. There is great uncertainty about the future levels of Lakes Powell and Mead, which account for a large share of regional visits. Under some combined temperature increase / water shortage scenarios, the net effect is a decline in reservoir recreation.

Carbon taxes would have modest, negative impacts on local employment. The elasticity of park visits with respect to gas price was about -0.23. Recent proposed legislation to increase public works and employment in national parks could counteract these negative impacts.

Finally, the elasticity of visits with respect to regional population was estimated to be close to unity. So, pure population change may have a greater impact on park visitation (and local economies) than the environmental changes or policies considered.

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**Table 1. Recreation Visits to Parks in Sample, 2003**

| Park | Recreation Visits |
|---|---|
| Lake Mead NRA | 7,915,581 |
| Grand Canyon NP | 4,124,900 |
| Zion NP | 2,458,792 |
| Glen Canyon NRA | 1,876,984 |
| Joshua Tree NP | 1,283,346 |
| Bryce Canyon NP | 903,760 |
| Canyon de Chelly NM | 866,498 |
| Arches NP | 757,781 |
| Saguaro NP | 643,697 |
| Montezuma Castle NM | 637,024 |
| Petrified Forest NP | 586,245 |
| Cedar Breaks NM | 569,455 |
| Capitol Reef NP | 535,441 |
| White Sands NM | 492,008 |
| Carlsbad Caverns NP | 457,631 |
| Canyonlands NP | 386,986 |
| Bandelier NM | 287,096 |
| Organ Pipe Cactus NM | 277,566 |
| Wupatki NM | 266,159 |
| Hubbell Trading Post NHS | 163,883 |
| Sunset Crater Volcano NM | 159,073 |
| Tuzigoot NM | 115,216 |
| Walnut Canyon NM | 111,465 |
| Natural Bridges NM | 98,874 |
| Rainbow Bridge NM | 98,865 |
| Coronado Nmem | 89,309 |
| Casa Grande Ruins NM | 87,687 |
| Chaco Culture NHP | 84,621 |
| Navajo NM | 76,620 |
| Capulin Volcano NM | 61,373 |
| Tonto NM | 59,216 |
| El Morro NM | 57,889 |
| Pipe Spring NM | 56,341 |
| Tumacacori NHP | 52,393 |
| Gila Cliff Dwellings NM | 47,869 |
| Chiricahua NM | 44,976 |
| Aztec Ruins NM | 42,493 |
| Pecos NHP | 38,326 |
| Salinas Pueblo Missions NM | 33,827 |
| Hovenweep, NM | 29,737 |
| Fort Union NM | 12,944 |
| Fort Bowie NHS | 8,445 |
| **Total** | **26,958,392** |

**Table 2. Descriptive statistics for variables used in park visitation regression**

| | | Mean | St. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| *Time varying variables* | | | | | |
| LnVisit | Ln (annual visits) | 12.163 | 1.525 | 8.50 | 16.10 |
| *LnGas* | Ln (real gasoline price) | 5.119 | 0.243 | 4.78 | 5.66 |
| *LnXRate* | Ln (real exchange rate) | 4.693 | 0.115 | 4.54 | 4.93 |
| *LnPop* | Ln (regional population) | 17.451 | 0.143 | 17.20 | 17.68 |
| *Post911* | Post 9/11 dummy variable | 0.092 | 0.274 | 0 | 1 |
| *Petrified* | Change in counting methods | 0.006 | 0.075 | 0 | 1 |
| *Sunset* | Change in counting methods | 0.008 | 0.087 | 0 | 1 |
| *Casa* | Change in counting methods | 0.002 | 0.044 | 0 | 1 |
| *Dry* | Year with SPI < -2 | 0.01 | 0.10 | 0 | 1 |
| *Cerro* | Dummy for fire year | 0.00 | 0.03 | 0 | 1 |
| *Tonto* | Dummy for fire year | 0.00 | 0.03 | 0 | 1 |
| *Time invariant / rarely changing variables* | | | | | |
| *CDInex* | Competing Destination Index | 0.160 | 0.040 | 0.09 | 0.28 |
| *MPIndex* | Market Potential Index | 1,276,056 | 2,731,426 | 306,076 | 25,529,214 |
| *Estab* | Year NPS site established | 1929 | 19 | 1906 | 1966 |
| *TopoVar* | Topographic variation index | 0.477 | 0.656 | -0.44 | 1.84 |
| *Lodging* | Concessional lodging dummy | 0.119 | 0.324 | 0 | 1 |
| *Area* | Park area | 152,369 | 349,155 | 40 | 1,495,664 |
| *NP* | National Park | 0.208 | 0.406 | 0 | 1 |
| *NHP* | National Historical Park | 0.049 | 0.216 | 0 | 1 |
| *NHS* | National Historical Site | 0.059 | 0.235 | 0 | 1 |
| *JanTemp* | Avg. Jan. temperature | 35.7 | 8.3 | 21.7 | 54.7 |
| *JulTemp* | Avg. July temperature | 76.8 | 7.7 | 60.1 | 94.2 |
| *JanSun* | Avg. Jan. days of sunshine | 220.21 | 32.22 | 141.00 | 266.00 |
| *JulHum* | Avg. July humidity | 27.31 | 8.68 | 14.00 | 68.00 |
| *LnPowell* | Ln (L.Powell surface area) | 0.28 | 1.80 | 0.00 | 11.94 |
| *LnLMNRA* | Ln (L. Mead NRA surface area) | 0.28 | 1.82 | 0.00 | 11.97 |

**Table 3. Annual recreation visits: Fixed Effect Vector Decomposition (FEVD) regression results**

Dependent Variable: Ln (Annual Recreation Visits) Number of Observations: 1008
Adjusted $R^2$: 0.98395

| | | Coefficient | Standard Error |
|---|---|---|---|
| Constant | | 32.18669 | 1.53768* |
| *LnGas* | Ln (real gasoline price) | -0.2334165 | 0.0608322* |
| *LnXRate* | Ln (real exchange rate) | -0.3006279 | 0.0746176* |
| *LnPop* | Ln (regional population) | 1.059815 | 0.1217164* |
| *Post911* | Post 9/11 dummy variable | -0.14437 | 0.0385546* |
| *CDInex* | Competing Destination Index | 13.56334 | 0.1375827* |
| *MPIndex* | Market Potential Index | 4.98e-08 | 1.76e-09* |
| *Estab* | Year NPS site established | -.0204284 | 0.0003031* |
| *TopoVar* | Topographic variation index | .2600213 | 0.0095831* |
| *Lodging* | Concessional lodging dummy | 1.631734 | 0.0247951* |
| *Area* | Park area | 9.12e-06 | 1.25e-07* |
| *AreaSq* | Park area squared | -6.69e-12 | 9.53e-14* |
| *Petrified* | Change in counting methods | -0.1221853 | 0.0598457** |
| *Sunset* | Change in counting methods | -0.940094 | 0.0329322* |
| *Casa* | Change in counting methods | -0.4119768 | 0.980818* |
| *NP* | National Park | 0.9814274 | 0.110322* |
| *NHP* | National Historical Park | -0.5925199 | 0.0404904* |
| *NHS* | National Historical Site | -0.2756065 | 0.0221629* |
| *JanTemp* | Avg. Jan. temperature | 0.4603223 | 0.0159172* |
| *JanTempSq* | Avg. Jan. temperature$^2$ | -0.0049867 | 0.0002095* |
| *JulTemp* | Avg. July temperature | -0.098604 | 0.0311719* |
| *JulTempSq* | Avg. July temperature$^2$ | 0.0005051 | 0.0002095** |
| *JanSun* | Avg. Jan. days of sunshine | -0.0408096 | 0.003303* |
| *JanSunSq* | Avg. Jan. days of sunshine$^2$ | 0.000547 | 8.10e-06* |
| *JulHum* | Avg. July humidity | 0.0805317 | 0.0028882* |
| *JulHumSq* | Avg. July humidity$^2$ | -0.0010695 | 0.0000382* |
| *LnPowell* | Ln (L.Powell surface area) | 0.1157354 | 0.0040682* |
| *LnLMNRA* | Ln (L. Mead NRA surface area) | 0.4455426 | 0.0057047* |
| *Dry* | Year with SPI < -2 | -0.016727 | 0.0588642 |
| *Cerro* | Dummy for fire year | -0.2648594 | 0.0920546* |
| *Tonto* | Dummy for fire year | -0.2973203 | 0.2154973 |
| Eta ($\eta$) | | 1.005091 | 0.010786* |

Final ρ after iterations: 0.799505;
Durbin Watson (original): 0.3746
Durbin Watson (transformed): 1.873178

** significant at 5% level; * significant at 1% level

**Table 4. Estimated Change in Visits and Visitor Spending, with 2°F July temperature increase and a 1° F January temperature increase**

| | | – Change in – | | |
|---|---|---|---|---|
| **Park** | Percent Change in Visits | Visits | Party Days | Visitor Spending (million's) |
| Grand Canyon NP | 6% | 243,701 | 94,824 | 20.0 |
| Glen Canyon NRA | 12% | 233,107 | 175,849 | 13.5 |
| Lake Mead NRA | 4% | 349,022 | 106,505 | 10.6 |
| Arches NP | 16% | 119,051 | 58,342 | 10.0 |
| Bryce Canyon NP | 12% | 112,561 | 65,759 | 5.1 |
| Canyon de Chelly NM | 10% | 89,025 | 45,811 | 4.1 |
| Zion NP | 4% | 107,864 | 41,386 | 3.5 |
| Capitol Reef NP | 14% | 77,365 | 44,228 | 3.3 |
| Canyonlands NP | 15% | 58,163 | 34,960 | 2.5 |
| Petrified Forest NP | 7% | 38,116 | 21,353 | 2.3 |
| Cedar Breaks NM | 11% | 60,715 | 30,415 | 1.9 |
| White Sands NM | 4% | 21,600 | 8,053 | 0.9 |
| Wupatki NM | 8% | 21,506 | 10,754 | 0.9 |
| Bandelier NM | 8% | 24,357 | 10,780 | 0.9 |
| Sunset Crater Volcano NM | 8% | 13,083 | 6,543 | 0.6 |
| Rainbow Bridge NM | 13% | 12,482 | 6,242 | 0.6 |
| Hubbell Trading Post NHS | 8% | 12,368 | 6,185 | 0.5 |
| Montezuma Castle NM | 2% | 11,881 | 5,941 | 0.5 |
| Natural Bridges NM | 12% | 11,642 | 5,969 | 0.5 |
| Tonto NM | 16% | 9,303 | 4,652 | 0.4 |
| Navajo NM | 9% | 7,226 | 3,658 | 0.3 |
| Walnut Canyon NM | 6% | 6,807 | 3,404 | 0.3 |
| Chaco Culture NHP | 12% | 9,940 | 4,122 | 0.2 |
| Hovenweep, NM | 14% | 4,063 | 2,070 | 0.2 |
| Pipe Spring NM | 7% | 3,953 | 1,977 | 0.2 |
| Salinas Pueblo Missions NM | 16% | 5,314 | 2,215 | 0.2 |
| El Morro NM | 8% | 4,725 | 1,959 | 0.1 |
| Aztec Ruins NM | 11% | 4,717 | 1,640 | 0.1 |
| Capulin Volcano NM | 7% | 4,192 | 1,557 | 0.1 |
| Pecos NHP | 6% | 2,248 | 774 | 0.0 |
| Gila Cliff Dwellings NM | 2% | 794 | 324 | 0.0 |
| Tuzigoot NM | 0% | 197 | 98 | 0.0 |
| Fort Union NM | 3% | 333 | 141 | 0.0 |
| Fort Bowie NHS | -1% | (90) | (45) | 0.0 |
| Casa Grande Ruins NM | -1% | (1,026) | (410) | 0.0 |
| Tumacacori NHP | -4% | (2,075) | (1,038) | -0.1 |
| Chiricahua NM | -3% | (1,423) | (787) | -0.1 |
| Coronado Nmem | -4% | (3,632) | (1,816) | -0.1 |
| Carlsbad Caverns NP | -2% | (7,319) | (3,483) | -0.3 |
| Organ Pipe Cactus NM | -6% | (15,452) | (8,016) | -0.7 |
| Joshua Tree NP | -2% | (20,279) | (9,491) | -0.8 |
| Saguaro NP | -4% | (27,030) | (15,149) | -1.7 |
| Total | | 1,603,095 | 768,256 | 80.5 |

| Table 5. Local economic impacts of a 2°F July and a 1° F January temperature increase | | | | | | |
|---|---|---|---|---|---|---|
| | Direct Effects | | | Total Effects | | |
| Park | Sales (millions) | Jobs | Income (millions) | Sales (millions) | Jobs | Income (millions) |
| Grand Canyon NP | 17.6 | 356 | 7.3 | 25.6 | 462 | 10.0 |
| Glen Canyon NRA | 10.7 | 263 | 3.9 | 15.5 | 331 | 5.6 |
| Lake Mead NRA | 7.8 | 229 | 2.8 | 10.3 | 267 | 3.6 |
| Arches NP | 8.5 | 235 | 2.9 | 11.3 | 276 | 3.9 |
| Bryce Canyon NP | 4.2 | 119 | 1.4 | 5.5 | 140 | 1.9 |
| Canyon de Chelly NM | 3.4 | 84 | 1.2 | 4.9 | 106 | 1.8 |
| Zion NP | 2.8 | 71 | 1.0 | 4.1 | 88 | 1.5 |
| Capitol Reef NP | 2.8 | 79 | 0.9 | 3.7 | 92 | 1.2 |
| Canyonlands NP | 1.9 | 55 | 0.7 | 2.6 | 65 | 0.9 |
| Petrified Forest NP | 2.0 | 49 | 0.7 | 2.9 | 62 | 1.0 |
| Cedar Breaks NM | 1.5 | 44 | 0.5 | 2.0 | 51 | 0.7 |
| White Sands NM | 0.8 | 23 | 0.3 | 1.1 | 27 | 0.4 |
| Wupatki NM | 0.8 | 19 | 0.3 | 1.1 | 24 | 0.4 |
| Bandelier NM | 0.8 | 19 | 0.3 | 1.1 | 24 | 0.4 |
| Sunset Crater Volcano NM | 0.5 | 12 | 0.2 | 0.7 | 15 | 0.3 |
| Rainbow Bridge NM | 0.5 | 11 | 0.2 | 0.7 | 14 | 0.2 |
| Hubbell Trading Post NHS | 0.5 | 11 | 0.2 | 0.7 | 14 | 0.2 |
| Montezuma Castle NM | 0.4 | 11 | 0.2 | 0.6 | 14 | 0.2 |
| Natural Bridges NM | 0.4 | 11 | 0.2 | 0.6 | 13 | 0.2 |
| Tonto NM | 0.3 | 8 | 0.1 | 0.5 | 11 | 0.2 |
| Navajo NM | 0.3 | 7 | 0.1 | 0.4 | 8 | 0.1 |
| Walnut Canyon NM | 0.2 | 6 | 0.1 | 0.4 | 8 | 0.1 |
| Chaco Culture NHP | 0.2 | 4 | 0.1 | 0.2 | 5 | 0.1 |
| Hovenweep, NM | 0.1 | 4 | 0.1 | 0.2 | 5 | 0.1 |
| Pipe Spring NM | 0.1 | 4 | 0.1 | 0.2 | 4 | 0.1 |
| Salinas Pueblo Missions NM | 0.1 | 4 | 0.0 | 0.2 | 5 | 0.1 |
| El Morro NM | 0.1 | 3 | 0.0 | 0.1 | 4 | 0.1 |
| Aztec Ruins NM | 0.1 | 3 | 0.0 | 0.1 | 3 | 0.1 |
| Capulin Volcano NM | 0.1 | 2 | 0.0 | 0.1 | 2 | 0.0 |
| Pecos NHP | 0.0 | 1 | 0.0 | 0.0 | 1 | 0.0 |
| Gila Cliff Dwellings NM | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 |
| Tuzigoot NM | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 |
| Fort Union NM | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 |
| Fort Bowie NHS | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 |
| Casa Grande Ruins NM | 0.0 | -1 | 0.0 | 0.0 | -1 | 0.0 |
| Tumacacori NHP | -0.1 | -2 | 0.0 | -0.1 | -2 | 0.0 |
| Chiricahua NM | -0.1 | -1 | 0.0 | -0.1 | -2 | 0.0 |
| Coronado NMem | -0.1 | -3 | 0.0 | -0.1 | -3 | 0.0 |
| Carlsbad Caverns NP | -0.2 | -6 | -0.1 | -0.4 | -8 | -0.1 |
| Organ Pipe Cactus NM | -0.6 | -14 | -0.2 | -0.8 | -18 | -0.3 |
| Joshua Tree NP | -0.6 | -14 | -0.2 | -1.0 | -18 | -0.4 |
| Saguaro NP | -1.4 | -34 | -0.5 | -2.1 | -44 | -0.7 |
| Total | 66.5 | 1,671 | 24.5 | 93.0 | 2,047 | 33.7 |

**Table 6. Economic Impacts of Declining Reservoir levels: Losses in 2003 and 2008 from Lake Surface Area Below 1998 Levels**

| | Glen Canyon NRA | Lake Mead NRA | Total |
|---|---|---|---|
| 2003 Reductions in | | | |
| Visits | 76,261 | 827,662 | 903,923 |
| Party Days | 57,529 | 252,562 | 310,092 |
| Visitor Spending (millions) | 4.4 | 25.1 | 29.5 |
| | | | |
| Direct Effects (reductions) | | | |
| Sales (millions) | 3.5 | 18.5 | 22.0 |
| Jobs | 86 | 543 | 630 |
| Income (millions) | 1.3 | 6.6 | 7.9 |
| | | | |
| Total Effects (reductions) | | | |
| Sales (millions) | 5.1 | 24.3 | 29.4 |
| Jobs | 108 | 633 | 741 |
| Income (millions) | 1.8 | 8.6 | 10.4 |
| | Glen Canyon NRA | Lake Mead NRA | Total |
| 2008 Reductions in | | | |
| Visits | 73,996 | 1,273,815 | 1,347,811 |
| Party Days | 55,820 | 388,707 | 444,527 |
| Visitor Spending (millions) | $4.3 | $38.7 | 43 |
| | | | |
| Direct Effects (reductions) | | | |
| Sales (millions) | $3.4 | $28.5 | 32 |
| Jobs | 84 | 836 | 920 |
| Income (millions) | $1.2 | $10.2 | $11.4 |
| | | | |
| Total Effects (reductions) | | | |
| Sales (millions) | $4.9 | $37.4 | $42.4 |
| Jobs | 105 | 974 | 1,079 |
| Income (millions) | $1.8 | $13.2 | $15.0 |

**Table 7. Decline in lake visitation in response to declining reservoir levels**

| Lake Mead NRA | |
|---|---|
| Elevation (ft.) | Percent Reduction in Visits |
| 1,145 (baseline) | — |
| 1,075 | -10.5% |
| 1,050 | -14.1% |
| 1,000 | -21.2% |
| **Glen Canyon NRA (Lake Powell)** | |
| Elevation (ft.) | Percent Reduction in Visits |
| 3,608 (baseline) | — |
| 3,560 | -2.8% |
| 3,490 | -7.5% |
| 3,370 | -17.7% |

**Table 8. Economic impacts of lake reduction scenarios**

| | Scenario 1 Level 1 Shortage | | | Scenario 2 Power Pool | | | Scenario 3 Powell Dead Pool | | |
|---|---|---|---|---|---|---|---|---|---|
| | Glen Canyon | Lake Mead | Total | Glen Canyon | Lake Mead | Total | Glen Canyon | Lake Mead | Total |
| Recreation Visits | -52,942 | -830,705 | -883,647 | -140,403 | -1,118,904 | -1,259,307 | -332,307 | -1,679,373 | -2,011,680 |
| Party Days | -39,937 | -253,491 | -293,429 | -105,916 | -341,435 | -447,351 | -250,682 | -512,463 | -763,145 |
| Visitor Spending (millions) | -$3.1 | -$25.2 | -$28.3 | -$8.1 | -$34.0 | -$42.1 | -$19.2 | -$51.0 | -$70.2 |
| | | | | | | | | | |
| Direct Effects | | | | | | | | | |
| Sales (millions) | -$2.4 | -$18.6 | -$21.0 | -$6.4 | -$25.0 | -$31.4 | -$15.2 | -$37.5 | -$52.8 |
| Jobs | -60 | -545 | -605 | -159 | -735 | -893 | -375 | -1103 | -1478 |
| Income (millions) | -$0.9 | -$6.6 | -$7.5 | -$2.3 | -$8.9 | -$11.3 | -$5.5 | -$13.4 | -$18.9 |
| | | | | | | | | | |
| Total Effects | | | | | | | | | |
| Sales (millions) | -$3.5 | -$24.4 | -$27.9 | -$9.3 | -$32.9 | -$42.2 | -$22.1 | -$49.4 | -$71.5 |
| Jobs | -75 | -635 | -710 | -200 | -855 | -1055 | -472 | -1284 | -1756 |
| Income (millions) | -$1.3 | -$8.6 | -$9.9 | -$3.4 | -$11.6 | -$15.0 | -$8.0 | -$17.4 | -$25.4 |

**Table 9. Combined Effects of Temperature Increases and Water Shortages on Glen Canyon and Lake Mead NRAs**

| | —Recreation Visits— | | Spending | —Direct Effects— | | | —Total Effects— | | |
|---|---|---|---|---|---|---|---|---|---|
| | Visits | Party Days | Visitor Spending (millions) | Sales (millions) | Jobs | Income (millions) | Sales (millions) | Jobs | Income (millions) |
| *Temperature Change Only* | | | | | | | | | |
| Glen Canyon | 233,107.4 | 175,849.0 | $13.5 | $10.7 | 263.3 | $3.9 | $15.5 | 331.3 | $5.6 |
| Lake Mead | 349,022.5 | 106,504.8 | $10.6 | $7.8 | 229.2 | $2.8 | $10.3 | 266.9 | $3.6 |
| Total | 582,129.9 | 282,353.8 | $24.1 | $18.5 | 492.4 | $6.7 | $25.8 | 598.2 | $9.2 |
| *Temperature Change Only + Level 1 Shortage Scenario* | | | | | | | | | |
| Glen Canyon | 180,165.8 | 135,911.5 | $10.4 | $8.3 | 203.5 | $3.0 | $12.0 | 256.1 | $4.3 |
| Lake Mead | -481,682.9 | -146,986.3 | -$14.6 | -$10.8 | -316.3 | -$3.8 | -$14.2 | -368.3 | -$5.0 |
| Total | -301,517.1 | -11,074.8 | -$4.2 | -$2.5 | -112.8 | -$0.9 | -$2.2 | -112.2 | -$0.6 |
| *Temperature Change Only + Power Pool Shortage Scenario* | | | | | | | | | |
| Glen Canyon | 92,704.1 | 69,933.1 | $5.4 | $4.3 | 104.7 | $1.5 | $6.2 | 131.8 | $2.2 |
| Lake Mead | -769,881.4 | -234,930.5 | -$23.4 | -$17.2 | -505.5 | -$6.1 | -$22.6 | -588.6 | -$8.0 |
| Total | -677,177.3 | -164,997.4 | -$18.0 | -$12.9 | -400.8 | -$4.6 | -$16.5 | -456.9 | -$5.7 |
| *Temperature Change Only + Dead Pool Shortage Scenario* | | | | | | | | | |
| Glen Canyon | -99,199.8 | -74,833.3 | -$5.7 | -$4.5 | -112.0 | -$1.6 | -$6.6 | -141.0 | -$2.4 |
| Lake Mead | -1,330,350.1 | -405,958.4 | -$40.4 | -$29.7 | -873.4 | -$10.6 | -$39.1 | -1,017.1 | -$13.8 |
| Total | -1,429,549.9 | -480,791.7 | -$46.1 | -$34.3 | -985.5 | -$12.3 | -$45.7 | -1,158.1 | -$16.2 |

**Table 10. Combined effects of temperature change and falling lake visits on visitor spending and local economies**

| | Temperature Change Only, 2003 Lake Elevations | Temperature Change with Level 1 Shortage Scenario | Temperature Change with Power Pool Scenario | Temperature Change with Dead Pool Scenario |
|---|---|---|---|---|
| Scenario Parameters | | | | |
| July Temperature | +2°F | +2°F | +2°F | +2°F |
| January Temperature | +1°F | +1°F | +1°F | +1°F |
| Lake Powell Elevation | 3,608 feet | 3,560 feet | 3,490 feet | 3,370 feet |
| Lake Mead Elevation | 1,145 feet | 1,075 feet | 1,050 feet | 1,000 feet |
| Changes in: | | | | |
| Recreation Visits | 1,603,095 | 719,448 | 343,787 | -408,585 |
| Party Days | 768,256 | 474,827 | 320,905 | 5,110 |
| Visitor Spending (millions) | $80.9 | $ 52.6 | $ 38.8 | $10.7 |
| Direct Effects | | | | |
| Sales (millions) | $66.5 | $ 45.5 | $ 35.1 | $13.7 |
| Jobs | 1,671 | 1,066 | 778 | 193 |
| Income (millions) | $24.5 | $ 17.0 | $ 13.2 | $5.6 |
| Total Effects | | | | |
| Sales (millions) | $93.0 | $ 65.1 | $ 50.8 | $21.5 |
| Jobs | 2,047 | 1,337 | 992 | 291 |
| Income (millions) | $ 33.7 | $ 23.9 | $ 18.8 | $8.3 |

**Table 11. Impact of carbon taxes on park visits and local economies**

| | | |
|---|---|---|
| Scenario Parameters | | |
| $ / Ton CO2 | $5.45 | $10 |
| $ / Ton Carbon | 20 | $36.67 |
| Gasoline Price Increase | 5 cents / gal. | 8.8 cents / gal. |
| Percent Increase from Base | 3.1% | 5.5% |
| | | |
| Changes in: | | |
| Recreation Visits (percent) | -0.7% | -1.2% |
| Recreation Visits | -192,988 | -334,897 |
| Party Days | -83,997 | -145,762 |
| Visitor Spending (millions) | -$9.0 | -$15.6 |
| | | |
| Direct Effects | | |
| Sales (millions) | -$7.4 | -$12.8 |
| Jobs | -182 | -316 |
| Income (millions) | -$2.8 | -$4.8 |
| | | |
| Total Effects | | |
| Sales (millions) | -$10.4 | -$18.1 |
| Jobs | -225 | -391 |
| Income (millions) | -$3.8 | -$6.6 |