Effects of Drought on National Park Visitation and Regional Economies in Southern Utah*

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Executive Summary

- Hotter, drier summers and increasingly intense wildfire seasons could change the makeup of park forests and dramatically affect visitor health.
- We hypothesize that the drought conditions may affect recreational visits to Utah's national parks and other public lands.
- Statistical models linking visitation at each of Utah's five national parks to drought condition suggests that visitation at three (Arches, Canyonlands, and Capitol Reef) are affected by drought condition. Visitation to the parks is expected to fall by 79,000 to 120,000 visitors in 2018, if southern Utah experiences mild drought and severe drought, respectively.
- The losses in visitor spending in the region of southern Utah, which are the direct effects, are estimated to be $7 million (moderate drought) and $11 million (severe drought).
- Visitation and spending directly related to the regional economies where national parks are located, supports regional businesses such as hotels and restaurants, and creates jobs in private sectors. The regional economic impact of drought is estimated to be a loss between $12 million and $18 million, depending on the extent of drought.
- The losses in labor income are estimated to be $4 million (moderate drought), which includes the loss of 129 jobs. In the severe drought case, the losses in labor income were $6 million and a loss of 196 jobs in the region.

Keywords: Drought, National Park visitors, Input-output analysis, Palmer Drought Severity Index

1. Introduction

Utah's natural wonders have long attracted visitors from Utah, other states, and other countries. Tourism is big business in Utah. In 2014, recreation activity in Utah resulted in tourism expenditures of almost $8 billion and generated over $1 billion in state and local tax revenue. Expenditures from tourism employ almost 130,000 people, comprising 9.3% of the state's workforce in 2014 (Leaver, 2016).

Utah is home to five national parks[1]. More than 10 million visitors were recorded at Utah's National Parks in 2019 (USNPS, 2020). Nonresidents accounted for the overwhelming majority of tourism expenditures (85%), making the tourism and travel industry Utah's largest export industry[2]. 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). This campaign has been very successful as the campaign brought half million additional tourists on average (Drugova et al., 2020).

In this study, we hypothesize that drought affects recreational visits to Utah's National Parks and other nearby public lands. Climate and weather are important factors taken into account by tourists when deciding to visit a destination (Mathivha et al., 2017). Weather conditions also influence the successful operation of tourism businesses (Becken, 2010). Warmer and drier conditions associated with drought can limit outdoor opportunities, because thouse conditions can result in detrimental fires (Westerling et al., 2011), decreased reservoir levels (Pielke Sr. et al., 2005), and diminished river flows (Shrestha and Schoengold, 2008).

[1] Arches NP, Bryce Canyon NP, Canyonlands NP, Capitol Reef NP, and Zion NP; in addition, Utah is home to seven national monuments, two national recreation areas, one national historical site, and 43 state parks.

[2] Economic base theory is one of approach to explain regional economic growth. The essential idea is that some industries in a region are basic in the sense that their growth leads and determines the region's overall growth. The economic base theory identifies basic industries as those that bring in money from the outside, generally by producing goods or services for export; thus basic industries are called export industries (Hoover and Giarratani, 1999). Selling of recreational and other services to tourists from outside is a major export activity in Utah.

Wildfires, which are closely related with drought, also have negative impacts on the national parks' visitation (Kim and Jakus, 2019).

Drought impact studies on tourism sector are relatively rare and mostly qualitative analysis within a local area (Ding et al., 2011). Leones et al. (1997) examined the impacts of streamflow depletion on rafting businesses in New Mexico. They found that the lower water levels generally had negative effects on visitor numbers and rafting-related expenditures, but the magnitude of the impacts depended on the characteristics of the river courses. Schneckenburger and Aukerman (2003) analyzed the economic effects of the 2002 drought on Colorado's tourism industry. The estimated revenue decline due to the 2002 drought was approximately $1.7 billion including both directly and indirectly in Colorado's tourism sectors. Drought impacts were found in the boating, the rafting, and the fishing industries as well as regional small businesses such as hotels and motels. Wilhelmi et al. (2008) investigated drought vulnerabilities specific to mountain resort communities to derive recommendations. They presented a case study conducted in Colorado's mountain communities evaluating the multi-year drought that culminated in 2002. Using a series of interviews were conducted to garner the experiences of state and local tourism officials, ski resort representatives, and environmental, municipal and agricultural organizations. They found that drought alone was not responsible for creating the variety of direct and secondary impacts on Colorado resort communities. Mathivha et al. (2017) analyzed the correlation between drought and the number of tourist arrivals to the Kruger National Park in South Africa. They found that 19.4% of the drought years corresponded to a negative change in tourist arrivals to the park. Kim and Jakus (2019) showed that wildfire, which might be associated with drought conditions, has negative effects on visitation in four of the five NPs in Utah. Aggregate annual visitation losses at each park are between 0.5% and 1.5% during a typical fire year. The negative regional economic impacts of seasonal wildfire at all national parks in Utah are estimated to be between $2.7 and $4.5 million.

2. Objectives of Studies

The goal of the research is to investigate the effects of drought on national park visitation and also the regional economic impacts of drought in southern Utah, where five national parks are located. Two objectives are identified as follows

(a) Determine if and how the drought has affected visitation in the following five national parks, Arches National Park, Bryce Canyon National Park, Canyonlands National Park, Capitol Reef National Park, and Zion National Park, and

(b) Using results gained from (a), quantify regional economic impacts of drought in southern Utah. Impacts examined include changes in employment.

3. Drought Visitation Model

Using the similar statistical methodologies discussed in Duffield et al. (2013) and Kim and Jakus (2019), the present study uses recreation visitation data to Utah's national parks in conjunction with Palmer Drought Severity Index (PDSI)[3] to estimate the statistical effect of drought 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):

$$\begin{aligned} \ln v_t = \beta_0 + \beta_1 PDSI_t + \beta_2 p_t^{gas} + \beta_3 Mighty5 + \\ + \beta_4 Trend + \beta_5 Recession + \sum_{m=1}^{11} \delta_m D_m + \varepsilon_t \end{aligned} \tag{1}$$

where $\ln v_t$ is the logged number of visitors in month t, $PDSI_t$ is PDSI value in month t, p_t^{gas} is the real gas price as a proxy of cost of traveling to the park, $Mighty5$ is the dummy for

[3]The PDSI is a measurement of dryness based on recent precipitation and temperature. The PDSI is an effective measure of long-term drought. A PDSI of 0 is normal; a negative PDSI indicates drought. For example, -2 is considered moderate drought, -3 indicates severe drought, and -4 is extreme drought. A positive PDSI indicates above-normal moisture. For example, +2 indicates moderate wetness, +3 severe wetness, and +4 is extreme wetness (Alley, 1984). We use PDSI in the study because, compared with other popular drought indices (e.g., SPEI), PDSI has a more comprehensive physical mechanism considering the balance of precipitation, evapotranspiration, and runoff and has the ability to assess local soil water and possibly vegetation properties (Trenberth et al., 2014).

the Utah's Mighty 5 ad campaign, D_m are monthly indicator variables to control seasonality, and ε_t is the error term. Coefficients β and δ were estimated using the data. Coefficient for the PDSI, β_1, measures the relative change in the number of visitors for a given change in PDSI value, i.e., $\beta_1 \times 100\%$ change in visitation[4]. The results of the drought-visitation models were used to derive estimates of the direct expenditure change[5] in the region.

4. Data

Data were collected from multiple sources, including the National Park Service, National Climate Data Center, and standard sources of economic data such as the St. Louis Federal Reserve and sites maintained by the US Bureau of Census.

4.1. Visitation Data

The National Park Service maintains historical data about the monthly number of visitors to each national park (USNPS, 2020). A Key metric that is used by all national parks is aggregate monthly visitation, so this measure was used as our visitation number, v_t. Monthly visitation data were collected for the five national parks for all months between May 1993 and December 2019[6] (320 observations for each park). Figure 1 presents the number of visitors in each national park during the sample period. Using 2019 visitation as a reference, the annual number of visitors was 1.66 million for Arches NP, 2.59 million for Bryce Canyon NP, 0.73 million for Canyonlands NP, 1.23 million for Capitol Reef NP, and 4.49 million for Zion NP. In 2019, the total number of visitors to all five national parks was 10.70 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

[4] In the log-linear setup, coefficient for the PDSI measures the relative change in visitor numbers for a given absolute change in PDSI, or

$$\beta_1 = \frac{d \ln v_t}{dPDSI} = \frac{dv_t/v_t}{dPDSI}.$$

Thus, 100 times β_1 gives the percentage change in visitation.

[5] The changes in sales by industries associated with visitors' expenditures. Park visitors have direct expenditures for lodging or camping, groceries, restaurant meals, gasoline or local transportation (bus, shuttles), equipment rentals, etc.

[6] One of variables explaining visitor numbers is gas price (see equation (1)). Monthly gas price is available only from May 1993.

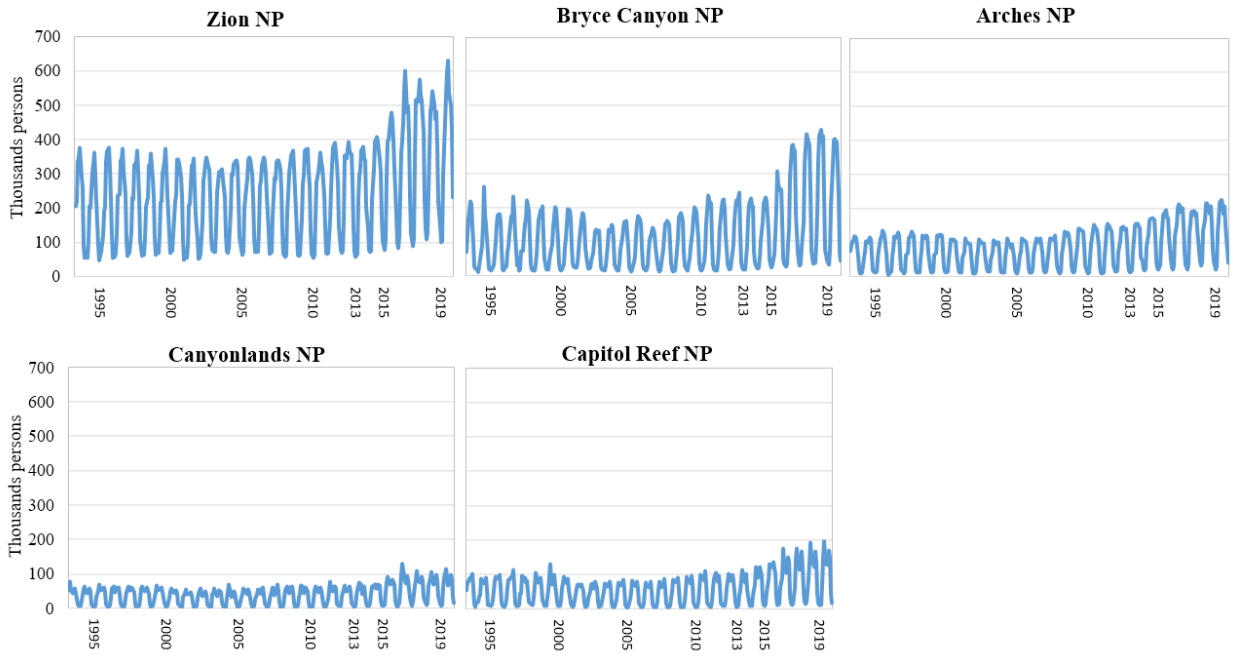

Figure 1: Number of Visitors in National Parks in Utah (000 persons)
Source: National Park Service

can expect autocorrelation[7] in the model.

4.2. Drought Data

The monthly PDSI data for Utah for the time period of May 1993 to December 2019 were compiled from NOAA's National Climatic Data Center (NCDC) which maintains historical climate data. Figure 2 presents PDSI value for the sample period. As shown in Figure 2, Utah experienced drought during 2000-2004, 2007-2010, 2012-2015, and 2018.

4.3. 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

[7]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, that is, estimated coefficient is not an underestimate or overestimate of the true value, but are not efficient, that is, the deviance between the estimated value and the true value could be large; in other words, 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.

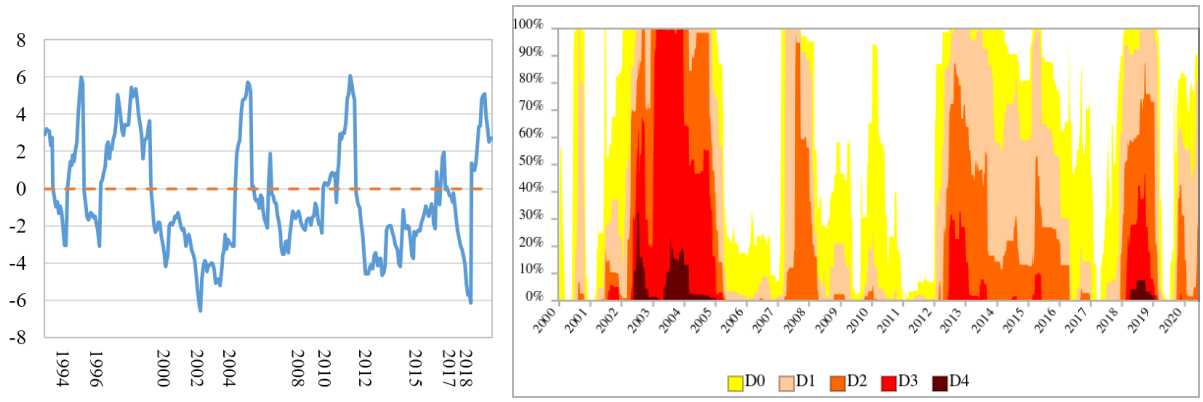

Figure 2: Monthly PDSI (Left) and Percent Area for Utah Experiencing Drought (Right)
Sources: National Climatic Data Center and NIDIS U.S. Drought Portal, the U.S. Drought Monitor (USDM). Note that USDM is available from 2000; D0-Abnormally dry, D1-Moderate drought, D2-Severe drought, D3-Extreme drought, and D4-Exceptional drought

"real gasoline price" (a proxy for travel cost). We capture the influence of economic recession using indicator variables (not shown in equation 1) 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 (https://fred.stlouisfed.org/series/USREC).

The Utah Office of Tourism began a 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 (Drugova et al., 2020). We include an indicator variable for the ad campaign in our empirical model to test if the ad campaign can be distinguished from the broader national trend of increased national park visitation observed the recent years .

Table 1: National Parks Visitation Models (Semi-Log Model)

	(1) Arches	(2) Bryce Canyon	(3) Canyonlands	(4) Capitol Reef	(5) Zion
$PDSI$	0.0100**	0.0095	0.0106**	0.0115*	0.0035
	(0.005)	(0.007)	(0.005)	(0.007)	(0.002)
p^{gas}	−4.4701***	−10.012***	−5.9127***	−7.7764***	−5.8650***
	(1.202)	(1.570)	(1.581)	(1.880)	(1.101)
$Mighty5$	0.2880***	0.2492***	0.3267***	0.3554***	0.0985*
	(0.068)	(0.090)	(0.083)	(0.095)	(0.051)
$Trend$	0.0017***	0.00140***	0.0006*	0.0003	0.0015***
	(0.0002)	(0.0004)	(0.0003)	(0.0004)	(0.0002)
$Recession$	−0.0086	−0.0161	−0.0151	−0.0359	−0.0538*
	(0.033)	(0.044)	(0.043)	(0.067)	(0.032)
Constant	9.4205***	9.9275***	8.6515***	9.1775***	11.100***
	(0.064)	(0.092)	(0.064)	(0.084)	(0.046)
Dependent var.	$\ln v_{arches}$	$\ln v_{bryce}$	$\ln v_{canyon}$	$\ln v_{capitol}$	$\ln v_{zion}$
Number of obs.	320				
R-squared	0.975	0.966	0.974	0.966	0.970
F	525.3 [0.00]	547.8 [0.00]	835.5 [0.00]	509.6 [0.00]	788.5 [0.00]

Newey-West standard errors are reported in parentheses; *, **, *** indicate the significance at 10%, 5% and 1%, respectively.
Results for monthly dummies are omitted to save space. Most dummies are statistically significant.

5. Estimation Results and Loss in Visitation

Estimated monthly visitation models in equation (1) are shown in Table 1. 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 PDSI for the current month. Other explanatory variables include the real price of gasoline, a simple time trend (t), and a variable indicating if the nation was in a recession during a particular month. All models in Table 1 are satisfactorily explanatory (R-squared > 0.95) and most of variables are statistically significant at the 5% level or less. The Breusch-Godfrey test (Breusch, 1978; Godfrey, 1978) confirmed a 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 adjusted for this problem by using Newey-West robust standard errors (Newey and West, 1987) with 12 lags.

The negative coefficient on the real price of gasoline, p^{gas}, indicates that higher gaso-

line prices (increased travel costs) result in decreased national park visitation in Utah. The positive coefficient on Mighty 5 dummy shows an indication of success in the Utah Office of Tourism 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 a statistically significant reduction with the exception of Zion National Park. It is unexpected as Poudyal et al. (2013) showed that recession was negatively associated with demand to visit national parks. According to Deseret News article (https://www.deseret.com/2010/2/25/20098056/national-park-visits-boom-amid-recession), "...Despite the recession, or perhaps because of it, 286 million visitors flocked to national parks last year, an increase of 10 million people..." and added "the increases may have come because families on tight budgets view parks as bargains... and parks attracted extra attention because of President Barack Obama's visit to the Grand Canyon ... "

Turning to the PDSI coefficients, we find that droughts has a statistically significant negative impacts on visitation in Arches National Park, Canyonlands National Park, and Capitol Reef National Park, but not in Bryce Canyon National Park and Zion National Park. This observation could be due to the fact that Zion National Park and Bryce Canyon National Park are already congested (that is, popular), and located near the highway and the town of St. George, Utah, so visitors may come to those parks regardless of drought status.

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 $\beta \times 100$ percent change in visitation. Thus, we can provide a numeric interpretation for the coefficients by considering the effect of a hypothetical drought. For example, a change from normal to moderate drought ($\Delta PDSI = -2$) depresses current month visitation by 2% ($2 \times 0.0100 \times 100$) in Arches National Park. For Canyonlands National Park, a moderate drought result in a 2.11% fall in the month concurrent with the drought, with a similar 2.31% decreases in Capitol Reef National Park visitation. Table 2 presents

Table 2: Visitation Losses due to Drought

	% Change in Visitation (%)	Loss in Visitation[1] (persons)	Loss in Visitor Spending[2] Million $
Moderate drought, $\Delta PDSI = -2$			
Arches NP	2.00	34,027	4.099
Bryce Canyon NP	-	-	-
Canyonlands NP	2.11	15,964	0.991
Capitol Reef NP	2.31	29,020	2.111
Zion NP	-	-	-
Sum		79,011	7.201
Severe drought, $\Delta PDSI = -3$			
Arches NP	3.00	51,568	6.212
Bryce Canyon NP	-	-	-
Canyonlands NP	3.17	24,207	1.503
Capitol Reef NP	3.46	44,051	3.204
Zion NP	-	-	-
Sum		119,826	10.919

[1] 2018 visitor number in NP $\div (1 - \%$ change)
[2] 2018 per person expenditure $\times$ loss in visitation, 2018 visitor spending is compiled from https://www.nps.gov/subjects/socialscience/vse.htm

the changes (losses) in visitation using 2018 visitor numbers[8] due to moderate and severe drought ($\Delta PDSI = -3$). Because Utah had experienced severe drought in 2018 (see Figure 2, average PDSI in 2018 was -2.99). Thus the visitor numbers to National Parks were lower than normal by the magnitude of β_1 (PDSI coefficient). In case of Arches National Park, the number of visitor in 2018 was 1.66 million and it would be 1.72 million if Utah experienced normal condition which is calculated as following

$$\begin{aligned} v_{arches,2018} &= \hat{v}_{arches,2018} + \Delta PDSI \beta_1 \hat{v}_{arches,2018} \\ \rightarrow \quad \hat{v}_{arches,2018} &= \frac{v_{arches,2018}}{1 + \Delta PDSI \beta_1} \\ \rightarrow \quad \frac{1.664 \text{ million}}{1 - 3 \times 0.0100} &= 1.715 \text{ million} \end{aligned} \tag{2}$$

where $\hat{v}_{arches,2018}$ is the visitor number under normal condition and $v_{arches,2018}$ is the actual visitor number to Arches National Park. Visitation loss in this case is estimated to be 51,568

[8] We are using 2018 visitor numbers to calculate direct impact as 2018 visitor expenditure data are available.

$= 1.715$ million $- 1.664$ million.

Visitation losses due to drought follow expected patterns. Visitation losses are a function of the PDSI parameter estimates (Table 1), the changes in PDSI or the magnitude of drought, and baseline visitation. With moderate drought, southern Utah may lose \$7.20 million (loss in visitor spending in Table 2) and with the severe drought, \$10.92 million. These losses are sufficiently large to affect economies of counties in the southern Utah. In case of the extreme drought ($\Delta PDSI = -4$), the loss in visitor spending is estimated to be \$14.72 million.

6. Regional Economic Impacts: Southern Utah

Changes (loss) in national park visitation effects economies of the counties that surround the national parks, including the counties of Garfield (Bryce Canyon National Park), Grand (Arches National Park), Wayne (Capitol Reef National Park) and Washington (Zion National Park), where the visitor spending is crucial in the local economy[9]. This research utilizes the Input-Output (IO) approach to measure the impact to local economies, combined the six counties that encompass the five national parks; Garfield, Grand, Kane, San Juan, Washington, and Wayne counties, from changes in visitation due to drought.

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, sporting goods and gift purchases, lodging (hotel/motel/cabin/camping), equipment and rentals including tour guides, 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 visitor (direct) expenditures. Direct impacts include hotel/motel/cabin lodging, gro-

[9]According to Leaver (2016), the leisure and hospitality industries in Garfield, Grand, and Wayne counties provide the largest share of total private employment in each county; Garfield, 56%, Grand, 46%, and Wayne, 36%. Washington county's economy is relatively diversified with 18% of the county's private employment in the leisure and hospitality sector.

Table 3: Direct Expenditures in 2018 (million dollars)

	Arches	Bryce Canyon	Canyonlands	Capitol Reef	Zion	Sum
Gas	14.2	23.5	6.9	13.3	20.2	78.1
Groceries	12.2	14.6	3.4	5.5	14.5	50.2
Hotels	71.3	75.8	15.1	34.9	82.4	279.5
Recreation industries	19.3	21.1	3.5	3.7	5.0	52.6
Restaurants	44.0	42.6	8.9	17.4	59.8	172.7
Retail	22.3	22.5	4.5	6.1	29.2	84.6
Transportation	12.6	21.6	2.3	5.5	28.4	70.4
Camping	4.5	5.7	1.3	2.9	6.8	21.2
Sum	200.4	227.4	45.9	89.3	246.3	809.3

Source: https://www.nps.gov/subjects/socialscience/vse.htm

cery, gift and souvenirs purchases from the local stores, restaurants, gasoline purchase, equipment rentals, other tour & recreation related services such as guides, 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 changes in economic activity for additional businesses (in the region) that support these direct industries. Examples include finance, information, real estate, education, and other services, wholesale, and manufacturing sectors.

- Induced effects are the changes 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.

- The total economic contribution of an activity is the sum of direct effects, indirect effects, and induced effects, and the 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(NPS). Direct expenditures are available at NPS Visitor Spending Effects website https://www.nps.gov/subjects/socialscience/vse.htm (Table 3.

For example, visitors to Arches National Park spent $200 million in the year 2018, including $75.8 million for lodging, $12.2 million for local grocery purchases from the local stores, $44.0 million at restaurants, $14.2 million for the purchase of gasoline, $19.3 million on services provided by recreation industries, $12.6 million on local transportation (bus, shuttles), etc. Table 3 presents 2018 direct expenditures in million dollars.

The losses in visitor spending in the local economy are shown for each park on the basis of visitation losses due to drought. For example, the loss of 34,027 (moderate drought) and 51,568 (severe drought) visitors to Arches National Park (Table 2) result in a loss of $4.10 million (moderate drought) and $6.21 million (severe drought) in visitor spending (direct effects) (Tables 2 and 4). Similar calculations are presented for all national parks under both drought scenarios. Altogether, losses in visitor spending due to drought in southern Utah (six counties combined) are estimated to be $7.20 million (moderate drought) and $10.92 million (severe drought) .

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 of 2017. As said, 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 into 13 sectors. For example, finance, information, real estate, education, and other services are aggregated into one sector, FIRES. While most of the economic sectors reported in the tables below are highly aggregated, we maintain disaggregated sectors for those sectors that are most impacted by drought-related losses in visitor spending, e.g., accommodation (hotels/motels/others), restaurants, and 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.

The gross regional product for the six county area was $7.33 billion (total value-added). This level of economic activity supported an estimated 119,016 jobs. Major economic sectors

Table 4: Loss in Visitor Spending due to Drought (million dollars)

	Moderate Drought					Sum by
	Arches	Bryce Canyon	Canyonlands	Capitol Reef	Zion	Category
Gas	0.290	-	0.149	0.314	-	0.754
Groceries	0.250	-	0.073	0.130	-	0.453
Hotels	1.458	-	0.326	0.825	-	2.609
Recreation industries	0.395	-	0.076	0.087	-	0.558
Restaurants	0.890	-	0.192	0.411	-	1.503
Retail	0.456	-	0.097	0.144	-	0.697
Transportation	0.257	-	0.050	0.130	-	0.437
Camping	0.092	-	0.028	0.069	-	0.189
Sum by NP	4.100	-	0.999	2.111	-	**7.201**
	Severe Drought					Sum by
	Arches	Bryce Canyon	Canyonlands	Capitol Reef	Zion	Category
Gas	0.440	-	0.226	0.477	-	1.143
Groceries	0.378	-	0.111	0.197	-	0.687
Hotels	2.210	-	0.494	1.252	-	3.957
Recreation industries	0.598	-	0.115	0.133	-	0.846
Restaurants	1.364	-	0.291	0.624	-	2.280
Retail	0.691	-	0.147	0.219	-	1.057
Transportation	0.391	-	0.075	0.197	-	0.663
Camping	0.139	-	0.043	0.104	-	0.286
Sum by NP	6.212	-	1.503	3.204	-	**10.919**

Author calculation
Drought coefficients in visitor equation for Bryce Canyon NP and Zion NP are not statistically significant; no impact.

include FIRES (finance, information, real estate, education, and other services), which supported 50,837 jobs. The retail trade sector produced $1.06 billion and supported 13,344 jobs as a whole. The restaurant sector produced $569 million and supported about 9,997 jobs in 2017, whereas the accommodation sector produced $308 million and hired 3,731 employees as a whole.

The estimated regional economic impact of drought-related losses in visitor spending in southern Utah is shown in Tables 5 and 6. The total loss of industry output associated with decreased expenditures by visitors is $11.78 million (moderate drought) and $17.87 million (severe drought). Relative to the gross change in expenditures, losses in output correspond

Table 5: Economic Loss of Decreases in Visitor Spending in Southern Utah from Moderate Drought in National Parks

Sector	Industry Output	Value Added	Labor Income	Employment
	(million dollars)			(persons)
Agriculture	0.009	0.003	0.000	0
Mining	0.008	0.005	0.001	0
Utilities	0.138	0.047	0.017	0
Construction	0.118	0.049	0.031	1
Manufacturing	0.067	0.018	0.011	0
Wholesale trade	0.121	0.065	0.032	1
Retail trade	2.228	1.214	0.804	28
Transport & Warehousing	0.696	0.351	0.236	4
FIRES	3.092	1.595	0.787	23
Recreation	0.596	0.293	0.154	7
Accommodation	2.808	1.523	0.820	33
Restaurants	1.712	0.864	0.617	29
Government	0.190	0.175	0.137	3
Total	11.783	6.202	3.648	129

[1] Finance, Insurance, Real estate, Education, and Other Services

to an effective expenditure multiplier of 1.64[10], which is reasonable for a relatively small economic region; that is, every dollar lost in the national parks generates $1.64 loss in total economic output.

The loss in value-added (net regional output) resulting from decreased industry output was estimated to be $6.20 million (moderate drought) and $9.40 million (severe drought), respectively. A portion of the value-added impact is the loss of income accruing to labor: losses in labor income are estimated to be $3.65 million (moderate drought), which includes the loss of 129 jobs (Table 5). In severe drought , losses in labor income were $5.53 million and a loss of $196 jobs (Table 6).

Tax revenues are also affected by losses in the level of output, labor income and value added; under the moderate drought scenario, state and local governments could expect to see losses of $0.853 million, whereas the federal government could experience losses of $0.859 million. In case of severe drought, the loss of tax revenue was estimated to be $1.294 million for state and local governments and $1.303 million for federal government.

[10] $\frac{\text{Total effects}}{\text{Direct effects}} = \frac{11.783}{7.201} = 1.636$

Table 6: Economic Loss of Decreased Visitor Spending in Southern Utah from Moderate Drought in National Parks

Sector	Industry Output	Value Added	Labor Income	Employment
	(million dollars)			(persons)
Agriculture	0.014	0.005	0.001	0
Mining	0.012	0.007	0.002	0
Utilities	0.209	0.072	0.026	0
Construction	0.180	0.074	0.047	1
Manufacturing	0.101	0.027	0.017	0
Wholesale trade	0.183	0.098	0.049	1
Retail trade	3.379	1.840	1.219	42
Transport & Warehousing	1.056	0.532	0.358	7
FIRES	4.688	2.419	1.194	35
Recreation	0.904	0.444	0.233	10
Accommodation	4.257	2.309	1.244	50
Restaurants	2.596	1.311	0.935	44
Government	0.288	0.266	0.208	4
Total	17.867	9.405	5.532	196

[1] Finance, Insurance, Real estate, Education, and Other Services

7. Summary

This study has quantified the effect of drought on recreation visitation at five National Parks in southern Utah. Using monthly data from May 1993 to December 2019, the study empirically linked drought (measured by PDSI) to monthly visitors to each national park. Results show that droughts have negative and statistically significant concurrent effects on visitation to Arches National Park, Canyonlands National Park, and Capitol Reef National Park. There is no statistically significant effects on visitation to Bryce Canyon National Park and Zion National Park. We find that there is the loss in aggregate visitation due to moderate and severe drought, that is, a loss of between 79,011 and 119,826 visitors in 2018. (Table 2). 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 $7.20 million and $10.92 million (Tables 2 and 4). Visitation and spending directly related to the regional economies where national parks are located, supports regional businesses such as hotels and restaurants, and creates jobs in private sectors. The regional economic impact of drought is estimated to be a loss between $11.78 million and $17.87 million (Tables 5

and 6). Counties where national parks are located may lose between 129 jobs (moderate drought) and 196 jobs (severe drought).

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