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 77,000 to 116,000 visitors relative to 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 ($11 million) due to the moderate drought (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 $11.53 million and $17.30 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 126 jobs. In the severe drought case, the losses in labor income were $5 million and a loss of 190 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 among Utah residents, residents of other states, and from other countries. Tourism 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, employing almost 130,000 people and making up 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. 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 (**?**).

In this study, we hypothesize that drought conditions may affect recreational visits to Utah's National Parks and other public lands. Climate and weather are some of the important factors taken into account by tourists when deciding on a destination (Mathivha et al., 2017). Weather conditions also influence the successful operation of tourism businesses (Becken, 2010). Warmer and drier conditions due to drought can contribute to diminished outdoor opportunities, as they are associated with detrimental fires (Westerling et al., 2011), decreased reservoir levels (Pielke Sr. et al., 2005), and diminished river flows (Shrestha and Schoengold, 2008). Wildfires, which are closely related with drought, also have negative impacts on the national parks' visitation (Kim and Jakus, 2019).

[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. Objectives

The goal of the research is to investigate effects of drought on national park visitation and regional economic impacts 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 five national parks; Arches, Bryce Canyon, Canyonlands, Capitol Reef, and Zion, and

(b) Using estimates, quantify the regional economic impact, for example, changes in employment, in Southern Utah.

3. Drought-Visitation Model

Similar to 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)[2] 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 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

[2]The PDSI is a measurement of dryness based on recent precipitation and temperature. The PDSI is an effective measure determining long-term drought. A PDSI of 0 is normal, and the negative PDSI indicates drought. For example, -2 is considered moderate drought, -3 indicates severe drought, and -4 is extreme drought. A positive PDSI indicates the excess moisture. For example, +2 indicates moderate wetness, +3 severe wetness, and +4 is extreme wetness (Alley, 1984).

in PDSI value, i.e., $\beta_1 \times 100\%$ change in visitation[3]. The results of the drought-visitation models were used to derive estimates of the direct expenditure change 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). 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 2019 (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 can expect autocorrelation[4] in the model.

[3]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.

[4]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.

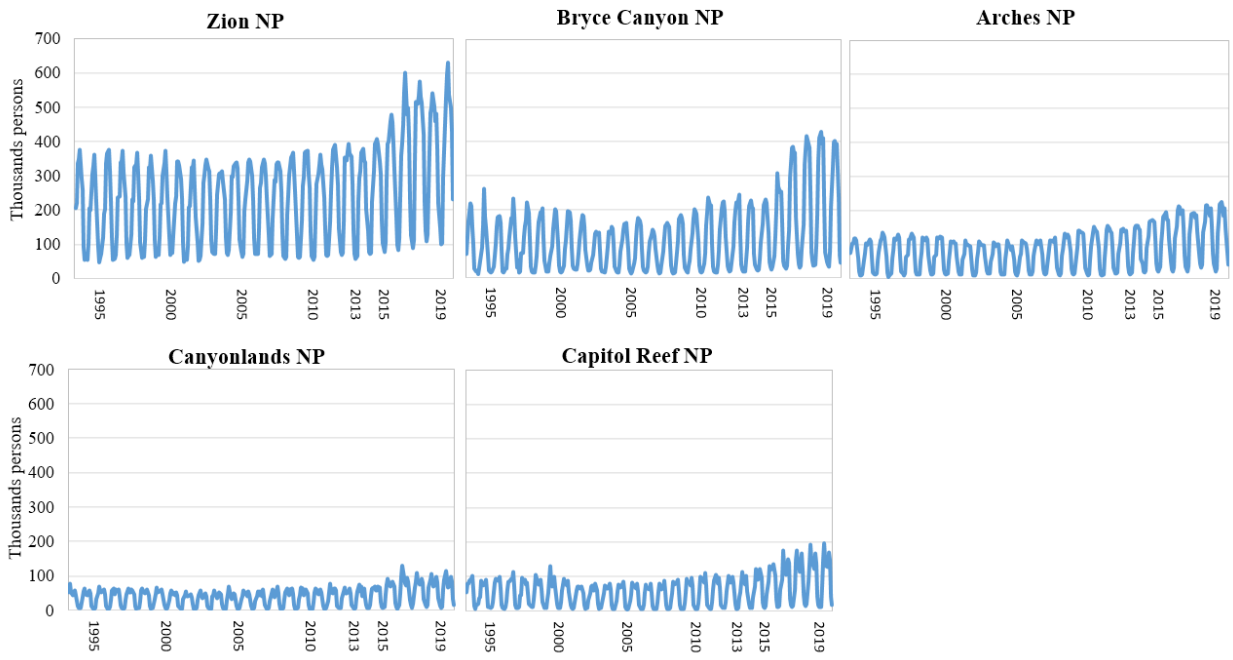

Figure 1: Number of Visitors in National Parks in Utah (000 persons)
Source: National Park Service

4.2. Drought Data

The monthly PDSI (for Utah) data between May 1993 to December 2019 were compiled from National Climatic Data Center which maintains historical climate data. Figure 2 presents the PDSI during 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 "real gasoline price". 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

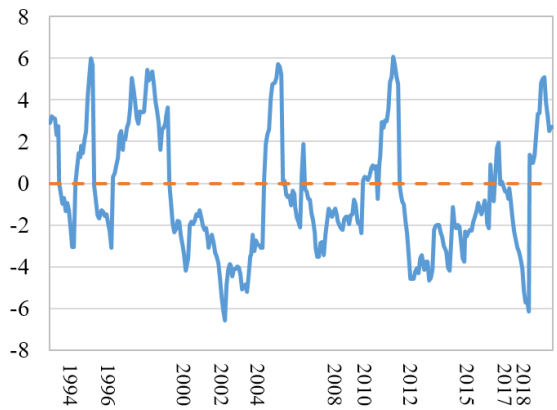

Figure 2: Monthly PDSI in Utah

Source: National Climatic Data Center

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 (**?**). 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 observe the recent years of increasing national park visitation.

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

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 of dummies are statistically significant.

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 gasoline prices (increased travel costs) result in a fall in visitation. The positive coefficient on Mighty 5 dummy shows an indication of success of the 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 if is not statistically significant except in Zion NP.

Turning to the PDSI coefficients, we find that drought has a statistically significant negative impact on visitation in Arches NP, Canyonlands NP, and Capitol Reef NP, but not in Bryce Canyon NP and Zion NP. This observation could be due to the fact that Zion NP

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	33,345	4.017
Bryce Canyon NP	-	-	-
Canyonlands NP	2.11	15,626	0.970
Capitol Reef NP	2.31	28,350	2.062
Zion NP	-	-	-
Sum		77,321	7.049
Severe drought, $\Delta PDSI = -3$			
Arches NP	3.00	50,018	6.025
Bryce Canyon NP	-	-	-
Canyonlands NP	3.17	23,439	1.455
Capitol Reef NP	3.46	42,525	3.093
Zion NP	-	-	-
Sum		115,982	10.574

[1] 2018 visitor number in NP × % Change
[2] 2018 per person expenditure × loss in visitation, 2018 visitor spending is compiled from https://www.nps.gov/subjects/socialscience/vse.htm

and Bryce Canyon NP are congested (that is, popular), and close to the highway and the city of St. George, Utah, reducing the impact of drought on visitation.

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 NP. For Canyonlands NP, the effect of the moderate drought is a 2.11% fall in the month concurrent with the drought, with a similar 2.31% decreases in Capitol Reef NP visitation. Table 2 presents the changes (losses) in visitation relative to 2018 numbers[5] due to the moderate and severe drought ($\Delta PDSI = -3$)

The visitation losses follow expected patterns. Visitation losses are a function of the

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

PDSI parameter estimates (Table 1), the changes in PDSI or the magnitude of drought, and baseline visitation. With the moderate drought, the Southern Utah may lose \$7.05 million (loss in visitor spending in Table 2) and with the severe drought, \$10.57 million. This is large enough to affect the regional economies. In case of the extreme drought ($\Delta PDSI = -4$), the loss in visitor spending is estimated to be \$14.10 million.

6. Regional Economic Impacts: Southern Utah

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 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, 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 visitor (direct) expenditures. There are 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 changes 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

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

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 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. For example, visitors to Arches NP 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, as reported on the NPS Visitor Spending Effects website.

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 33,345 (50,018) visitors to Arches NP (Table 2) due to the moderate drought (severe drought) results in a loss of $4.02 million ($6.03 million) in visitor spending (direct effects) (Tables 2 and 4). Similar calculations are presented for all national parks under both drought scenarios. All together, the losses in the visitor spending in the region of Southern Utah are estimated to be $7.05 million ($10.57

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

	Moderate Drought					Sum by
	Arches	Bryce Canyon	Canyonlands	Capitol Reef	Zion	Category
Gas	0.285	-	0.146	0.307	-	0.738
Groceries	0.245	-	0.072	0.127	-	0.443
Hotels	1.429	-	0.319	0.806	-	2.554
Recreation industries	0.387	-	0.074	0.085	-	0.546
Restaurants	0.882	-	0.188	0.402	-	1.472
Retail	0.447	-	0.095	0.141	-	0.683
Transportation	0.253	-	0.049	0.127	-	0.428
Camping	0.090	-	0.027	0.067	-	0.185
Sum by NP	4.017	-	0.970	2.062	-	**7.049**
	Severe Drought					Sum by
	Arches	Bryce Canyon	Canyonlands	Capitol Reef	Zion	Category
Gas	0.423	-	0.219	0.460	-	1.106
Groceries	0.367	-	0.108	0.191	-	0.665
Hotels	2.144	-	0.479	1.209	-	3.831
Recreation industries	0.580	-	0.111	0.128	-	0.819
Restaurants	1.323	-	0.282	0.603	-	2.208
Retail	0.670	-	0.143	0.211	-	1.024
Transportation	0.379	-	0.073	0.191	-	0.642
Camping	0.135	-	0.041	0.100	-	0.277
Sum by NP	6.025	-	1.455	3.093	-	**10.574**

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

million) due to the moderate drought (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. 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. 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 drought-related losses in visitor spending, e.g., accommodation (hotels/motels/others), restaurants, and recreation industries, which are broken out in detail.

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	0.135	0.046	0.017	0
Construction	0.116	0.048	0.030	1
Manufacturing	0.065	0.017	0.011	0
Wholesale trade	0.118	0.064	0.032	1
Retail trade	2.181	1.188	0.787	27
Transport & Warehousing	0.682	0.344	0.231	4
FIRES[1]	3.027	1.562	0.771	23
Recreation	0.584	0.287	0.151	7
Accommodation	2.748	1.491	0.803	33
Restaurants	1.676	0.846	0.604	29
Government	0.186	0.172	0.134	2
Total	11.535	6.071	3.571	126

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

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 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. 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.

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 $11.54 million (moderate drought) and $17.30 million (severe drought). Relative to the gross change in expenditures, losses in output correspond to an effective expenditure multiplier of 1.64, 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.

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	0.202	0.069	0.025	0
Construction	0.174	0.072	0.046	1
Manufacturing	0.098	0.026	0.016	0
Wholesale trade	0.178	0.095	0.048	1
Retail trade	3.272	1.782	1.180	41
Transport & Warehousing	1.023	0.515	0.347	6
FIRES	4.540	2.343	1.156	34
Recreation	0.876	0.430	0.226	10
Accommodation	4.122	2.236	1.204	49
Restaurants	2.514	1.269	0.905	43
Government	0.278	0.258	0.201	4
Total	17.302	9.107	5.357	190

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

The loss in value-added (net regional output) resulting from decreased industry output was estimated to be $6.07 million (moderate drought) and $9.11 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 $3.57 million (moderate drought), which includes the loss of 126 jobs (Table 5). In the severe drought case, losses in labor income were $5.36 million and a loss of 190 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 $0.835 million, whereas the federal government could experience losses of $0.841 million. In case of severe drought, the loss of tax revenue was estimated to be $1.253 million for state/local government and $1.262 million for federal government.

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, this study empirically linked drought (measured by PDSI) to monthly visitors to each national park.

Results show that drought conditions have negative and statistically significant concurrent effects on visitation to Arches NP, Canyonlands NP, and Capitol Reef NP. There is no statistically significant effects on visitation to Bryce Canyon NP and Zion NP. We find that there is the loss in aggregate visitation due to moderate and severe drought, that is, a loss of between 77,321 and 115,982 visitors relative to 2018 visitor numbers (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 $7.05 million and $10.57 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 $11.53 million and $17.30 million (Tables 5 and 6). Counties where national parks are located may lose between 126 jobs and 190 jobs, depending on the extent of the drought.

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