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Dark Sky Tourism: Economic Impacts on the Colorado Plateau Economy, USA

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Star Light, Star Bright: The Economic Impact from Dark Sky Tourism on the Colorado Plateau Economy

Abstract: This case study examines the economic impact from dark-sky tourism in national parks in the United States on the Colorado Plateau. The Colorado Plateau is a region encompassing parts of Arizona, Colorado, New Mexico, and Utah that is known for its dark, star filled night skies.

Tourists to national parks are increasingly interested in observing this natural recreational amenity—especially considering that it is an ecological amenity that is quickly disappearing from the planet. Employing a 10-year forecast of visitors to the national parks and using standard Input-Output modeling, we show, for the first time anywhere, the value of dark skies to tourism in this area. We find that non-local tourists who value dark skies will spend \$5.8 billion over 10 years in the Colorado Plateau. These tourist expenditures will generate \$2.4 billion in higher wages and create over 10,000 additional jobs each year for the region. Furthermore, since dark skies are better in the non-summer months, they have the ability to increase national park visitation year-round, leading to a more efficient use of local tourism-related resources throughout the year.

Keywords: Dark Skies, Ecotourism, Economic Impact Analysis, National Parks, Light Pollution, Colorado Plateau

I. Introduction

Tourism has been an important industry for local and regional economic growth and development for many decades. Tourists bring an inflow of domestic and international monies with purchases of lodging, food, and other goods and services. This spending helps to sustain local jobs and incomes for people involved in meeting tourists needs (Sinclair, 1998; Page and Dowling, 2001). Academic literature has documented that tourism has played a major economic role in the growth and development of many areas including Eastern Europe, rural South Africa, and Taiwan (Hall, 1991; Briedenhann and Wickens, 2004; Kim, Chen, and Jang, 2006). Over the past 30 years or so, there has been a growing movement within the tourism industry towards ecotourism. Ecotourism provides local citizens a stake in maintaining the ecological aspects of sites (Fennell and Eagles, 1990; Muloin, 1998; Carr and Mendelsohn, 2003; Weaver, 1999). Our case study shows that dark-sky ecotourism is a multi-billion dollar industry on the Colorado Plateau.

In 2015 the US National Park Service recorded nearly 26 million visitors to the national parks contained within Arizona, Colorado, New Mexico, and Utah. These 26 million visitors spent almost \$1.8 billion dollars impacting the local and state economies and creating almost 27,000 jobs. The visitors to the national parks are interested in a variety of recreational activities including camping, fishing, wildlife watching, hiking, and photography. A significant, and growing, number of these visitors are also interested in star gazing and are willing to pay to be able to see dark skies at night (Mitchell, et. al., 2017).

The national parks in this four-state region provide visitors with the opportunity to experience nature and see wildlife and picturesque vistas. They also provide a rare scenic and recreational resource that most tourists cannot find at home—the nocturnal world in its wild and natural state, largely free from light pollution. Light pollution is so pervasive that over 80% of the world's population and 99% of the populations of Europe and the United States live under light

1
2 polluted skies. Nearly 80% of North Americans cannot see the Milky Way from home and
3
4 approximately 40% of the US population no longer has the ability to see the night sky with an eye
5
6 that can truly adapt to darkness—in other words, it's as if 40% of the population never experiences
7
8 'nighttime' (Cinzano et. al., 2001; 2016; Gallaway, et. al. 2010). By maintaining dark skies, these
9
10 national parks are able to provide visitors with a scenic and ecological asset that is unavailable in
11
12 many parts of the country. To date, we are unaware of any literature that has sought to place a
13
14 dollar value, from a tourism standpoint, on the dark skies at these national parks. This case study
15
16 seeks to remedy this by examining visitor spending for dark skies in national parks. Section 2
17
18 discusses light pollution in general, while section 3 examines the area of study. Section 4 outlines
19
20 our methodology and section 5 discusses results of the economic impact analysis. Section 6
21
22 sketches out some ways that local communities can leverage dark skies to increase tourism while
23
24 section 7 draws some conclusions.

30 **II. Understanding Light Pollution**

31
32 Light pollution (LP) is increasingly recognized as a serious environmental problem. Light
33
34 pollution is the artificial light at night that degrades the utility, function, biota, or aesthetics of the
35
36 surrounding environment. Often this is due to the presence of poorly engineered lighting. In fact,
37
38 the light pollution within a city can create 'sky glow' that can be seen from over 100 miles away.

39
40
41 Light pollution first attracted academic scrutiny by astronomers (e.g. Bertiau, 1973). Then,
42
43 in recent decades, the problem has increasingly been studied by those in the natural and biological
44
45 sciences. The presence of light pollution is known to interfere with the normal behavior of animals,
46
47 especially nocturnal animals, and even some flora. This interference with activities such as eating,
48
49 evading predators, mating, and the like, and can have an adverse effect on the health and population
50
51 size of many different species (Bennie, 2018; Cruz et al., 2018; Davies and Smyth, 2018; Kim et al.,
52
53 2018; Underhill and Höbel, 2018; Meier, et al. 2015; Salmon and Witherington, 1995; Salmon et.
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2
3 al, 1995 Verheijen, 1985;). Artificial light at night is a radical alteration of the environment. It can
4
5 have devastating impacts on ecology and aesthetics. Accordingly, economists can study the costs of
6
7 economic light pollution in much the same way as they might study how the *Exxon Valdez* oil spill
8
9 devastated commercial fishing and tourism (Shaw, 1992; Bue, Sharr, and Seeb, 1998).

10
11
12 Dark nighttime skies, especially in national parks, can help maintain existing tourism and be
13
14 used as a vehicle for attracting additional tourists to an area (Cater, 2010; Fayos-Solá, Marín and
15
16 Jafari, 2014; Hänel 2016; Labuda, Kolch, and Nagyová, 2015; Labuda, Pavličková, and Števoová
17
18 2016; Rodrigeus, Rodrigues and Peroff, 2015). This effect is multifaceted. By having some areas
19
20 that are free of LP, tourists have a place to observe the night sky, experience a naturally dark
21
22 environment, and observe a less trampled wilderness in the same way that some people travel to
23
24 Yellowstone National Park to see bison and geysers. Secondly, preserving dark nighttime skies
25
26 helps to protect the health and diversity of local wildlife populations which are often the primary
27
28 amenity that visitors to national parks are seeking. In short, dark skies are both a necessary and
29
30 complementary characteristic to the more well-known amenity of ‘wildlife’ that attracts visitors to
31
32 national parks. Both the damage to scenic nightscapes and any related deleterious effects on
33
34 wildlife will likely reduce a visitor’s willingness to pay to visit areas such as a national parks.

35 36 37 38 39 **III. Understanding the Colorado Plateau**

40
41
42 This case study examines the economic impact from dark sky tourism in the area known as
43
44 the ‘Colorado Plateau Dark Sky Cooperative’ (Colorado Plateau) which covers approximately
45
46 130,000 square miles over the aforementioned states in the Southwestern United States and is
47
48 shown in Figure 1. The Colorado Plateau is home to many national parks as well as America’s first
49
50 Dark Sky Cooperative. Table 1 lists the different national parks on the Colorado Plateau as well as
51
52 their size in square miles. In addition to the national parks, there are public lands administered by
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54 the state parks, the National Forest Service (USFS), and the Bureau of Land Management (BLM).
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1
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3 The size of these public lands can be extensive. For example, more than 70% of the state of Utah is
4
5 under public control, while Colorado, Arizona, and New Mexico are between 30 to 34% public
6
7 lands. Protecting these public lands has helped safeguard dark skies on the Colorado Plateau. One
8
9 would expect that explicit consideration about the value of dark skies would facilitate caring for
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11 public lands and their contribution to the landscapes, wildlife, and natural experiences sought out by
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13 tourists.
14

15
16 <<Figure 1 here>>

17
18 <<Table 1 here>>
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23 Because of the low population density, abundance of public lands, and a generally arid
24
25 climate and high elevations, the Colorado Plateau has long enjoyed a reputation for excellent night
26
27 skies with spectacular views of the stars. This combination of natural and demographic conditions
28
29 creates a scarce ecotourism asset with important cultural, aesthetic, historical, and recreational
30
31 dimensions (Gallaway, 2010). Such high-quality views of the night sky are increasingly rare in
32
33 modern, urbanized, society. For many, a dark night sky is, in its own way, as exotic of a sight as a
34
35 herd of bison or a crystal-clear glacial lake.
36
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38
39 International recognition of the importance of night skies on the Colorado Plateau has, in recent
40
41 years, become more explicit and formalized (see Figure 2). On March 6th, 2007, Natural Bridges
42
43 National Monument became the first International Dark Sky Park certified by the International
44
45 Dark-Sky Association. Since then, many national parks and state parks on the Colorado Plateau
46
47 have received similar recognition. This recognition is given in acknowledgement of extraordinary
48
49 dark sky conservation efforts. The Colorado Plateau is unique in both the number of these Dark Sky
50
51 Parks and by their superior quality; many of these parks are gold-tier certified, signifying that they
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53 have the best and rarest night skies.
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<<Figure 2 here>>

The concentration of these International Dark Sky Parks on the Colorado Plateau points to the global importance of maintaining dark skies in this region. It is an immense area with skies dark enough and clear enough to make it the envy of the world. Much of the landscape is protected and even though the area is vast and remote, it is highly accessible and already a destination for millions of tourists each year. Consequently, the Colorado Plateau has a very unique and substantial potential for night sky tourism. Importantly, dark skies give tourists a reason to extend visits to include one or more overnight stays.

IV. Economic Impact Analysis Methodology

We will examine the economic impact of non-local tourists to the national parks in the Colorado Plateau who stay inside the park and consider the ability to see and enjoy night skies to be an important park amenity. We analyze the impact such tourists have on the state level economies of New Mexico, Utah, Colorado, and Arizona. We estimate economic impacts of existing dark-sky oriented visitors to National Parks in the area. However, it is important to recognize that the potential for night sky tourism and its economic impact is larger. For example, we have not counted non-local visitors who value dark skies but stayed outside of the park. Furthermore, there are good reasons to believe that there is significant growth potential for this type of ecotourism. However, the pace of this growth and the eventual magnitude of night-sky tourism depend on the willingness of stakeholders to promote night-sky tourism and leverage the region's unparalleled assets. This economic impact analysis measures existing trends, where comparatively little is done to promote night-sky tourism.

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3 Our focus in this study is 27 parks in the Colorado Plateau administered by the National
4 Park Service (NPS). Many of the parks are quite large, with four of them each exceeding 1,500
5 square miles in area. Together, these parks cover a vast area.
6
7

8
9 We used the Park Service's own data about visitation numbers and tourists' lodging choices.
10 Economic impacts from visitor spending were analyzed using Input-Output Analysis (IO).¹ IO is
11 commonly used in economic research and has a long history in tourism studies (Briassoulis, 1991;
12 Los and Steenge, 2010; Kim and Kim, 2015; Tohmo, 2018; Kronenberg, Fuchs, Lexhagen, 2018;
13 Cline and Seidl, 2010). More specifically, we used detailed models, developed by IMPLAN², of the
14 US and state level economy to analyze the economic impact of spending by overnight tourists at
15 parks on the Colorado Plateau.
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25 Input-Output analysis recognizes that the impact of tourist spending gets multiplied as one
26 person's spending creates income and more spending by others. Tourism spending creates income
27 for hoteliers that is used to buy supplies and hire workers to meet the needs of customers; but
28 hoteliers also have their own personal consumption spending that is entirely unrelated to the tourism
29 industry.
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37 The production of all goods and services requires multiple forward and backward linkages.
38 For example, restaurants must purchase supplies of food from a wholesaler. The restaurant
39 combines the input *eggs* with other labor and capital inputs, *cooks* and *stoves*, to provide an output,
40 *breakfast* for customers. Raw eggs are an input for restaurants but an output for wholesalers. Input-
41 Output analysis traces and aggregates the inter-industry linkages that exist between different goods
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50
51 ¹ The literature on using IO analysis, especially in economic impact studies, is vast and extensive such that the
52 nomenclature and measurement of the different effects (direct, indirect, and induced) is well understood.
53 This paper is not a review of that methodology. However, for the reader who is interested, they can examine: McCann
54 (2013), Armstrong and Taylor (2000), Isard, et. al. (1998).

55 ² IMPLAN is an industry-leading software package that is used in Input-Output analysis to determine the size and
56 nature of economic linkages using a classification system of 509 different sub-sectors of the economy.
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1
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3 and services. Some industries are closely related with big impacts on each other, while others have
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5 relatively few interconnections. Modeling all of these complex interconnections allows one to
6
7 better understand the total impact on jobs and incomes within the region from an activity such as
8
9 tourism to an area.³ For example, Cline and Seidl (2010) showed that the economic impact from
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11 tourism related to open spaces and water quality levels were larger than the economic costs of local
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13 tax levies necessary to maintain open spaces. Thus, they argued that local tax levies that help to
14
15 maintain open spaces should be implemented.
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19 We offer similar analysis in that we are seeking to quantify the economic impact from
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21 tourism related to an environmental amenity that appeals to tourists—dark skies. To forecast the
22
23 economic impact of dark skies for the next 10 years we first examine National Park Service
24
25 visitation data for the past 10 years. We emphasized the spending behavior of non-local visitors.
26
27 Local visitors to parks shift spending within a region rather than create new economic activity.⁴
28
29 Non-local visitors were disaggregated to account for day visitors and overnight visitors. Overnight
30
31 visitors were divided up into two distinct groups—those staying at the park lodges and those that
32
33 were tent, Recreational Vehicle, and backcountry campers—due to differences in the amount of
34
35 spending by lodge and non-lodge visitors. We also determined the compound average annual
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37 growth rate over the past ten years in overnight and day visitors. These rates were used to project
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39 total visitors, overnight lodge visitors, and other overnight visitors for each park under study for
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48 ³ When conducting economic impact analysis, different assumptions and methodologies can artificially inflate the true
49 economic impact. For example, Input-Output studies will often examine ‘total spending’ on a good rather than ‘new
50 spending’ to inflate the economic impact estimates. They count increased spending at new attractions but not the
51 reduced spending elsewhere. We have endeavored to act in the opposite way—taking conservative views on the data,
52 assumptions, and methodologies. Therefore, one can assume that the results from our analysis provide a lower bounds
53 on the true economic impact of dark skies.

54 ⁴ A local visitor to the park for dark skies could create new economic spending if the spending was actually new and not
55 a rearrangement of current spending. However, we do not have data to make such judgments. Furthermore, any new
56 local spending on gas, food and lodging would be very small. .
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3 each year for the next 10 years. As of the writing of this case study, 2015 is the most recent year for
4
5 complete data not subject to future revisions.
6

7 Table 2 shows these growth rates as well as the number of non-local visitors by category.
8
9 For example, Bryce Canyon had 1.6 million non-local visitors of which 53,792 spent the night at the
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11 park lodge and 96,694 spent the night at the park in a non-lodge format. The number of lodge visits
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13 to Bryce Canyon is expected to grow at an annual rate of 1.82% each year for the next 10 years
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15 while non-lodge overnight visitors are expected to grow at a rate of 1.73%.
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21 <<Table 2 here>>
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26 Significantly, examining Table 2 illustrates some patterns that should be striking for those
27
28 interested in the economic impact of tourism. For example, based on recent trends at Grand Canyon
29
30 National Park, the number of overnight lodge visitors is expected to decline at an annual rate of
31
32 0.95% while at the same time, the number of overnight non-lodge visitors can be expected to
33
34 increase by 1.51% per year every year. This means that by overnight lodge visitors to the Grand
35
36 Canyon will decline from 540,000 in 2015 to 490,838 in 2025—a decrease of nearly 49,161
37
38 visitors. Meanwhile, other overnight visitors will increase from 635,342 in 2015 to 758,997 in
39
40 2025—an increase of 123,635.
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43

44 We then used National Park Service data from past studies such as park-specific expenditure
45
46 surveys and other NPS sources to determine visitor spending on several different categories of
47
48 goods and services (Cui, et. al., 2013; Thomas, et.al, 2014). These categories were retail sales,
49
50 recreation spending, auto and transportation related spending, grocery spending, restaurant
51
52 spending, and lodging spending. Category specific price index data for the past 10 years was
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54 collected on each of the different categories and was used to project the future prices of each of the
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1
2 different spending categories via the past average annual growth rate of prices within the category.
3
4 Once each category's price growth rate was determined, a weighted average using each category's
5
6 relative share of spending to total spending was established and used to determine the growth rate of
7
8 future spending. For example, visitors who stayed at a NPS lodge tended to spend 45.92% of the
9
10 total tourism dollars on lodging while those who stayed overnight in another format only spent
11
12 24.9% of the tourism dollars on lodging. These group-specific spending profiles, one for overnight
13
14 lodge visitors and for other overnight visitors, were adjusted for inflation so that all spending during
15
16 the project time period is occurring in 2017 dollars. Finally, the spending and all economic impacts
17
18 were discounted during the study period in accordance with standard economic methodology. The
19
20 average yield of the 10-year US Treasury bond over the past 10 years was used as the discount rate.
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26 Once we had the yearly number of overnight visitors by category and knew how much each
27
28 visitor was going to be spending in inflation-adjusted dollars on each spending category, we needed
29
30 to determine how important the dark skies were for the purpose of their visit. If a non-local visitor
31
32 is spending the night at a park, but does not value a dark night sky as an attracting amenity, then it
33
34 would be inaccurate to count their spending, and subsequent economic impact from that spending,
35
36 in our analysis. As previously discussed, visitors who do not explicitly value dark skies might still
37
38 be benefit from them if, as research suggests, dark skies help protect wildlife. Accordingly, the
39
40 economic impact of preserving dark skies could be larger than the numbers presented here. Figure 3
41
42 gives a visual illustration of which visitors' expenditures are being counted in the Input-Output
43
44 model. Tourists are divided into local and non-local groups which are then further subdivided into
45
46 those that value dark skies and those that do not. Finally, visitors are subdivided again into
47
48 overnight visitors or day visitors. Only visitors with a 'Yes' are having their tourism expenditures
49
50 entered into the Input-Output model—the tourism expenditures of visitors with a 'No' are left out of
51
52 our Input-Output analysis. As one can see, there is a significant amount of spending by visitors that
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3 is outside the focus of our model, which further suggests our estimate of the economic impact of
4
5 dark skies on the regional economy is conservative.
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10 <<Figure 3 here>>

11
12 Previous research has investigated the importance of scenic views and dark skies in national
13
14 parks (Culesza, 2013). Researchers conducted surveys to ascertain visitor opinions about dark
15
16 night skies and other issues. Forty-one studies were conducted between 1988 and 2011 in 15
17
18 National Parks. The surveys gathered responses from 18,345 visitor groups (Culesza, 2013). These
19
20 included several from the Colorado Plateau. Visitors were asked how important dark starry skies
21
22 were to their visit. They ranked the importance on a five-tier scale from not important to extremely
23
24 important. The percentage of respondents who answered that dark skies were very important or
25
26 extremely important were compiled and this weighed average of 65.1% was used for parks where
27
28 no dark sky opinion survey was conducted. In parks that did have data on visitor attitudes, those
29
30 specific survey numbers were used to determine the percentage of visitors who valued dark skies.
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35 Over the past two decades, the percentage of people who believe that dark skies are
36
37 important has been increasing. For example, in 1990 only 14% of visitors to Death Valley thought
38
39 of dark skies as very or extremely important. By 1996, that figure had risen to 44%. Similarly, when
40
41 asked to rank the park asset that was the most important to protect, visitors to Death Valley rated the
42
43 night sky number 8 in 1990, 7 in 1996 and 6 in 2009 (Culesza, 2013). For the study as a whole,
44
45 2010 saw the largest number of visitors, from the most parks, surveyed. In that year, 69% of
46
47 respondents, on average, rated the night sky as very important or extremely important. What might
48
49 be driving this increase? Perhaps people are becoming more aware of light pollution. Or perhaps,
50
51 people are beginning to realize that dark skies are becoming 'endangered' and are now more apt to
52
53 act to preserve them. It should also be noted that scenic amenities have always been important to
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2
3 park visitors. Across the National Park Service, 90% of visitors say scenic views are an extremely
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5 or very important resource to protect and preserve (Culesza, 2013). Therefore, it seems that
6
7 visitors are simply more aware that there is something worth seeing in the parks at night. No matter
8
9 the reason, the conclusion is clear—dark skies and their preservation is becoming increasingly
10
11 important to people. This fact suggests, once again, that the results of our study are a lower bound
12
13 on the economic impact of dark skies. Growing awareness of light pollution as well as the creation
14
15 and promotion of Dark Sky Parks suggests the percentage of visitors emphasizing the importance of
16
17 dark skies will be higher, by the end of the decade, than the backwards looking average we used.

21 **V. Economic Impact Results**

22
23 The results of our IO analysis are shown in Table 3. They show the economic impact of dark
24
25 sky related tourism on the Colorado Plateau, by year, for 10 years based upon recent trends in the
26
27 number of visitors, spending, and attitudes towards dark skies. This economic impact is examined
28
29 under several different metrics including visitor spending, wages, value added, and jobs and these
30
31 are tallied in Table 3 for both Lodge and non-lodge overnight visitors. The data on total non-local
32
33 visitor spending and the income (wages) and value added created from this spending, is reported in
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35 real 2015 discounted dollars. All of the figures in the table represent the sum of direct, indirect, and
36
37 induced changes in the economy.
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44 <<Table 3 here>>

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48 As one can see, the effect of dark skies on the state economies is quite large. In the 10 years
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50 from 2015 to 2024, visitors will spend nearly \$5.75 billion visiting NPS parks on the Colorado
51
52 Plateau trying to see a dark sky at night. About 58% of this spending will be due to NPS lodges
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54 with the remaining 42% at other NPS lodging. This is despite the fact that the NPS lodges receive
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1
2 fewer visitors. This additional \$5.75 billion in spending creates \$3.8 billion in additional value
3
4 added for the local state economies. The total effect of all of this additional spending is to create an
5
6 average of 10,127 additional jobs per year for a total of 113,656 future job years. This will increase
7
8 wages in the states by over \$2.423 billion dollars.
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11 12 13 14 **VI. Leveraging Dark-Sky Tourism** 15

16 Table 2 shows a downward trend in the number of park visitors for several national parks.
17
18 This is problematic for local businesses that depend upon park visitors. Recall that some parks in
19
20 our study are expected to see visitorship increases—however, based on recent trends, a majority of
21
22 them are projected to see decreases. Of the 20 different NPS areas that had non-lodge overnight
23
24 visitors, 6 of them are expected to have decreases in the number of overnight visitors. The average
25
26 annual decline in the number of visitors was over 6.7% with a weighted average annual decline of
27
28 1.1%. Some of these decreases are quite substantial. If recent trends continue, Canyon de Chelly
29
30 would have annual non-Lodge overnight visitors decrease by 33% every year meaning that at the
31
32 end of the study period there will only be 8 non-Lodge overnight visitors to Canyon de Chelly per
33
34 year. Only 2 of the 7 lodges are projected to have increasing numbers of visitors over the next 10
35
36 years. The average annual decline in lodge visitors to the Colorado Plateau region is almost 7%
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38 with a weighted average yearly decline of 1.3%. The declines for lodge visitors are even more
39
40 worrisome since they have a larger economic impact on local communities than non-lodge visitors.
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46 This creates a strong incentive for both the NPS parks and local businesses on the Colorado
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48 Plateau to work together to reverse recent trends, attract more visitors, and increase the number of
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50 overnight stays. Survey data shows that visitors are increasingly considering dark skies as an
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52 attraction and are willing to pay to see dark skies (Mitchell, et. al. 2017). Therefore, the dark skies
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54 of the Colorado Plateau can be used, and promoted, as a magnet for tourism. Crucially, from an
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1
2 economic standpoint, the single most important thing about dark-sky tourism is that it necessitates
3 one or more overnight stays. The NPS estimates that the average spending per party per day is
4 about \$90 for non-local day trips. For parties staying overnight at an NPS lodge, this spending rises
5 to over \$390, for those staying in motels outside the park, the amount is a little over \$270 (Thomas,
6 et. al. 2014; Cui, et. al. 2013). Increasing the number of visitors and encouraging overnight stays
7 can have large economic benefits for the local communities.
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16 Similarly, by focusing on dark skies as a method of attracting visitors, the parks and local
17 communities can better utilize their resources without significant capital investment. Most national
18 parks have a surge of visitors in the summer months but far fewer visitors in the other seasons (see
19 Figure 4). This means the tourism related businesses and community infrastructure cannot be used
20 in an efficient manner. Hotel rooms and restaurants vacillate between being overcrowded and
21 empty. Dark skies grow in value as an amenity during off-peak times and can therefore be used to
22 spur tourism during the off season leading to an increase in efficiency of tourism related
23 infrastructure and resources.
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34 Stargazing is, in many ways, better in the fall, winter, and spring due to longer nights and
35 other factors. For example, a popular activity among some recreational astronomers is participating
36 Messier Marathons, where individuals try to observe as many of the 110 deep-sky objects, such as
37 nebulae and galaxies, cataloged by the 18th century astronomer Charles Messier.
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46 <<Figure 4 here>>
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51 Messier marathons are held near the new moons in early spring, because it is possible to see
52 all of the objects in one night for mid to low latitudes of the Northern Hemisphere. In the Colorado
53 Plateau, cloud free nights with good air quality are most likely to be found during May and June, as
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2 well as September and October (Moore, 2015). Accordingly, promoting dark skies will increase the
3 number of visitors during the off-peak seasons and provide a longer more sustained period of
4 tourism activity providing the park and local businesses with a steadier source of income.
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9 **VII. Conclusion**

10
11 This case study has examined the impact that dark skies have on the local economies for
12 areas around national parks in the Colorado Plateau. The Colorado Plateau is an area known for its
13 dark skies. This amenity is becoming increasingly more important to visitors at the exact same time
14 that it is becoming more threatened. Our results indicate that the current economic impact of the
15 dark skies tourism is substantial. Of the over 4.1 million non-local overnight visitors to NPS parks
16 on the Colorado Plateau, those who rate the night sky as very important or extremely important will,
17 over ten years, create an additional 10,127 jobs per year on average because they will spend over
18 \$5.75 billion. This will increase wages by over \$2.4 billion and increase gross state product by over
19 \$3.8 billion.
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32 Importantly, these numbers do not include the very substantial economic impact of the
33 majority of non-local overnight visitors because they stayed in lodging outside the parks and were
34 not included in our calculations. Similarly, these figures do not measure the full *economic*
35 *significance* of these parks. Such a measure would include spending by locals as well. Nationally,
36 it should be noted, spending by locals and by visitors who lodge outside of the parks account for
37 over two-thirds of the total spending (Cui, et al., 2013). Additionally, these figures do not include
38 the impact of visitors to USFS or BLM lands. For now, we do not have sufficient data to estimate
39 the additional economic impact of night sky tourism associated with these lands. However, we do
40 know that, on the Colorado Plateau, both of these types of lands attract tens of millions of visitors
41 per year. We also know that experiencing nature and viewing scenic vistas are consistently
42 important factors to many visitors to public lands. These facts speak both to the existing additional
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3 economic impact of night sky tourism in the region and to the potential for leveraging the unique
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5 resources of the Colorado Plateau to further promote such tourism.
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7 The reported figures assume simply the continuation of existing trends, with no increase in
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9 efforts to promote night sky tourism. We have shown that dark skies are a valuable resource. This
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11 presents the local communities and the parks in the Colorado Plateau with a unique opportunity for
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13 partnership. If public land managers and local communities were to work together to promote dark
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15 sky tourism and increase the number of visitors to the area, the economic impact would be
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17 substantial. We leave this impact to future research.
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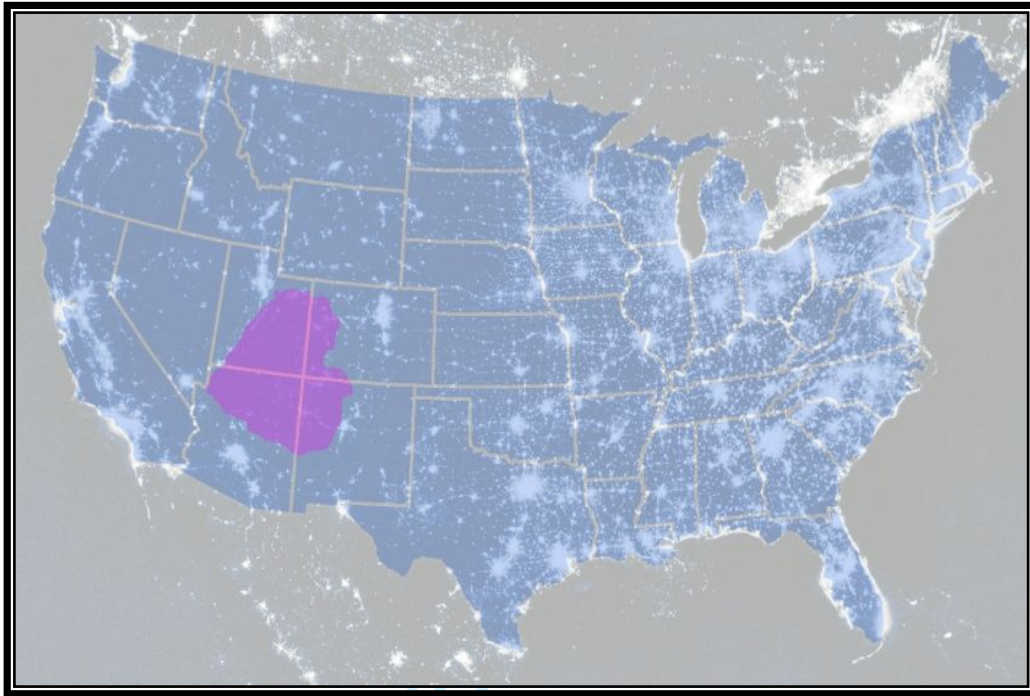
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Figure 1. The Colorado Plateau shown in pink with areas of light pollution shown in white



Tourism Review

Table 1. NPS Parks in the Colorado Plateau

National Park	State	Area (sq. miles)
Arches NP	UT	120
Black Canyon of the Gunnison NP	CO	47
Bryce Canyon NP	UT	56
Canyon de Chelly NM	AZ	131
Canyonlands NP	UT	527
Capitol Reef NP	UT	378
Cedar Breaks NM	UT	10
Chaco Culture NHP	NM	53
Colorado NM	CO	32
Dinosaur NM	CO, UT	329
El Malpais NM	NM	179
El Morro NM	NM	2
Glen Canyon NRA	AZ, UT	1875
Grand Canyon NP	AZ	1902
Hovenweep NM	CO, UT	1.2
Hubbell Trading Post NHS	AZ	NA
Lake Mead NRA	AZ, NV	2338
Mesa Verde NP	CO	81
Natural Bridges NM	UT	12
Navajo NM	AZ	0.6
Grand Canyon Parashant (Meade)	AZ	1638
Petrified Forest NP	AZ	146
Rainbow Bridge NM	UT	0.25
Sunset Crater Volcano NM	AZ	5
Walnut Canyon NM	AZ	6
Wupatki NM	AZ	55
Zion NP	UT	229

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6 **Figure 2. IDA and Tourism Promotion Posters for Dark Sky Parks in the Colorado**
7 **Plateau (credit: Tyler Nordgren, NPS, IDA)**
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Table 2. 2015 Visitation and 10 Year Compound Annual Growth Rates (CAGR*)

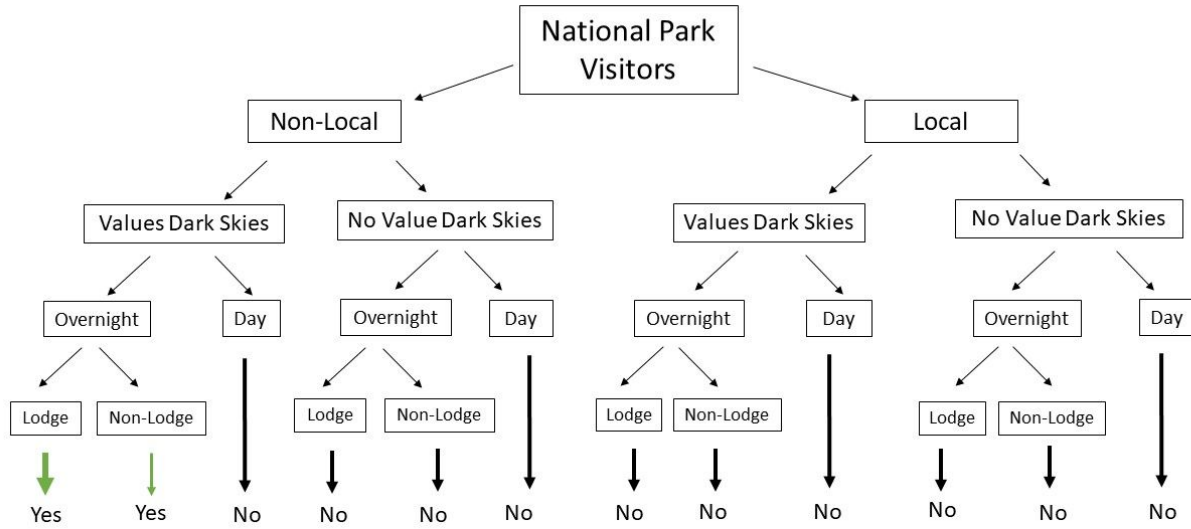
Park	Total Non-Local Visits	Overnight Lodge Visits	Other Overnight Visits	CAGR* Overnight Lodge Visits	CAGR* Other Overnight Visits
Arches	1,399,247	0	50,936	N/A	-0.32
Black Canyon	196,800	0	22,199	N/A	4.88
Bryce Canyon	1,649,360	53,792	96,694	1.82	1.73
Canyon de Chelly	762,587	6,536	607	-14.26	-32.98
Canyonlands	598,440	0	97,731	N/A	-0.05
Capitol Reef	921,558	0	43,522	N/A	2.13
Cedar Breaks	743,004	0	1,337	N/A	-1.69
Chaco Culture	37,007	0	12,987	N/A	-3.51
Colorado N M	551,344	0	19,602	N/A	3.02
Dinosaur	275,953	0	62,580	N/A	0.76
El Malpais	146,523	0	0	N/A	
El Morro	46,395	0	3,565	N/A	2.71
Glen Canyon	2,495,092	77,429	1,511,145	-5.87	4.77
Grand Canyon	5,520,736	540,000	635,342	-0.95	1.51
Hovenweep	32,980	0	2,375	N/A	5.37
Hubbell Trading Post	55,712	0	0	N/A	N/A
Lake Mead	5,063,423	21,162	461,402	-7.37	-1.57
Mesa Verde	536,320	22,019	56,407	-6.19	3.50
Natural Bridges	89,080	0	7,501	N/A	1.94
Navajo	66,964	0	3,362	N/A	0.30
Petrified Forest	742,614	0	437	N/A	4.86
Rainbow Bridge	64,907	0	0	N/A	N/A
Sunset Crater Volcano	153,050	0	0	N/A	N/A
Walnut Canyon	128,791	0	0	N/A	N/A
Wupatki	199,245	0	0	N/A	N/A
Zion	3,388,435	82,853	250,928	0.74	2.63
SUM	25,865,567	803,791	3,340,659		

Not all parks have lodges. *CAGR is the rate at which a given present value grows to a given future value in a given amount of time. $CAGR = (FV/PV)^{1/n} - 1$ where FV is the future value, PV is the present value, and n is the number of years.

Table 3. Economic Impact of Dark Skies Total Spending in 2015 \$

Year	Visitor Spending	Value Added	Income	Jobs
2015	497,643,649	331,654,954	212,717,012	8,695
2016	513,682,130	341,730,051	218,934,460	8,949
2017	513,869,262	341,559,369	218,565,144	9,224
2018	514,932,369	341,911,087	218,515,616	9,522
2019	516,855,780	342,777,292	218,780,730	9,845
2020	519,628,241	344,152,476	219,356,778	10,194
2021	523,242,484	346,033,313	220,241,354	10,570
2022	527,694,871	348,418,477	221,433,248	10,975
2023	532,985,127	351,308,507	222,932,361	11,412
2024	539,116,114	354,705,691	224,739,639	11,882
Sum	5,745,743,681	3,802,865,197	2,423,073,364	113,656

Figure 3. Tourism Classification Illustrated



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Figure 4. Average Number of Visitors per Day to All NPS Units by Month, 2013

