Feasibility of a Public Transportation System in Yellowstone National Park

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Abstract

Yellowstone National Park (hereafter referred to as Yellowstone) is experiencing increased visitation in a time when sustainable development is being widely adopted. Because of this, a solution is needed to alleviate the overcrowded conditions in Yellowstone. The objective of this study is to determine if it is feasible and practical for Yellowstone to implement a public transportation system to reduce stressors on the park caused by excessive private vehicle use. Ideally, this system would consist of frequent and abundant loop shuttle services for the different regions of the park. Because of high levels of overcrowding and traffic congestion, this study proposes to start with a bus loop for the West Yellowstone to Old Faithful corridor that travels back and forth between the two destinations. This study takes a multi-step approach to analyze the feasibility of public transportation in Yellowstone. First, it analyzes public opinion on national park shuttles. Costs and benefits are analyzed for the potential shuttle system. While the costs were found to be very high, especially the upfront capital costs, Yellowstone is encouraged to implement public transportation to any extent because of the numerous short-term and long term benefits that it provides for the park's natural resources, visitors, and spending budget.

Introduction

Yellowstone is the world's first national park, established in 1872. The park is 3,472 square miles (8992 km²) and is mainly located in northwest Wyoming, with 4% of its area in Montana and Idaho. Within park boundaries is one of the world's largest active supervolcanoes, known as the Yellowstone Caldera. Other fascinating works of nature that allure 4 million visitors per year are its hydrothermal features such as geysers and charismatic megafauna such as grizzly bears (*Ursus arctos horribilis*), American bison (*Bison bison*), and gray wolves (*Canis lupus*). Because of the park's extensive acreage and countless destinations, the main mode of transportation in the park is by private vehicles such as cars, vans, and RVs.

Like many popular national parks, Yellowstone is experiencing increased visitor use. These last 3 consecutive years have also become the top 3 visitation years in the park (National Park Service, n.d.). Excessive crowding, as seen in Figure 1, has caused decreased visitor enjoyment of the Montana park because of the frustration caused by crowded roads and parking lots (Holly et al., 2010). Increased visitation also contributes to traffic congestion, which increases travel times (Lawson et al., 2011). This causes issues during peak tourist season when roads are almost always overcrowded. At the West



Figure 1

Entrance corridor of Yellowstone, traffic in July is 30% higher than what roads and parking lots can handle (Atwell et al., 2017). Overcrowded roads also have the following effects:

> Since 2008, annual visitation to Yellowstone has increased close to 40%, causing… a rise in traffic jams, roadside soil erosion and vegetation trampling, and unsanitary conditions around busy bathrooms. Half of this increase in visitation occurred in just two years (2014 to 2016), coupled by an even greater rise in motor vehicle accidents (+90%), ambulance use (+60%), and search and rescue efforts (+130%) over the same time period (National Park Service, 2020).

Overcrowded roads and excess visitation have added stressors on the park's fragile ecosystem. Some of the most direct environmental impacts come from private vehicles, including cars, vans, and RVs. The use of private vehicles leads to higher levels of air pollution in the form of engine exhaust and road dust (Shepherd, 2001). Additionally, vehicle emissions cause damage to sensitive roadside vegetation by increasing nitrogen levels in the soil which negatively impacts nutrient cycling and native plant communities (D'Antonio & Sidder, 2018). Also on the roadside, vehicles cause wildlife mortality and this vulnerability is made worse by increased tourism (Ament et al., 2008). These environmental risks could be reduced with public transit options offered in Yellowstone.

A bus system in Yellowstone would not only reduce environmental risks to the park but also contribute greatly to sustainability. Holly et al. (2010) determined that

traveling by bus is more affordable than by private vehicle. Buses are provided at no cost to the visitor in other national parks, and this can be seen as an incentive to utilize them (Upchurch, 2019; Holly et al., 2010). Alternative public transportation systems are a vital part of sustainably developed infrastructure. A bus system in Yellowstone can provide this for many reasons including reducing traffic, congestion on roads and parking lots, road maintenance costs, and more (Holly et al., 2010; Wilson et al., 2018; Pettebone et al., 2011). National parks, especially heavily visited ones like Yellowstone, must implement these systems to take a considerable step toward sustainable development. Additionally, the existence of public transportation in a national park raises climate awareness. Visitors that use the bus will be learning about the benefits to the environment in which they are part of the solution. They can also be encouraged to park and ride if the specific benefits of their choice are communicated (White, 2007; Wilson et al., 2009). Buses limit the use of private cars in the park, leading to less emissions in the air and surrounding ecosystems, and less roadside vegetation damage from traffic and parking overflow.

The West Entrance at West Yellowstone, Montana, is a popular entrance for visitors because of its proximity to Old Faithful Geyser (Figure 2). At the geyser, there



Figure 2

are up to 500 visitors per hour (D'Antonio & Sidder, 2018). This is just for the most popular attraction at the park. Employees working in the park are warned of guest irritability because of lack of parking and too much traffic which are usually underestimated. Fifty-five percent of visitors were not able to visit all attractions, which they blamed on not having enough time in the park, travel time inside the park being greater than expected, not being able to find parking, and traffic inside the park (National Park Service, 2017). This is because during peak visitation in July and August, congested areas such as Old Faithful are over capacity by 29% (Atwell et al., 2017). Introducing a bus system as a potential way to reduce wait times for tourists would be appealing to many different types of visitors (White, 2007). Despite the immense natural grandeur of the park, visitors are often on their way before they fully experience all the treasures of Yellowstone. In fact, 34% of visitor groups spend less than one day in the park (Kidd et al., 2018). Since a substantial number of tourists spend more than a day visiting Yellowstone, buses would be a realistic option for them. Many other national parks, such as Denali, Zion, and Valley Forge, have existing bus systems that have received positive feedback from visitors (Miller, 1999; Upchurch, 2019; Villwock-Witte, 2011). While implementation of a bus system could offer a solution to traffic congestion, it also has the potential to double visitation levels to popular sites, which would be an unintended impact, but new routes can be added to divert some crowds (Lawson et al., 2011).

Yellowstone currently has no alternate public transportation options. Instead they have many expensive private tour companies that transport tourist groups around the park, as well as five park-specific private transportation systems for tours only (Plides et al., 2019). Recently, the park joined with other federal and local transportation organizations to determine the feasibility of a transit system originating within the park (National Park Service, 2020). This is not the first time Yellowstone has attempted an alternate transportation system. In 2014, the Yellowstone Linx Bus provided transport between the park and gateway cities, but it was discontinued due to lack of funding and the majority of ridership coming from park employees (Stuntz, 2014). Despite its shortcomings, the Yellowstone Linx Bus shows that a public transportation system is at least possible.

Lack of funding appears to be the most significant obstacle to implementing a public transportation system. A comprehensive cost-benefit analysis is a tool that is used to determine whether a new mode of transportation would be feasible and provide more benefits to the public (Litman, 2019). National parks are underfunded at the federal level so it is easy to assume that a large scale project in Yellowstone would automatically be considered infeasible because of that undeniable obstacle. A cost-benefit analysis will reveal all the possible sources of income, direct and indirect, that could potentially offset

costs. This study aims to provide social, economic, and environmental perspectives that show the importance and feasibility of a shuttle system in Yellowstone.

Methods

The first analytical approach was done considering the social perspective of national park public transportation systems. This was done through a synthesis of public opinion on various shuttle systems in other national parks to determine similarities in what is most valued in a shuttle system. Thirteen studies containing visitor surveys on public transportation in national parks were used in this analysis. The fourteenth study did not relate to a national park but was included to show behavior of habitual car users. Similarities in visitor feedback of shuttles fell under seven categories that influenced their opinion: financial/environmentally conscious encouragement, comfort, efficiency, perceived freedom, options for alternate routes, availability of information, and trip characters and demographics.

Next, a cost-benefit analysis (CBA) was done to determine whether the benefits outweigh the costs and to help determine if this project would be worth pursuing. In order to have more accurate and specific numbers, the scope of the CBA is limited to a bus route beginning at the West Entrance at West Yellowstone, Montana and ending at the Old Faithful Visitors Center. This is similar to the route that is currently being considered by Yellowstone park managers (National Park Service, 2020). This route was also chosen

because the majority of single-day visitors (55%) and overnight visitors (49%) enter and exit the park through this entrance (Atwell et al., 2017). Consequently, the West Yellowstone-Old Faithful corridor is the most congested area in the park (Atwell et al., 2017).

There are three types of costs: one-time capital costs, annual operations and maintenance costs, and environmental externalities. After categorizing and listing costs and benefits, monetary values were assigned. The main parameter affecting cost is the ridership percentage. Because this project would change the way visitors experience Yellowstone, there will be an adjustment period to the new shuttle system and it will take time for visitors to accept the change (Mace et al., 2013). There were four different scenarios for this CBA: 25%, 50% 75%, and 100% of tourists that enter through the West Entrance opt to park and ride. The amount of anticipated shuttle riders will significantly impact the costs of implementing the shuttle system. Information on the specific costs and benefits were found from various sources, including executive reports on current national park bus systems, cost-benefit studies on city public transit, and government agency information. Since Yellowstone does not currently have any public transportation option, costs were mostly assigned based on assumptions made through comparisons with other national parks and the information provided by them. The parks used for comparison were Zion, Rocky Mountain, and Yosemite National Parks.

The Proterra ZX5 40 foot bus, shown in Figure 3, was selected to be considered for Yellowstone's first in-park public transportation system. Zion and Yosemite National Parks are currently using these buses. The savings associated with a smaller carbon footprint were another incentive to choose electric buses over diesel, propane, or natural gas. National parks that own fleets of these buses have plans to phase them out for electric. Inscribed on the Roosevelt Arch near the North Entrance of the park are the words: "For the benefit and enjoyment of the people." Electric buses provide more financial and environmental sustainability and will be more beneficial to both the park and its visitors. To incentivize buyers and keep up front capital costs down, Proterra sells their buses at the same price as the average diesel bus (Proterra, 2019). The average diesel bus is $500,000 so this was set as the cost of each electric bus (Quarles et al., 2020). Having saved money that would have been allocated for diesel fuel, Proterra instituted a battery lease program that allows bus owners to pay yearly on the lease with the money saved from not purchasing a diesel bus (Proterra, 2019). There are also other options to increase affordability such as operating leases and working with Proterra to identify a grant, loan, or financing program that accommodates the buyer's budget needs (Proterra, 2019).

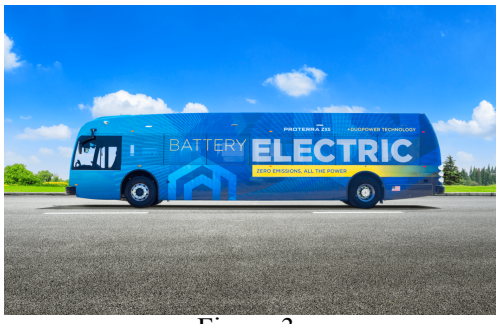


Figure 3

As stated before, costs and benefits will be affected greatly by the percentage of riders. During summer visitation months, it is reasonable to expect 860 cars per hour coming through the West Entrance (Regula et al., 2018). The average visitor group size per car is 3.73 according to a survey of visitors at the West Entrance (National Park Service, 2017). That number was rounded up to 4 to ensure the CBA is accounting for increasing visitation rates and not short changing any costs or benefits. Each electric bus has a seating capacity of 40 people (Proterra, 2019). Peak visitation hours are from 11 a.m to 3 p.m (Regula et al., 2018; D'Antonio & Sidder, 2018). In order to account for any outlier circumstances, one hour was added to the starting and ending times in order to come to the total of 6 anticipated operating hours per day for the buses. Peak visitation months are June, July, and August, so the buses would be in operation for 92 days. These days were also used to calculate driver salaries per year, which were set at $20.10/hr because that is the average hourly wage of tour bus drivers in Yellowstone (Indeed, 2020).

There is a distance of 31.5 miles between the gateway city of West Yellowstone and the Old Faithful Visitor Center. It takes an average of 53 minutes to drive between the two destinations which is rounded up to an hour to account for traffic and wildlife jams. Therefore, if there were 10 buses then there could be 1 bus every 15 minutes arriving at Old Faithful and departing from the West Entrance. This would accommodate 400 people

at a time if bus ridership is at 25%. As ridership increases by 25%, two new buses should be added to accommodate more people while keeping waiting times down.

Results

Table 1. Most prevalent factors influencing shuttle bus ridership

	Bamberg et al., 2003	Collum & Daigle, 2015	Daigle & Zimmermann, 2004	Dilworth, 2003	Holly et al., 2010	Kack & Chaudhari, 2009	Mace et al., 2013	NPS, 2004	Nelson et al., 2008	Pettebone et al., 2011	Sims et al., 2005	White, 2007	Wilson et al., 2008	Yillwock-Witte, 2011
Incentives and advertisements	✓	✓		✓	✓			✓	✓	✓	✓	✓	✓	
Comfortability of buses		✓					✓		✓	✓		✓	✓	✓
Frequency of bus arrivals		✓			✓		✓		✓	✓		✓		✓
Freedom to explore the park				✓			✓			✓	✓	✓	✓	✓
Availability of alternate bus routes		✓					✓			✓				
Communication of bus and park information/ITS			✓				✓	✓		✓			✓	
Trip characteristics and demographics				✓	✓	✓		✓	✓	✓		✓		

Table 1

Table 1 shows similarities between 13 studies done on public transportation in national parks and 1 in a city. In these studies, visitors from the following parks were surveyed or interviewed: Grand Teton, Rocky Mountains, Great Smoky Mountains, Zion, Yosemite, Muir Woods National Monument, Sequoia and Kings, Golden Gate Recreation Area, and Valley Forge Historical Park. Seven common factors were found to influence shuttle bus ridership, supported by more than one study.

Category	Item	Units	Unit price	Source
One-time capital	Proterra ZX5 40 ft. buses	per bus	$500,000.00	Proterra, 2019; Quarles et al., 2020
One-time capital	Battery	per battery	$100,000.00	Quarles et al., 2020
One-time capital	Bus storage facility	per facility	$300,000.00	Federal Transit Administration, 2020
One-time capital	Charging infrastructure + installation	per charging station	$495,636.00	Johnson et al., 2020
Annual operations and maintenance	Driver salaries	yearly pay per driver	$11,095.20	Indeed, 2020; National Park Service, 2020
Annual operations and maintenance	Routine maintenance	mi/yr	$0.44	Regional Transportation Commission of Washoe County, 2016
Annual operations and maintenance	Fuel	per mile	$0.46	Eudy & Jeffers, 2019
Environmental externalities	Tailpipe emissions	per vehicle mile	$0.00	Environmental Protection Agency, 2018

Table 2

Table 2 shows cost parameters for the purchase of a bus fleet. These are the unit prices for the items that will need to be purchased for Yellowstone's public transportation system. One-time capital costs will only be purchased once whereas the rest of the costs will be recurring.

Item	25% ridership	50% ridership	75% ridership	100% ridership
Proterra ZX5 40 ft. buses	$5,000,000.00	$6,000,000.00	$7,000,000.00	$8,000,000.00
Battery	$1,000,000.00	$1,200,000.00	$1,400,000.00	$1,600,000.00
Bus storage facility winter	$300,000.00	$300,000.00	$300,000.00	$300,000.00
Charging infrastructure + installation	$991,272.00	$991,272.00	$991,272.00	$991,272.00
Driver salaries	$221,904.00	$266,284.80	$310,665.60	$355,046.40
Routine maintenance	$164,332.08	$328,980.96	$493,471.44	$657,961.92
Fuel	$171,967.32	$343,934.64	$515,901.96	$687,869.28
Tailpipe emissions	$0.00	$0.00	$0.00	$0.00
TOTAL	**$7,849,475.4**	**$9,430,472.4**	**$11,011,311**	**$12,592,149.6**

Table 3

Table 3 shows the different types of costs for Yellowstone's public transportation system based on different ridership percentages. Along with the total cost at the bottom, a total was included without parking lot related costs which would be for outside of the park.

Category	Benefits	Description	Cost	Source
Economic	Local tourism economy	Shuttle parking near local shops encourages people to walk inside while waiting for the bus	n/a	National Park Service, 2004
Economic	Job creation	New jobs created for bus drivers and interpreters	n/a	-
Economic	Public-private partnerships	Corporate sponsorships to help keep shuttle bus free and show support for national parks	≥$1,000,000.00	Tom Crikelair Associates, 2008
Economic	Federal grant eligibility	Yellowstone could be eligible for federal grants as they work towards implementing a public transit system	n/a	DOT Volpe Center, 2013
Economic	Shuttle passenger donations	Passengers who support the shuttle system are likely to donate to keep it running	≥$25,000.00	Tom Crikelair Associates, 2008
Environmental	Air pollution savings	Reduction of air pollutants (CO2, NOX, VOCs, particulate matter, etc.)	$140,927.24-$563,708.96[1]	Litman, 2015
Environmental	Noise pollution savings	Reduced man made noise in the park, leading to better park ambience that will benefit wildlife and increase visitor enjoyment	$41,492.22-$171,468.86[1]	Victoria Transport Policy Institute, 2020
Environmental	Reduced soil erosion and vegetation trampling on the roadside	Reduced chance of parking in roadside habitats when in-park parking lots are at capacity or pulling over onto roadside vegetation to observe wildlife	n/a	D'Antonio & Sidder, 2018
Environmental	Reduction in wildlife-vehicle collisions	Less private vehicles on the road means reduction in likelihood of wildlife being hit by cars	n/a	Manning et al., 2014
Environmental	Enforce carrying capacity	Use of shuttles can enable Yellowstone to better manage amount of people coming in to lessen habitat disturbance levels	n/a	Manning et al., 2014
Social	Visitor acceptance over time	Implementation and success over time of shuttle system will lead to higher ratings by visitors	n/a	Mace et al., 2013
Social	Reduction of overcrowding impacts	Roads will be less congested and parking lots will not exceed capacity	n/a	Lawson et al., 2007
Social	Convenience	Less stress from finding parking or routes in park	n/a	White, 2007

Social	Road safety	Reduced car accidents, ambulance use, and search and rescue efforts	n/a	Litman, 2015
Social	Improved mobility	Multiple transportation modes to increase accessibility and ways to explore the park	n/a	Kack & Chaudhari, 2009
Social	Travel time savings	Reduced traffic congestion will allow tourists to have more time to explore the park during their stay	n/a	Kack & Chaudhari, 2009
Social	Improved visual experience	Lack of long lines of cars will improve the beauty of the scenery	n/a	Plides et al., 2019

Table 4

[1]These ranges are based on ridership percentages.

Table 4 shows the benefits of a public transportation system in Yellowstone. All of these items are recurring, quantitative, and provide direct monetary benefits to the park. Costs that are not applicable (n/a) only mean that there is not an accurate number to contribute to a solid prediction because Yellowstone has not done something like this before.

Discussion

1. Public opinion discussion

The most popular determining factor for visitors to utilize national park shuttles was encouragement in the form of shuttle advertisements and lack of extra fees. This was not surprising because of the individualized aspect of this decision-influencing factor. It is important to communicate the specific environmental benefits of taking the bus so that visitors will know exactly how they are helping to conserve the park's natural resources (Holly et al., 2010). One example would be communicating that visitors are reducing air pollution while also reducing traffic congestion (White, 2007). Yellowstone visitors

would most likely like to see that they are helping keep important wildlife habitats clean. One possible bus advertisement could be communicating to visitors that the more people who ride the bus, the less traffic there will be, so there will be more roadside wildlife to observe (National Park Service, 2004). This would be an effective advertisement to Yellowstone visitors because watching roadside wildlife, especially grizzly bears, is one of the main reasons people come to Yellowstone (Richardson et al., 2015). Information about what the bus can provide, such as sightseeing without the stress of finding routes or parking (Collum & Daigle, 2015). Additionally, communicating to visitors that taking the shuttle would be a new way to experience the park would be intriguing to them (Pettebone et al., 2011). Without free shuttles, the only ways to experience the park are in a long line of car traffic or in an expensive tour bus. When in a new place, people are more motivated to process information and use it to make a decision (Bamberg et al., 2003). This is especially true for visitors under the age of 40, who are more likely to make trade-offs and take public transportation, so ads should target this age group the most (Pettebone et al., 2011).

In addition to Yellowstone-specific advertisements in favor of the shuttle, visitors are also persuaded to park and ride if they would be paying less to do so. It is important in Yellowstone to keep the shuttle option cheaper than the private vehicle option. If keeping the shuttle optional is not reducing private vehicle use in the park, then

it might be worth considering another form of encouragement. One example is instituting private vehicle restrictions (National Park Service, 2004; Nelson et al., 2008). However, it doesn't make sense to have a parking fee for shuttle-users because that would discourage visitors from parking and riding (Nelson et al., 2008). People who pay for park passes will strongly oppose paying an additional shuttle fee (National Park Service, 2004). This is why most national parks have optional, free shuttles for visitors. The same should be done in Yellowstone to ensure that the most visitors possible will welcome this change. One possibility would be to have a parking fee for lots inside Yellowstone. Another option would be a reduced entrance fee for shuttle users. Some parks, such as Zion and Great Smoky Mountains National Parks, had to institute mandatory shuttles because too many people continued to use their cars and these parks were still experiencing excessive crowding (Mace et al., 2013; Sims 2005). However, private vehicle restrictions or mandatory ridership aren't readily welcomed by visitors, so it is important to keep the shuttles optional unless it is absolutely necessary to add extra incentive (Nelson et al., 2008).

The most obvious reason why visitors choose to ride national park shuttles is their frequency of arrival and travel time efficiency. The most common reason people decide to use the shuttle is if they know and can depend on the fact that it will arrive and depart frequently (Nelson et al., 2008; Holly et al., 2010; Collum & Daigle, 2015; Mace et al.,

2013). Going along with this, visitors will have a higher opinion of the shuttle if the wait times are shorter (Holly et al., 2010; Mace et al., 2013; Daigle & Zimmermann, 2016; Pettebone et al., 2011). The most desirable wait time is 7 minutes or less (Mace et al., 2013). This is especially important at peak hours to keep the wait times short (White, 2007). It would probably take time for Yellowstone to achieve this, depending on the cost of the electric buses, the park might not be able to buy enough buses at once to accommodate this wait time. Visitors also value punctuality of the shuttles and flexibility (Villwock-Witte, 2011). These are two things that Yellowstone can do from the start and increase ridership and visitor acceptance of the shuttle system.

The most common and obvious reason visitors are opposed to a shuttle system is loss of their freedom to explore the park in their own way. Visitors see private vehicles as the most convenient form of transportation because it is the only way to get to the park and it holds all their stuff (Dilworth, 2004). Sometimes the buses are perceived to have limited schedules and routes, especially by first-time visitors (White, 2007). Visitors value independence, especially in being able to stop wherever they want and experience solitude in nature (White, 2007; Pettebone et al., 2011). However, there are ways to increase visitors' perceived freedom even when they are riding the shuttles on fixed routes. One way is to provide handouts to riders of the shuttle stops and routes (Wilson et al., 2018). Visitors also perceive buses as convenient because they alleviate traffic and

reduce travel times between different destinations (Sims et al., 2005). Buses are also more convenient because they allow visitors to avoid traffic, parking shortages, and route finding (White, 2007).

Visitors are motivated to take shuttles when they are provided with real-time bus information and interpretation. Intelligent transportation systems (ITS) is a new form of technology that gives visitors real-time information on bus arrivals and departures and traffic and parking conditions. ITS is currently being used in many national parks in the form of real-time information displays. These displays allow visitors to make their decision on whether they want to ride the bus based on parking and traffic conditions (Daigle & Zimmermann, 2016). If real-time displays show that traffic conditions are severe and parking lots are full or at capacity, visitors will be more motivated to take the bus instead (Nelson et al., 2008; Pettebone et al., 2011). In Yellowstone, visitors might also be interested to know how crowded boardwalks are, especially at peak hours. Additionally, if popular destinations such as Midway Geyser Basin are overcrowded and this is shown by ITS, visitors will be able to switch around their plans. Bus drivers could also be trained in interpretation and provide interesting facts about the park to riders, or an NPS interpreter could be on every bus. An educational aspect provided by bus drivers would be very appealing to visitors who are eager for a unique experience at a national park (Mace et al., 2013; Wilson et al., 2018). ITS also makes visitors aware of exact bus

departure times so they will feel more in control of their national park experience (National Park Service, 2004).

The existence of alternate routes would also be appealing to a bigger group of visitors. Special opportunities such as pickup and dropoff for one way treks, such as backcountry camping, may increase shuttle use by being inclusive to a wider group of people (Collum & Daigle, 2015). Visitors at Rocky Mountains National Park value shuttle routes that take them to less crowded locations (Pettebone et al., 2011). Including stops for campgrounds and trailheads will have the same positive effect (Mace et al., 2013). This would work well for Yellowstone shuttles because most trailheads and campgrounds are in the same general area as boardwalks, which are the tourist-heavy destinations.

Comfortability of the bus was another popular decision-making factor for national park shuttle users. This is one that might be overlooked by park managers because it is only realized by people who actually ride the bus and notice that whether the bus is comfortable is a significant reason they choose to use the bus or not. Bus amenities were the most frequent request by shuttle users in multiple national parks. One amenity mentioned often was bike racks (Mace et al., 2013; Wilson et al., 2018). This would probably not be a common complaint in Yellowstone. Biking is not a practical activity because of blind curves, high road elevations, and unpredictable weather conditions

(National Park Service, 2019). Another amenity to make buses more appealing is storage areas for outdoor equipment (Mace et al., 2013). This would motivate visitors who like to go backcountry hiking to ride the bus. Additionally, visitors want the bus stops to be pleasant and accessible (Nelson et al., 2008). In the bus, visitors want there to be ample space and low encounter levels, meaning they do not want to feel like the bus is too crowded (Collum & Daigle, 2015; White, 2007). Air conditioning would also increase comfortability of the bus (Mace et al., 2013). The bus stops should be labelled clearly and be easy to get to from the parking lot. Lastly, visitors' bus experience would be made better if their driver is friendly (Villwock-Witte, 2011).

There are two apparent factors outside of the park's control that influence a visitor's decision. The first is tourist demographics, including country or region of origin, age, choice of vehicle, and whether or not children are present. Foreign tourists are more likely to use shuttles than domestic tourists (National Park Service, 2004). Foreign tourists make up an average of 17% of visitors in Yellowstone (National Park Service, 2017). Europeans make up the largest percentage of foreign visitors, and they prefer public transportation more than Americans because that is what they are used to (Dilworth, 2004). On a similar note, tourists from urban areas are more likely to choose the shuttle as opposed to rural areas because public transportation is already the norm in cities (Dilworth, 2004). As stated earlier, younger visitors (aged <40) are more willing to

use public transportation whereas older visitors are more resistant (Pettebone et al., 2011). The National Park Service (2016) found that 25% of Yellowstone visitors are aged 20 or less and 31% were between the ages of 35 and 54. These are high enough percentages to expect high levels of shuttle ridership. However, another study on baby boomers (aged 56-74) in national parks found that this age group are very interested in national park bus systems and would be likely to use them (Wilson et al., 2018). Shuttles in Yellowstone should be expected to transport visitors of all ages. RV users also would prefer shuttles because it is more convenient than driving an RV all over the park and having to find a parking spot for a larger vehicle (National Park Service, 2004). While RVs only make up 7% of private vehicles that enter Yellowstone, it is beneficial to the park to have these larger vehicles off the roads (National Park Service, 2017). Visitor groups that contain children are less likely to use shuttles (White, 2007). 60% of Yellowstone tourist groups do not contain children (National Park Service, 2017).

The second factor is trip characteristics which includes the duration of a trip, experience with the park, and reason for visiting. Visitors on shorter trips are less likely to take a shuttle because they feel more time-constrained and are probably entering and exiting at different sections of the park (Holly et al., 2010). 66% of visitor groups spend only 1 or more days in Yellowstone and 44% of this group spend 3-4 days (National Park Service, 2017). Only 34% of visitor groups spend less than a day in Yellowstone and 31%

of this group spend 7-8 hours (National Park Service, 2017). Since the majority of tourist groups stay overnight in Yellowstone, shuttle systems would be very convenient to them since they will always be returning to the same gate in which they entered. Experience-use history is a factor that influences tourist behavior and therefore likelihood of choosing public transportation over one's private vehicle. Visitors with greater experience-use history in a national park are more likely to support a shuttle system because they are more familiar with the park and can see that buses will alleviate undesirable conditions (White, 2007). The majority of tourists' purpose in visiting a national park is to view wildlife (Kack & Chaudhari, 2009). This is similar to Yellowstone, where tourists value seeing a wild place and seeing geysers and thermal areas the most (National Park Service, 2019).

Because a shuttle system inside of Yellowstone National Park would be a completely new concept, it is expected that it will take time for visitors to accept the existence of shuttles. Of course it is reasonable to expect frequent car users to have strong reactions to small, inexpensive interventions such as the new implementation of a shuttle system (Bamberg et al., 2003). However, since views toward new technology are evolving, peoples' views of what is or is not appropriate in national parks may change (Dilworth, 2004). Additionally, the more visitors see the shuttles in operation and see its success, it will be more welcomed by them over time (National Park Service, 2004). With

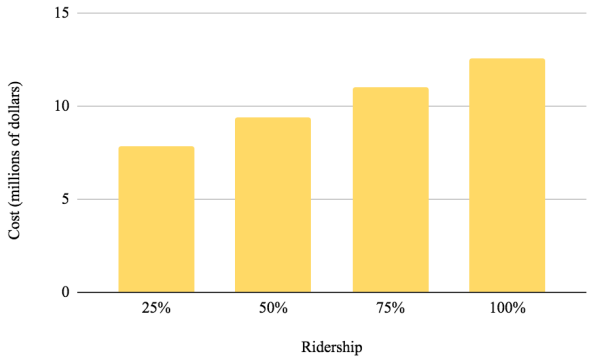
this in mind, Yellowstone may expect a lower rate of ridership at first but see a rapid increase after those inaugural years. This is exhibited by Mace et al. (2013) in their study of Zion National Park: when the shuttle system began, only 76% of visitors supported it, but then in 2003 and 2010, the numbers rose 96% and 98% of visitor support, respectively. The more visitors come to Yellowstone, the more they will support it because of experience-use history (White, 2007). In Grand Teton National Park, which is directly below Yellowstone and likely gets a lot of the same visitor groups, a survey concluded that 46% of visitors are likely to use public transit if it was an option (Kack & Chaudhari, 2009).

There are several limiting factors that would make shuttles not realistic for certain tourist groups. Tourists with pets would not be able to ride shuttles (Wilson et al., 2018). As mentioned before, tourists entering and exiting through separate gates would also not be able to use the shuttle (Wilson et al., 2018). One concern brought up by a study in Rocky Mountain National Park was that with an expanded shuttle service potentially comes with higher levels of visitation that can be accommodated (Lawson et al., 2011). This would need to be addressed so that buses in Yellowstone would not make the overcrowding issue even worse.

2. Cost-benefit analysis discussion

The up-front costs and continued need for funding are the main reason why this project would not be feasible. Funding at the federal level is too unreliable. There is an $11.92 billion deferred maintenance backlog because the needs of national parks exceeds the amount of money that was allocated to them (National Park Service, 2020). The anticipated percentage of visitors that choose the bus has a significant impact on the cost, as seen in Figure 4. It is reasonable to assume that ridership will be at 25% or less in the beginning years of this new system. Over time, demand will increase and the park can purchase more buses. Including 100% ridership was done to show that making buses mandatory should not be recommended for the park at this time.

Figure 4. Total costs vs. Anticipated ridership



A non-National Park Service funding source would need to be secured to make any new public transportation system feasible (Kack & Chaudhari, 2009). One possible solution would be to devote a couple dollars from every entrance fee to pay back the costs of the buses. In addition, the existence of the shuttle system creates opportunities for new sources of money. For example, as stated in the benefits, there is the potential for corporate sponsorships and passenger donations as outside sources of funding for the

shuttles (Tom Crikelair Associates, 2008). Yellowstone Forever, the nonprofit partner of the park that provides philanthropic support by funding its priority projects, would be an important organization to include in the potential sources for funding. Yellowstone Forever receives consistent donations from many corporations such as Canon, Coca-Cola, and Conoco-Phillips. Two notable corporations that have already funded Yellowstone transportation-related projects in the past are Michelin and Toyota Motor Sales.

Most of the benefits provided by public transportation are indirect and long-term. Growth and success of the shuttles would be advantageous for businesses in Yellowstone gateway communities. These local economies of these cities, such as West Yellowstone, depend greatly on tourism. If the bus system is successful, it can expand into gateway cities and visitors can gain access to local shops and restaurants (National Park Service, 2004). Shuttles can display advertisements from these businesses to further encourage tourists to explore gateway cities. This can lead to mutually beneficial partnership between Yellowstone shuttles and gateway city businesses (Tom Crikelair Associates, 2008). Another indirect benefit of public transportation is creation of jobs for bus drivers and national park interpreters. Park visitors are more likely to ride the shuttle if an interpreter is present (Mace et al., 2013). Shuttle passengers are also a source of income to keep shuttles running. Acadia National Park receives an average of $25,000 a year from passengers just by putting a box in every bus that says “Help keep me free.

Donations appreciated" (Tom Crikelair Associates, 2008). Since Yellowstone receives 1 to 2 million more visitors per year than Acadia, it is possible that donations will be higher and increase over time as the shuttle becomes more accepted.

Social benefits, while they cannot be accurately quantified, lead to increased acceptance of a new bus system. This means that more people over time might decide to leave their car outside of the park and take the bus. It won't happen immediately but over time as visitors adjust to the change, travel in Yellowstone is likely to become more convenient, safe, and accessible (White, 2007; Litman, 2015; Kack & Chaudhari, 2009). A shuttle system that reduces the amount of cars on the road will also decrease the likelihood of wildlife-vehicle collisions. This can be quantified because a main reason visitors come to Yellowstone is to observe roadside wildlife (Richardson et al., 2015). With less instances of wildlife-vehicle collisions, visitors will be more attracted to Yellowstone because of greater numbers of observable wildlife.

Yellowstone has some shuttle bus infrastructure already in place because tour buses drive throughout the Old Faithful area. There is a semi-developed area in between the city of West Yellowstone and the West Entrance that could be converted into a parking lot, an area within the black lines in Figure 5 on the following page. This is an ideal location for a parking lot because it is just outside of the entrance, so car riders that go through the entrance can easily be distinguished from bus riders.



3. Limitations and recommendations for future research

These results relating to public opinions on national park public transportation are based on visitors at national parks not including Yellowstone. Therefore, it should be taken into consideration that public opinion at Yellowstone may be slightly different. Yellowstone is a much larger park in acreage and has many different regions within the park that have different natural features. For example, some tourists come to Yellowstone to see the Old Faithful Geyser and then are on their way. Tourist behavior seems to be different than tourist behavior in other smaller national parks. Because of this, future research needs to be done that would determine the opinion of Yellowstone visitors on a potential public transportation system.

There were many limitations when creating the cost-benefit analysis. Because Yellowstone has never used in-park public transportation before, each cost had to be found from outside sources and should not be considered the actual cost that will be paid by the park. An accurate number could not be found in the literature for average insurance costs a bus fleet equivalent to Yellowstone. Also, there were too many unknown variables to accurately estimate costs for constructing a parking lot outside of the West Entrance.

One unintended impact of shuttles is their ability to transport large numbers of people at one time (Manning et al., 2014). This could lead to more crowding in popular areas like the boardwalks around the Upper Geyser Basin. However, Old Faithful has the infrastructure in place to support a lot of tourists. It is the cars that are the root cause of social, economic, and environmental stressors put on the park. Also, people come to Old Faithful to watch the Old Faithful Geyser erupt. There is a possibility that there is an influx of tourists trying to board the bus back to West Yellowstone after an eruption. This is something that would need to be assessed further to determine if it is an issue that would cause negative perceptions of the shuttles. The route proposed in this study is a direct route back and forth between West Yellowstone and Old Faithful. On the way, the buses would drive past Midway Geyser Basin and the Madison Campground. A larger fleet of buses would be needed to accommodate these extra stops.

There is an abundant need for more research on this topic. As mentioned before, Yellowstone has never implemented a system like this so it is not possible to accurately predict costs. Similarly, more case studies on current national park bus systems are needed with more detailed information about how they are paid for. This might help other national parks make a more educated decision on how they should implement public transportation.

A shuttle bus system that travels between West Yellowstone and Old Faithful is just the beginning of the wide range of possibilities to change visitor experience while mitigating negative impacts of excessive private vehicle use in the park. Such a wide scale project like this is likely to have countless financial and social obstacles but it is important to remember that other national parks have been implementing these public transportation systems since the 1990s. Yellowstone is inevitably headed toward such a change.

Figures and Tables

Figure 1. A day during peak tourist season at Old Faithful. (National Park Service, 2019).

Figure 2. Map of key locations in Yellowstone National Park. (National Park Trips Media, 2020).

Figure 3. Proterra ZX5 40-Foot Bus (Proterra, 2019).

Figure 4. Total costs vs. Anticipated ridership.

Figure 5. West Entrance Parking.

Table 1. Most prevalent social factors influencing shuttle bus ridership.

Table 2. Cost parameters for the purchase of bus fleet.

Table 3. Costs based on ridership percentage.

Table 4. Benefits that can be applied to a potential Yellowstone public transportation system.

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