Effects of Wildfire on National Park Visitation and Regional Economic Impacts

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Introduction

Utah's natural wonders have long attracted visitors from among Utah residents, residents of other states, and from other countries. Utah is home to five national parks, seven national monuments, two national recreation areas, one national historical site, and 43 state parks. Almost 8.4 million visitors were recorded at Utah's National Parks in 2015, with another 4.9 million visitors observed at the national monuments, recreation areas and historical site (USNPS 2016). State parks accounted for another 4.2 million visitors in 2015 (Leaver 2016). Millions of acres of public lands in Utah (administered primarily by the Bureau of Land Management and the US Forest Service) are also open for dispersed recreation, but visitor counts for dispersed recreation are difficult to obtain. Finally, Utah has 14 ski resorts, 10 of which are located within one hour of the international airport in Salt Lake City. In the past five years, skier day counts at Utah's resorts have averaged over 4 million skier days per season, with a record 4.47 million skier days established during the 2015/16 season (SkiUtah.com, 2016).

Tourism, by any definition, is big business in Utah. In 2014, recreation activity in Utah resulted in expenditures of almost $8 billion and generated over $1 billion in state and local tax revenue. The tourism and travel industry is one of largest industries in the state, with expenditures by tourists employing almost 130,000 people and making up 9.3% of the state's workforce in 2014 (Leaver, 2016). Nonresidents accounted for the overwhelming majority of tourism expenditures (85%), making the tourism and travel industry Utah's largest export industry. The state of Utah has recognized the importance of this industry in recent years. The Utah Governor's Office of Economic Development has promoted Utah's recreation assets to national and international audiences through ad campaigns such as the "Mighty Five" (highlighting the five national parks) and its current campaign called "Road to the Mighty Five" (highlighting state parks and other places located near the national parks). Further, during the 16 day shutdown of the federal government in October 2013, the state of Utah provided funds to keep the five national parks open to the public (McCombs, 2014). The justification for this action was the importance of the national parks to the local and regional economies of southern Utah.

Just as the amount of winter snow affects the number of skier visits (and thus the economic impact of skiing in the state), it is possible that the visibility, safety, and health effects of seasonal wildfire may affect recreational visits to Utah's national parks and other public lands. Fires can lead to road and campground closures, create smoke that damages health and reduces visibility, and changes the landscape in and around the national parks. In addition visitors may believe that visiting a national park with nearby wildfire activity may be dangerous. This chapter uses a statistical model to quantify the effect of wildfire on visitation to each of Utah's five national parks (NPs). We focus on national parks because of the availability of reliable and accurate long-term datasets on wildfire (from the USFS) and visitation (from the National Park Service). Our primary hypothesis is that wildfire negatively affects recreational

visitation at Utah's NPs. Reduced visitation, in turn, means that tourism expenditures will fall, resulting in a cascade of employment and income effects throughout the regional economy.

Wildfire and Recreation

We are not the first to hypothesize such an effect of wildfire on recreation. Prior research on wildfire effects has focused on the response of visitors to onsite fire-related changes in the post-fire landscape (Table 1). Most of the previous literature has used survey methods to document the economic impacts from wildfire by measuring changes in the probability a site would be visited, the number of visits to a site, and the consumer surplus (net welfare) derived from a recreational visit. Much of the literature employs stated preference methods (Vaux et al 1984; Englin et al. 2001; Loomis et al. 2001; Hesslen, et al. 2003) wherein photographs and hypothetical questions are used to estimate the welfare change associated with fire. This portion of the literature can be distinguished from the work of Love and Watson (1992), Englin et al. (1996), Hesseln et al. (2004), and Boxall and Englin (2008), all of whom used revealed preference methods (i.e., observations of actual—not hypothetical—recreation behavior) to examine visitation patterns immediately after a fire, and for years afterward, to calculate the effect of wildfire on the number and quality of visits to fire-damaged locales.

In contrast with the first seven studies listed in Table 1, Duffield et al. (2013) examine the contemporaneous effects of wildfire on visitation. The authors used aggregated visitation data and wildfire data to estimated changes in visitation to Yellowstone NP due to wildfire. The authors' specification was based on the travel cost model that links visits to a recreation site to the cost of getting to the site. Economic theory suggests that the number of visits will fall as the cost of travel to the site, which is a function of distance, increases. The vast travel cost literature has consistently found empirical support for this link. Economic theory also suggests that, all else equal, people will make more trips to higher quality recreation sites than to lower quality sites. Again, hundreds of studies have reported statistical support for this theoretical prediction. Aggregate visitor data such as monthly visitor counts prevent calculation of a travel cost variable as used in the studies cited above because such data do not report the distance traveled by each visitor. Instead, Duffield et al. use the price of gasoline as a proxy variable because it is highly correlated with travel cost. For their monthly visitation model, wildfire effects are captured by the total acreage of fires burning within 50 miles, 100 miles, and 200 miles of the park center during the month of visitation, as well as the preceding month. The authors' models found a statistically and negative effect of fire and lagged fire on monthly park visitation over the 1986-2011 study time frame.

Table 1. Selected Prior Research on Wildfire Effects on Recreation

Study	Brief summary
Stated Preference Studies	
Vaux, Gardner and Mills (1984)	Intense wildfires may have detrimental effects on recreation values
Loomis, Gonzales-Cabán, and Englin (2001)	Recreation values after a fire follow a nonlinear intertemporal path (Colorado).
Hesseln et al. (2003)	Hikers and bikers in New Mexico experience decreases in consumer surplus following either crown or prescribed fire.
Revealed Preference Studies	
Love and Watson (1992)	The 1988 Gates Park fire had relatively little impact on the choice to visit the North Fork or the South Fork, Montana.
Englin et al. (1996)	Nopiming Park, Manitoba; presence of historical fires along a canoe route were a disamenity to backcountry recreationists.
Hesseln, Loomis and Gonzales-Cabán (2004)	Compared economic effects of fire on hiking in Montana and Colorado suggests that the annual value of trips decreases after fire.
Boxall and Englin (2008)	Marginal per-trip welfare declines immediately after a fire, but recovers on a nonlinear path after ~35 years of regrowth (Nopiming Park, Manitoba).
Duffield et al. (2013)	Proximate wildfire has measurable and statistically significant concurrent effects on aggregate visitation at Yellowstone NP.

Methodology

Similar to Duffield et al., our study used recreation visitation data to Utah's national parks in conjunction with existing time series data on wildfire activity to estimate the statistical effect of wildfire on national park visits. Linear regression models of visitation to each of five national parks in Utah, i.e., Arches, Bryce Canyon, Canyonlands, Capitol Reef, and Zion, were estimated using the model shown in Equation 1:

$$\ln v_t = \beta_0 + \beta_1 wf_t + \beta_2 wf_{t-1} + \beta_3 p_t^{gas} + \sum_{m=1}^{11} \delta_m D_m + \varepsilon_t, \quad (1)$$

where $\ln v_t$ is the logged number of visitors in month t, wf_t is acre burned from wildfire in month t within 50 miles (80.5 km) radius to the park (visitor center or park entrance), p_t^{gas} is the real gas price adjusted by real personal income as a proxy of cost of traveling to the park, D_m are monthly indicator variables, and ε_t is the error term. Coefficients β and δ were estimated using the aggregate data. Coefficients for concurrent and lagged wildfire activities, β_1

and β_2, measure the relative change in the number of visitors for a given change in the wildfire activities (acre burned), i.e., $\beta \times 100$ % change in visitation (semi-log model). The results of the fire-visitation models were used to derive estimates of the direct expenditure change in the region.

Data

Data were collected from multiple sources, including the National Park Service, the National Wildfire Occurrence dataset, and standard sources of economic data such as the St. Louis Federal Reserve and sites maintained by the US Bureau of Census. Descriptive statistics may be found in Table 2.

Visitation Data

The National Park Service maintains historical data about the monthly number of visitors to each national park (USNPS, 2016a). Reported statistics vary by park, with some parks reporting only the number of visitors, while other parks also report the number of overnight stays and the total number of hours on site. The metric common to all national parks was aggregate monthly visitation, so this measure was used as our visitation number, v_t. Data were collected for the five national parks for all months between May 1993 and December 2015 (273 observations for each park). Figure 1 presents the number of visitors in each national park during the sample period. Using 2015 visitation as a reference, the annual number of visitors was 1.40 million for Arches NP, 1.75 million for Bryce Canyon NP, 0.63 million for Canyonlands NP, 0.94 million for Capitol Reef NP, and 3.65 million for Zion NP, respectively. In 2015, the total number of visitors to all five national parks is 8.37 million. As shown in Figure 1, the data exhibit strong seasonality in visitation, with the peak season between May and September. The seasonality clearly evident in Figure 1 means that, econometrically, one can expect autocorrelation[1] in the model.

Wildfire Data

Numerous federal and state agencies keep track of wildfire statistics for Utah, including the National Interagency Fire Center, the Bureau of Land Management, the US Forest Service, and Utah's Division of Forestry, Fire, and State Lands.

[1] Autocorrelation (also known as serial correlation) refers to the correlation of a time series with its own past (and future) values. For example the number of visitors to a National Park in July might be related to the number of visitors in May and June of the same year, as well as the number of visitors in July of the previous year. In this case estimated coefficients remain unbiased but are not efficient—they no longer have minimum variance (Greene, 2000). As a result, confidence intervals and hypothesis tests based on the t and F distributions are unreliable. Fortunately we can adjust for this problem to obtain estimated coefficients with desirable properties.

Table 2: Recreation Model Data

	Mean	Median	Min	Max	Std. Dev.
Arches NP					
Visitation (# per month)	76,437	77,963	5,009	195,748	49,126
Wildfire, May (acres)	110	10	0	1,300	302
Wildfire, June	5,218	39	0	94,404	20,040
Wildfire, July	772	114	0	6,026	1,642
Wildfire, August	275	3	0	3,432	779
Wildfire, September	15	0	0	270	57
Bryce Canyon NP					
Visitation (# per month)	96,576	82,038	9,535	305,465	72,604
Wildfire, May (acres)	2,241	5	0	42,839	9,137
Wildfire, June	1,347	40	0	10,655	2,634
Wildfire, July	2,617	616	0	23,903	5,301
Wildfire, August	294	76	0	2,174	500
Wildfire, September	75	0	0	1,096	246
Canyonlands NP					
Visitation (# per month)	36,672	43,078	2,792	91,284	22,768
Wildfire, May (acres)	219	4	0	2,513	595
Wildfire, June	591	21	0	6,355	1,589
Wildfire, July	478	86	0	6,026	1,330
Wildfire, August	201	3	0	3,432	729
Wildfire, September	23	0	0	304	65
Capitol Reef NP					
Visitation (# per month)	52,967	58,850	4,604	135,543	35,337
Wildfire, May (acres)	206	0	0	4,406	938
Wildfire, June	394	0	0	3,733	1,031
Wildfire, July	1,739	25	0	32,053	6,806
Wildfire, August	205	0	0	1,865	556
Wildfire, September	21	0	0	338	73
Zion NP					
Visitation (# per month)	221,152	230,959	47,283	479,538	116,357
Wildfire, May (acres)	696	13	0	6,177	1,736
Wildfire, June	8,171	667	0	73,919	17,099
Wildfire, July	6,695	2,112	0	40,898	9,815
Wildfire, August	1,150	696	0	11,165	2,327
Wildfire, September	220	34	0	943	304

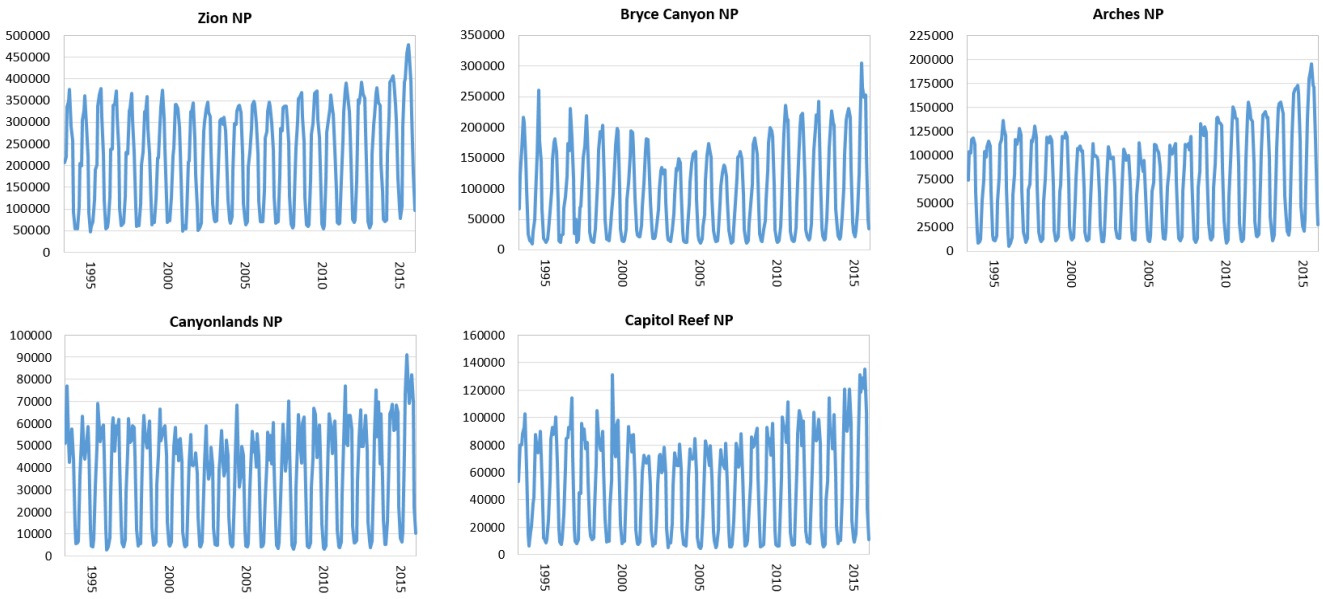


Figure 1. Number of Visitors in National Parks in Utah (persons)

Source: National Park Service (2016a)

The wildfire data set used for this study was based on Short (2015)'s cleaned wildfire occurrence data was combined with 2014 and 2015 wildfire data downloaded from National Federal Fire Occurrence database. This dataset contains 4,620 fires of 5 acres or greater in the state if Utah over the time range (1992-2015). We select only those fires occurring between May 1993 and December 2015, after which geolocation coordinates (longitude and latitude) for each wildfire are used to calculate distance between the fire origin and the visitor centers[2] of each NP. Any wildfire igniting outside a 50 mile radius of any national park's visitor center is eliminated, leaving a total of 990 wildfires as possibly influencing visitation at one or more national park (50 mile radii overlap for Zion NP and Bryce NP, and for Arches NP and Canyonlands NP). The total burned acreage of a fire was assigned to the month the fire started. For each park and for each month, all fires within the 50 mile zone are summed to create a variable measuring monthly fire activity in, or in close proximity, to national parks. Figure 2 shows a plot of the fire data and the locations of five national parks included. From 1993 to 2015, the average size of wildfires within a 50 mile radius of a national park was 670 acres. The

[2] Geolocations of a park visitor center or entrance was obtained from each national park's webpage and/or Google Maps.

largest fire close to a national park during the period of interest is the lightning-caused 88,421 acre Diamond Creek fire, which occurred in June 2002 near Arches NP.[3]

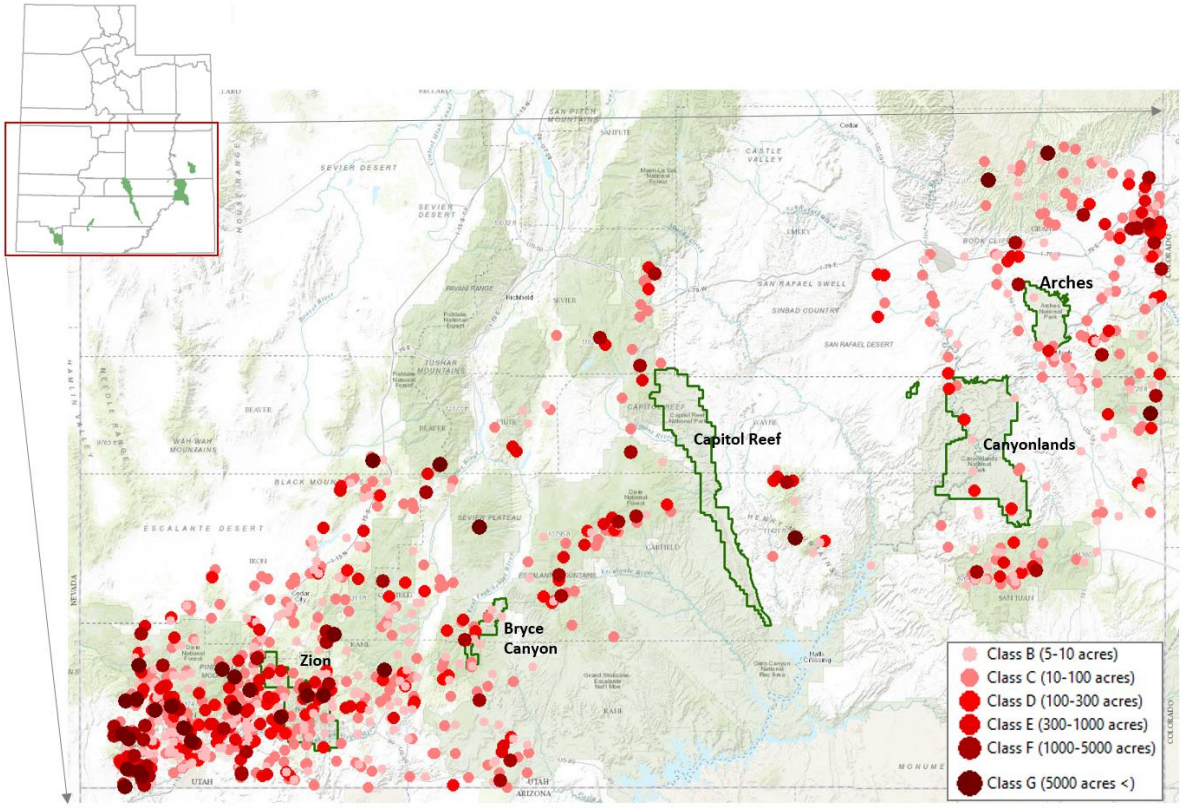
The size distribution of the fire is highly skewed as most fires were relatively small. Some 71% of wildfires burned less than 100 acres whereas there are only 11 wildfires that burned more than 10,000 acres (Table 2 and Figure 3). The mean acreage per fire is quite high, at 670 acres while the median acreage—the acreage burned that divides the fire distribution exactly in half, with 50% of fires being smaller and 50% being larger—is 26 acres. A single large wildfire, such as the Diamond Creek fire, can heavily skew the data. For Arches NP the mean size of fires in June was 5,218 acres whereas the median fire size was 39 acres (Table 2). We can use this variation in fire size to conduct sensitivity analysis.

Economic Data

The gasoline price was obtained from U.S. Energy Information Administration (EIA) (http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_m.htm) and adjusted for inflation to a 2015 "real gasoline price" and again adjusted by real personal income per capita. Recreation is considered a luxury good (an income elasticity greater than one) and is thus sensitive to broader economic forces that can affect income. We capture the influence of economic recession using indicator variables that take on a value of one during times of recession and zero otherwise. Two recessions occurred during our time frame: the first was the "dot.com" recession from April 2001 through November 2001, and the second was the "great Recession from January 2008 through June 2009. Beginning and ending dates for each recession were drawn from the Recession Indicators for the U.S. as calculated by the National Bureau of Economic Research and reported at the "FRED" website of the St. Louis Federal Reserve Bank (FRED, 2016). (https://fred.stlouisfed.org/series/USREC).

The Utah Office of Tourism began marketing campaign focusing on the five National Parks in Utah in April 2013 and has promoted out-of-state visitation to Utah through integrated communications, marketing and travel trade initiatives. The "Mighty 5" campaign has been considered highly successful in bringing more visitors to Utah's National Parks. We include an indictor variable for the ad campaign in our empirical model to test if the ad campaign can be distinguished from the broader national trend observe din recent years of increasing national park visitation.

[3] This fire was contained two months later, on August 22. While the fire occurrence data set reliably includes the start date of the 4,620 fires of interest to our study, almost 18% of fires do not have a reported contain date. Thus, our empirical analysis is limited to only the start date of fires.



Note: Red dots are origins of wildfires. Dark colors indicate the larger size of wildfires.

Figure 2. Plot of Wildfire Activities near National Parks in Southern Utah (May 1993 – December 2015)

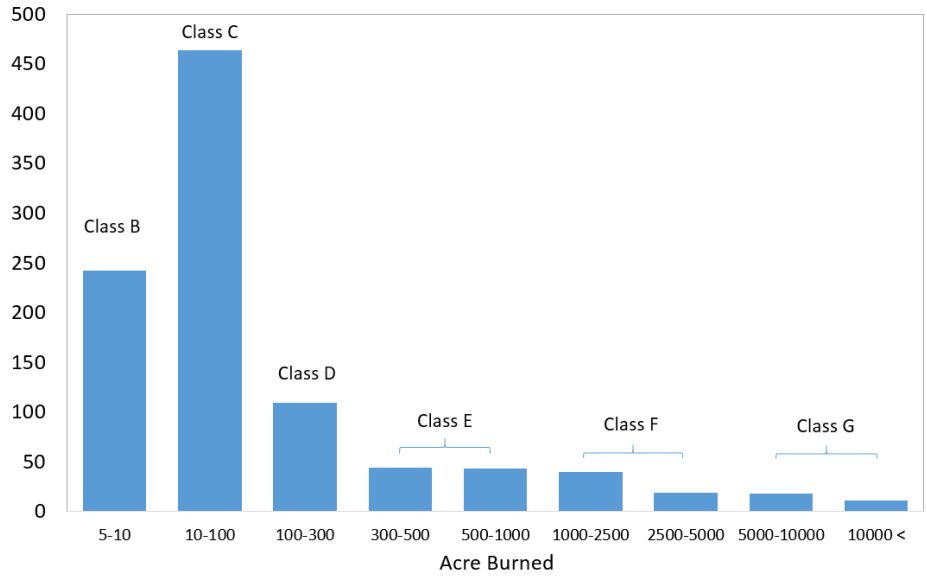


Figure 3. Wildfire Size Distribution within 50 miles Radius to National Parks in Utah (990 wildfires)

Estimation Results and Loss in Visitation

Estimated monthly visitation models in equation (1) are shown in Table 3. The dependent variable is the natural log of the number of visitors (i.e., we are estimating a semi-log model). The key explanatory variables are total acres burned within 50 miles radius, $wf50$, of each national park for the current month and the previous month. Other explanatory variables include the income adjusted real price of gasoline (*adj_r_gas_p*), a simple time trend (*t*), and a variable indicating if the nation was in a *recession* during a particular month. All models in Table 3 are satisfactorily explanatory ($R^2 > 0.95$) and most of variables are statistically significant at the 5% level or less. The Breusch-Godfrey test confirmed a problem high order of autocorrelation: the error in predicting visitation in one month is correlated with the error for the same month in the previous year. We adjust for this problem by using Newey-West (1987) robust standard errors with 12 lags.

The negative coefficient on the income adjusted real price of gasoline indicates that higher gasoline prices (increased travel costs) result in a fall in visitation but all of coefficients are not statistically significant. The positive coefficient on Mighty 5 dummy shows an indication of success marketing campaign. The positive coefficient on the time trend shows an increasing trend in national park visitation over time. The estimated parameter for recession indicates that, all else equal, a nationwide recession results in reduced visitation to Utah's national parks but not statistically significant except Zion NP.

Table 3. National Parks Visitation Models (Semi-Log Model)

	(1) Arches	(2) Bryce	(3) Canyonlands	(4) Capitol Reef	(5) Zion
$wf50_t$	-0.000001433***	-0.000003365*	-0.000009225	-0.000006009***	-0.000000674*
	(0.002)	(0.074)	(0.561)	(0.000)	(0.094)
$wf50_{t-1}$	-0.000001864***	-0.000005209***	-0.000005104	-0.000005391***	-0.000000648
	(0.000)	(0.001)	(0.675)	(0.000)	(0.338)
adj_r_gas_p	-2.3718	-3.3074	0.4352	0.1124	-1.9242
	(0.384)	(0.419)	(0.895)	(0.978)	(0.357)
Mighty 5	0.2660***	0.2455***	0.3160***	0.3514***	0.09272
	(0.000)	(0.010)	(0.000)	(0.001)	(0.101)
trend	0.001411***	0.0007718	-0.00003943	-0.0005035	0.001163***
	(0.000)	(0.154)	(0.905)	(0.223)	(0.000)
recession	-0.02624	-0.02479	-0.02584	-0.04479	-0.05957**
	(0.471)	(0.552)	(0.524)	(0.386)	(0.025)
Constant	9.3278***	9.8017***	8.4836***	9.0123***	10.991***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
depvar	ln(v_arch)	ln(v_bryce)	ln(v_canyon)	ln(v_capitol)	ln(v_zion)
R^2	0.989	0.980	0.988	0.983	0.986
F statistic	673.76	407.53	758.61	431.85	627.18

Note: Numbers in parentheses are P-values. Significance levels are 1% (***), 5% (**), and 10% (*).
Note: Results for monthly dummies are omitted to save space. Most of dummies are statistically significant.

Turning to the wildfire coefficients, we find that wildfire activities have statistically significant negative impact on visitation in all of Utah's national parks except Canyonlands NP (model 3 in Table 2). Arches, Bryce, and Capitol Reef National Parks each show current and lagged effects of wildfires in close proximity to park entrances, whereas Zion NP exhibits reduced visitation for only current month wildfires (lagged effects are not significant). Current and lagged effects may occur because people can alter vacation plans in response to wildfire. For example, tourists may choose to forgo a visit to Zion NP and instead spend more time at, say, the Grand Canyon NP or Las Vegas upon hearing of wildfire activity in or near Zion NP. The semi-log form of the model allows us to easily calculate the relative change in visitation for a given change in an explanatory variable. For this model, a one unit change in an explanatory variable yields a $\beta \times 100$ % change in visitation. Thus, we can provide a numeric interpretation for the coefficients by considering the effect of a hypothetical 100 acre fire occurring near or in a national park. For example, a 100 acre fire within the 50 mile radius of Zion NP depresses current month visitation by 0.007% [(100 acres) × (-6.744×10^{-7}) × 100%)]. For Arches NP, the effect of a 100 acre wildfire is a 0.014% fall in the month concurrent with the wildfire and 0.019% fall in the month after the wildfire, for a total loss of about 0.033%. Similar calculations can be done for Bryce NP (0.086%) and Capitol Reef NP (0.114%).

Even using the calculations presented in the previous paragraph, we still don't know the predicted change in the number of visitors to a park. To investigate the impact of wildfire activity on park visitation we use a multi-step simulation approach, where monthly wildfire acreage burned is considered a random variable:

1. Generate random wildfires within the 50 mile radius of each national park based on the historical spatial distribution, timing, and size of wildfires. Intertemporal correlation among months is considered in the random draws.
2. For each park and its simulated monthly wildfires, calculate the effect of wildfire acreage on the number of visitors to each park using the model coefficients reported in Table 3. All variables other than wildfire acreage are fixed at their 2015 values.
3. Find the difference between the number of monthly visitors "with wildfire" (calculated in step 2) and the predicted visitors assuming zero wildfires in that month.
4. Repeat the steps one through three 1,000 times to generate an empirical distribution of wildfire effects on visitation at each park.

The skewed distribution of wildfire acreage results in a skewed empirical distribution for visitation losses. Hence, we report both median and median visitation losses arising from the 1,000 random wildfire draws. Wildfire activity is concentrated in the summer months, so the percentage changes in monthly visitation predicted by the model in Table 2 are assigned to visits occurring in the peak months of May through September (peak season). The implicit assumption is that off-peak season wildfires do not affect national park visits; given the

relatively few fires occurring in off-peak months this assumption seems warranted. Table 4 presents the changes (losses) in visitation in each national park.

The visitation losses follow expected patterns. Visitation losses are a function of the wildfire parameter estimates (Table 3), the amount of burned acreage, and baseline visitation. Large wildfire parameter effects—such as those for Capitol Reef—lead to large percentage changes in visitation, but the low baseline visitation (less than 1 million visitors in 2015) means that losses in visitor days are modest. The wildfire parameter estimates for Zion NP are relatively small (leading to small percentage effects), but baseline visitation (3.65 million visitors) is high enough to generate relatively large losses in visitor numbers.

Table 4. Visitation Losses due to Wildfire

National Park	Mean	% of peak season (May-Sep)	Median	% of peak season (May-Sep)
Arches	3,692	-0.41%	432	-0.05%
Bryce	12,802	-1.01%	4,662	-0.37%
Canyonlands	1,498	-0.38%	352	-0.09%
Capitol Reef	2,877	-0.45%	302	-0.05%
Zion	9,983	-0.46%	5,377	-0.25%
Sum	30,851	-0.60%	11,125	-0.22%

Note: % change in peak season visitation in 2015 (May through September)

Regional Economic Impacts

Changes (loss) in visitation have effects on the regional economies of the counties that surround the national parks including counties such as Garfield (Bryce Canyon NP), Grand (Arches NP), Wayne (Capitol Reef NP) and Washington (Zion NP), where the visitor spending is crucial in the local economy. This research utilizes the Input-Output (IO) approach to measure the impact of local economies from changes in visitation due to wildfire. Economic impacts or contributions are based on visitors' expenditures associated with visiting national parks. Expenditures include food and beverage purchased at restaurants or grocery stores, gasoline and oil, purchasing sporting goods, lodging (hotel/motel/cabin/camping), equipment and rentals, and other transportation expenses. Expenditures affect the local and regional economy through the inter-relationships among different sectors or industries of the local economy. Multipliers can be described through the following definitions:

- Direct effects (or direct expenditures) are the changes in the industries associated with visitors (direct) expenditure. We have direct impacts from hotel/motel/cabin lodging, grocery purchases from the local stores, restaurants, gasoline purchase, equipment rentals, local transportation (bus, shuttles), etc.
- Indirect effects are the changes in inter-industry purchases as they respond to the new demands of the directly affected industries. The direct effect creates increases in economic activity for additional businesses (in the region) that support these direct industries.
- Induced effects are the increases in household income expenditures generated by the direct and indirect effects. In other words, induced effects are created as the new income generated by the direct and indirect effects is spent and re-spent within the local economy.
- Total economic contribution is the sum of direct effects, indirect effects, and Induced effect, and multiplier is the ratio of the total effect to the direct effect.

Our economic impact analysis is based on direct expenditures by park visitors as gathered by the US National Park Service (2016b). For example, visitors to Arches NP spent $162.7 million in the year 2015, including $58.1 million for lodging, $9.2 million for local grocery purchases from the local stores, $34.9 million at restaurants, $11.4 million for the purchase of gasoline, $15.9 million on services provided by recreation industries, $11.4 million on local transportation (bus, shuttles), etc. Table 5 presents 2015 direct expenditures in million dollars as reported on the NPS Visitor Spending Effects website.

Table 5. Direct Expenditures in 2015 (million dollars, $2015)

	Arches	Bryce	Canyonlands	Capitol Reef	Zion	Sum
2015 visitors (million)	1.399	1.746	0.634	0.941	3.649	8.370
Expenditures						
Gas	11.4	14.8	5.7	9.8	16.4	58.1
Groceries	9.2	8.7	2.6	3.8	11.0	35.3
Hotels	58.1	48.7	12.5	26.3	67.5	213.1
Recreation industries	15.9	13.7	2.9	2.8	4.1	39.4
Restaurants	34.9	26.6	7.2	12.7	47.8	129.2
Retail	17.9	14.3	3.7	4.5	23.7	64.1
Transportation	11.4	15.2	2.2	4.6	25.8	59.2
Camping	3.7	3.9	1.1	2.1	5.8	16.6
Sum	162.5	145.9	37.9	66.6	202.1	615.0

Source: US National Park Service (2016b)

We can use the changes in visitation reported in Table 4 to calculate the change in direct expenditures due to wildfire activities, $\Delta Expnd$, by the following:

$$\Delta Expnd_i = \sum_j \Delta v_i \cdot \frac{expnd_{ij}}{total\ v_i}, \quad (2)$$

where Δv_i is the change in visitation in national park i= Arches, Bryce Canyon, Canyonlands, Capitol Reef and Zion, $expnd_{ij}$ is the direct expenditure in a category j = gas, groceries, …, camping in Table 5, and $total\ v_i$ is the annual visitor numbers in each national park in 2015 reported in Table 5 as well.

The losses in visitor spending in the local economy are shown for each park on the basis of mean visitation losses (Table 6) and median visitation losses (Table 7). The loss of 3,692 visitors to Arches (Table 4, based on mean acreage burned) results in a loss of $429,287 in visitor spending (Table 6). For the median acreage burned, Arches lost 432 visitors (Table 4) for a total loss of $50,208 in visitor spending (Table 7). Similar calculations are presented for all national parks under both fire scenarios. Tables 6 and 7 show the aggregate loss in visitor spending across all national parks to be between $0.780 million (median visitation loss) and $2.345 million (mean visitation loss).

The regional economic model that calculates the direct, indirect, induced and total effects builds upon models using the IMPLAN (Impact analysis for PLANning, www.implan.com) software for the year 2013. The six counties that encompass the bulk of southern Utah, Garfield, Grand, Kane, San Juan, Washington, and Wayne, are aggregated into a single economic region that is home to all of Utah's national parks. The regional economy is further aggregated to 13 sectors from Implan's 435 disaggregated sectors. While most of the economic sectors reported in the tables below are highly aggregated, we maintain disaggregated sectors for those sectors that are assumed to be most impacted by wildfire-related losses in visitor spending, e.g., accommodation (hotels/motels/others), restaurants, recreation industries, which are broken out in detail. Other key visitor expenditure categories such as gas, groceries and retail, are aggregated into the retail trade sector.

Table 6. Loss in Visitor Spending – Mean ($2015)

	Arches	Bryce	Canyonlands	Capitol Reef	Zion	Sum
Gas	30,079	108,527	13,453	29,957	44,868	226,884
Groceries	24,274	63,796	6,136	11,616	30,095	135,917
Hotels	153,298	357,112	29,501	80,394	184,672	804,977
Recreation industries	41,952	100,461	6,844	8,559	11,217	169,034
Restaurants	92,084	195,055	16,993	38,821	130,775	473,729
Retail	47,230	104,860	8,732	13,756	64,840	239,418
Transportation	30,079	111,460	5,192	14,061	70,586	231,378
Camping	9,763	28,598	2,596	6,419	15,868	63,244
Sum	428,760	1,069,870	89,448	203,583	552,921	2,344,581
% of visitor spending in 2015	0.26%	0.73%	0.24%	0.31%	0.27%	0.38%

Table 7. Loss in Visitor Spending – Median ($2015)

	Arches	Bryce	Canyonlands	Capitol Reef	Zion	Sum
Gas	3,518	39,524	3,162	3,150	24,165	73,519
Groceries	2,839	23,234	1,442	1,221	16,209	44,945
Hotels	17,929	130,055	6,933	8,453	99,461	262,832
Recreation industries	4,907	36,586	1,609	900	6,041	50,043
Restaurants	10,770	71,036	3,994	4,082	70,433	160,315
Retail	5,524	38,189	2,052	1,446	34,922	82,133
Transportation	3,518	40,592	1,220	1,478	38,016	84,825
Camping	1,142	10,415	610	675	8,546	21,388
Sum	50,146	389,632	21,022	21,405	297,795	780,000
% of visitor spending in 2015	0.03%	0.27%	0.06%	0.03%	0.15%	0.13%

The gross regional product for the six county area was $6.096 billion (total value-added); this level of economic activity supported an estimated 97,497 jobs. Major economic sectors include FIRES (finance, information, real estate, education, and other services) which supported 43,102 jobs and government which were estimated to support 11,887 jobs. Retail trade produces $812 million and supports 11,473 jobs. The restaurant sector produces $398 million and supports about 8,125 jobs in 2013 whereas the accommodation sector produces $240 million and hires 3,069 employees.

The estimated regional economic impact of wildfire-related losses in visitor spending is shown in Tables 9.8 and 9.9. The total loss of industry output associated with decreased expenditures by visitors is $3.654 million (mean visitation loss, Table 8) and $1.216 million (median visitation loss, Table 9). Relative to the gross change in expenditures, losses in output correspond to an effective expenditure multiplier of 1.56, which is reasonable for a relatively small economic region; that is, every dollar spent in the national parks generates $1.56 in total economic output.

The loss in value-added (net regional output) resulting from decreased industry output was estimated to be $1.993 million (mean loss in visitation) and $0.662 million (median loss in visitation), respectively. A portion of the value-added impact is the loss of income accruing to labor: losses in labor income are estimated to be $1.152 million (mean loss in visitation), which includes losses of 42 full- and part-time jobs (Table 8). In the median visitation loss case losses in labor income were $0.383 million loss and a loss 14 jobs full and part-time jobs. Tax revenues are also affected by losses in the level of output, labor income and value added; under the mean visitation loss scenario state and local governments could expect to see losses of $0.268 million whereas the federal government could experience losses of $0.292 million. In case of median loss in visitation the loss of tax revenue was estimated to be $0.129 million for state/local government and $0.142 million for federal government.

Table 8. Economic Loss of Decreased in Visitor Spending from Wildfires in National Parks (Mean Loss in Visitation)

Sector	Industry Output	Value Added	Labor Income	Employment
		(in dollars)		(persons)
Agriculture	2,397	1,277	318	0
Mining	3,406	2,163	621	0
Utilities	38,738	8,932	4,825	0
Construction	38,446	13,541	10,410	0
Manufacturing	13,603	3,785	1,661	0
Wholesale	48,403	27,567	11,425	0
Retail trade	704,210	421,319	261,150	10
Transport & Warehousing	309,120	141,100	89,515	2
FIRES[1]	865,042	492,646	206,756	7
Recreation	172,901	96,682	56,482	3
Accommodation	870,957	475,886	274,469	10
Restaurant & Food Services	540,995	266,447	202,272	10
Government	45,656	41,916	32,077	1
Total[2]	3,653,874	1,993,261	1,151,981	42

[1] FIRES = Finance, Insurance, Real estate, Educational services, and other services

[2] May not sum to total due to rounding

Table 9. Loss of Decreased in Visitor Spending from Wildfires in National Parks (Median Loss in Visitation)

Sector	Industry Output	Value Added	Labor Income	Employment
	(in dollars)			(persons)
Agriculture	797	424	106	0
Mining	1,140	724	208	0
Utilities	12,815	2,955	1,596	0
Construction	12,750	4,491	3,452	0
Manufacturing	4,556	1,268	556	0
Wholesale	16,191	9,221	3,822	0
Retail trade	234,494	140,295	86,960	3
Transport & Warehousing	111,203	50,759	32,202	1
FIRES[1]	287,343	163,643	68,679	2
Recreation	51,326	28,701	16,767	1
Accommodation	285,129	155,793	89,854	3
Restaurant & Food Services	182,618	89,942	68,279	4
Government	15,248	13,999	10,713	0
Total[2]	1,215,610	662,215	383,194	14

[1] FIRES = Finance, Insurance, Real estate and Educational services, and other services

[2] May not sum to total due to rounding

Summary

This chapter has quantified the effect of wildfire on recreation visitation at national parks in Utah. Using monthly data from May 1993 to December 2015, we empirically linked wildfire activities (measured as monthly acres burned within a 50 mile radius) to monthly visit to each national park. Results show that wildfire activities have negative and statistically significant concurrent and lagged effects on visitation (Arches, Bryce Canyon, Canyonlands, and Zion NPs but Capitol Reef NP). We find that there is 0.1%~1.0% loss in aggregate visitation due to wildfire, that is, a seasonal loss of between 11,125 to 30,851 visitors relative to visitor numbers that would occur in the absence of wildfire. We also estimated the regional economic impacts of losses in visitor spending due to the decrease in visitation. The loss in direct visitor spending was estimated to be between $0.78 million and $2.34 million. Visitation and spending directly related to the regional economies where national parks are located, which supports regional businesses such as hotels and restaurants, and creates jobs in private sectors. The regional economic impact of wildfire activities is estimated to be a seasonal loss between $1.22 million and $3.65. Counties where national parks are located may lose 14 jobs and 42 jobs depending on the extent of acreage burned in proximity to national parks. Wildfire-related reductions in expenditure also decrease the tax revenue for state and federal governments (seasonal losses between $0.19 million~$0.56 million).

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