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# Evaluating Electric Bicycle Access in US National Parks: Advantages and Controversy

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**Abstract**

Rising global temperatures are causing a higher likelihood of future climate disaster. Changes in personal behavior, that reduce the emissions driving this increase in global temperatures, contribute to the greater good. Electric bicycles (e-bikes) offer a viable option for individuals to reduce their personal contribution to this problem, while at the same time benefit from outdoor recreation. These benefits, along with affordability, are driving the current increase in popularity of this form of transportation. The COVID 19 pandemic fueled an increased interest in outdoor recreation, which in turn contributed to an increase in visitation at US National Parks. This thesis explores e-bike use in US National Parks, the effect of legislation to influence that use, the issue of overcrowding in general, and explores expansion of e-bike use in future. The thesis also describes the history and strength of the e-bike industry, gauges the effectiveness of different state and National Park Service (NPS) e-bike regulations, and examines how stakeholders responded to these regulations. More visitors coming to national parks raises awareness of overcrowding, and the mitigation techniques employed by different parks are evaluated. These findings could potentially provide context to NPS managers on general practices that seem effective for future infrastructure planning. Reducing overcrowding protects the natural ecosystems and improves visitor experience, ultimately supporting increased access to park exploration with e-bikes and other alternatives to using gas-powered vehicles.

Keywords: *Climate Change, Electric Bicycles, E-bikes, Overcrowding, NPS*

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## INTRODUCTION

Greenhouse gases are rising annually, driving a unidirectional increase in global warming, increasing the risk of extreme climatic events. Scientists warn of reaching +1.5 degrees Celsius above pre-industrial levels, which may trigger irreversible changes to the world's ecosystems. Extreme drought and coastal flooding are some of the dramatic consequences of increased atmospheric pollution, negatively affecting billions of people. The incentive for combatting this issue is self-preservation, making it unsurprising that there has been increasing social pressure to contribute to a solution. The social prompt for more sustainable, less polluting, lifestyles has catalyzed into new technologies, which have become more commonplace and integrated faster into the public sphere. Technological innovations such as electric vehicles (EVs) and solar panels are being utilized by more people across the United States every year. Many consumers are interested in engaging in greener practices, but the intimidating price investment of an EV makes it impractical. Electric bicycles (e-bikes) are filling some of this market space as a cost-efficient alternative. E-bikes require far less physical exertion to travel the same distance as conventional bicycles, therefore attracting new cyclists, no longer constrained by physical limitations, and making cycling an attractive alternative to short-distance commutes in a gas-powered vehicle. When the COVID-19 pandemic lockdowns restricted individual movement, the public showed renewed interest in outdoor recreation as it allowed socially distancing and provided daily exercise while gyms were closed. The popularity of the electric bicycle industry had already been steadily rising since the early 2010's, but the pandemic opened the consumer flood gates to even more individuals with reinvigorated demand. With this resurgence in public outdoor recreation interest, national parks across the United States saw record-breaking visitation, including visitors with a desire to recreate with e-bikes, bringing to

the forefront the negative effects of overcrowding. In 2019, just before COVID 19 lockdowns, leadership in the federal government made an abrupt policy change that allowed e-bikes the same access to park roads and trails as conventional bicycles. This change was initially introduced without public input and was controversial with some user groups. This occurred as the increase in National Park Service (NPS) visitors required park officials to re-evaluate visitor use management strategies and park carrying capacity to maintain public safety and a positive visitor experience.

As parks independently enacted projects to handle traffic congestion or funded studies to understand traffic patterns and e-bike use, collective data on these projects and its effect on e-bike future use in national parks is largely undocumented. Therefore, the purpose of this thesis is to describe the history, and evaluate the strength, of the e-bike industry; explore how expanded usage of e-bikes can be beneficial to the public; describe how legislation affecting e-bike usage in national parks has evolved, partially in response to public input; and explore how future guidance might be more effective. In addition, this paper examines the differences between several national park, e-bike initiatives, and reviews independent studies of e-bike usage in parks, both of which provide insight into how e-bike access in national parks might co-exist with other forms of recreation without negatively impacting park resources.

## CHAPTER 1: E-bike Industry Overview and U.S. Regulatory History

[1] This chapter will introduce the concept of electric bicycles and provide historical context for their relatively recent rise in public popularity, technological advancements that lay the groundwork for the current industry, and policy changes or introductions affecting e-bike use. The chapter will begin by providing background on conventional bicycles and how they were a catalyst to important transportation developments, and how later technology allowed their commercial production and better integration into the public. From an understanding of how e-bikes have become more popular, a scope of industry will be provided detailing the growth potential and rational for social popularity changes of e-bikes alternative to affordability and availability. Finally, exploring recent legislation passed that benefits e-bikes in addition to Federal land regulation changes to understand how the US government has helped facilitate domestic e-bike utilization.

[2] Introduced in 1860, the simple human-powered bicycle was the initial personal transport device, utilized as an alternative to horse travel and catalyzed inventions that would transform future transportation.[1] During the late 19th century, the invention of pneumatic tires and chain drive were two components that provided an important foundation for automobiles that followed. Arguably more impressive, the excitement surrounding this cutting-edge technology influenced air travel as well, with the first airplane being built by bike mechanics Orville and Wilbur Wright.[2] During this period of transportation advancement, in addition to internal combustion engines being used to develop motorcycles, electric motors were applied to bicycles as well. During the beginning of the 20th century, the earliest technical "electric bicycles" were

[1] Herlihy, *Bicycle: The History,* 15.
[2] Johnson-Laird, *Flying bicycles: How the Wright Brothers invented the airplane,* 27-48.

more comparable to today's mopeds, as the pedals were independent of the primary propulsion of the motor. It was not until the early 1990s that the first recognized pedal assist e-bike was developed by Michael Kutter with Swiss company Dolphin E-bikes, and with Japanese company Yamaha launching the first electric assist bicycle product to the public in 1993.[3] The base models used a lead-acid battery power source that made them much heavier than conventional bicycles. This power source was chosen, because during the late 20th and early 21st century there was not a more efficient power use for less cost per kilowatt hour(kWh). For comparison, the first lithium-ion cell was introduced by Sony in 1993, but due to the high price ($3200 per/kWh) was not a cost-effective solution for public use or as a power alternative to the lead-acid battery. Until the early 2010s, the e-bike industry remained somewhat niche because of the high price, weight, and limited availability. E-bike sales from 2009-2011 had modest, steady growth, but from 2012-2013 sales reported an 80% increase in e-bike sales, fueled partially by post-2008 economic recession making consumers look for more cost-effective lifestyle changes.[4] Consumer interest in e-bikes increased throughout the decade, rising from 185,000 e-bikes sold in the US in 2013 to 263,000 in 2017, and 400,000 in 2018. The global e-bike market was valued at $40 billion in 2019 and is projected to continue its current annual growth rate (CAGR) of 10.5% from 2020-2030, predictively reaching a valuation of over $100 billion by 2030.[5] The sudden domestic explosion in e-bike popularity in the United States comes from several key developments, including technological improvements, price decreases, e-bike policy changes at federal and state level, and external social events such as the COVID pandemic.

[3] Eto, *Innovation created from differences in regulations: A case study of the electric-assist bicycle,* 1303-1313.
[4] Juiced Bikes (2020), "E-Bike Facts and Statistics 2020."
[5] Akshay (2021), "E-bikes Market Statistics 2021-2030."

[3] During this period of development, improvements to battery technology allowed a shift to more efficient batteries that were lighter and cheaper, high-torque magnetic motors became less expensive, and electronics able to control synchronous motors were developed. Advancements in battery capability introduced more options to consumers and producers, with nickel metal hydride (NiMH) batteries utilized by the EV industry as a safer alternative to lithium-ion (Li-ion) batteries, and more powerful than lead-acid batteries at a similar price.[6] Lead-acid batteries were still the cheapest option, but NiMH offered improvements to the lead-acid battery problems of short cycle life and power capability.[7] However, as Li-ion technology advanced, it led to improvements in safety and efficiency and a decrease in price, which increased the utilization of Li-ion batteries by the EV industry. Compared to NiMH and lead-acid batteries, Li-ion provides better cycle life and energy capacity. Lead-acid batteries' life decays significantly from high temperatures and NiMH batteries generate more heat which can cause more overheating and damage over time. As of 2020, the plurality (46%) of e-bikes use lead-acid, while 30% utilize Li-ion for the lower cost of lead-acid batteries makes them more consumer friendly though the recent reductions in Li-ion pricing is increasing their popularity as they are more sustainable.[8] Currently, many of the lithium-ion batteries used in e-bikes can contain over 1000 kWh and weigh approximately 10 lbs, while a lead-acid battery of similar capacity would weigh over 80 lbs. Batteries were not the only component of the e-bike that were improved during this time, the e-bike motors were also being significantly improved as new technology advancements permitted. First developed in the 19$^{th}$ century, permanent magnet AC motors were unable to create the required AC waveforms for variable speed drive until higher

[6] Global Lightning Forum (2020), "Rechargeable Batteries: Lead-acid vs. Lithium-ion vs. NiMH."
[7] Power Tech Systems (2023), "Lead Acid battery downside."
[8] Precedence Research (2023), "E-bike market – Global industry analysis, size, share, growth, trends, regional outlook and forecast."

power transistors were developed at the end of the 20th century. Coincidentally, the motors declined in price while increasing in capability, due to the increased availability and affordability of rare-earth magnets, partially driven by the personal computer hard drive industry.[9]

[4] Though affordability of e-bike components and availability improved during this time, increases in e-bike use and popularity was not purely due improved performance and cheaper materials. The timing of the global pandemic, and the socially perceived importance of reducing one's personal carbon footprint, also had a roll in the increasing popularity of e-bikes. The COVID-19 pandemic pushed US consumers toward buying products focused on providing social connection, physical activity, or outdoor recreation. During the 12-month period ending October 2020 versus 2019, the US cycling market saw a 45% growth. During this increased popularity of cycling, the e-bike market specifically grew 47% in the 12-month period ending October 2021 compared to the previous period in 2020.[10] This growth was not predicted during the start of the pandemic, with concerns regarding how retail businesses could survive enforced shutdowns reinforced by the supply chain issues with components such as chains and tire tubes.[11] As supply chain shortages began to end following the lockdowns being lifted, the bike industry, including e-bikes, continued growing post 2021 because of the renewed interest. The pandemic acted as an unexpected catalyst propelling e-bikes further into public thought and acceptance, further cementing their impact on the domestic transportation economy and providing rationale for continued promotion and e-bike research funding.[12] The combination of government mandated quarantining and the already rising e-bike industry coincided perfectly with providing

[9] US Dept. of Energy (2023), "Electric Vehicle Battery Pack Costs in 2022 Are Nearly 90% Lower than in 2008, according to DOE Estimates."
[10] Richter, (2022). *Has COVID-19's bicycle boom reached its peak?*
[11] Sutton, (2023). *What changed forever when Covid landed with the biking industry?*
[12] Ibid

a family friendly and urban use alternative that required less effort and ability for faster speeds and further distances. In general, the push for greener alternative energy has also been a stronger focus across the world as the understanding of climate change impacts and the need for mitigation through a reduced dependence on fossil fuels has gained more widespread support. This awareness coincided well with the introduction and expansion of e-bikes, which provide cheaper, cleaner alternatives to conventional transportation. This green influence is seen stronger in developed countries such as the United States, where the drive to be more sustainable increases consumer demand for more emission neutral products, like e-bikes, through increased awareness and social pressure. Consumers in developed countries generally have a higher individual spending capability, so e-bikes are naturally more likely to grow there as well. The social push to be more sustainable prompting individuals to make a shift to electric vehicles (EV), but even with the tax credits provided by the Inflation Reduction Act, EVs are more expensive than gas-powered cars and therefore remain out of reach for many consumers and not a perfect replacement.[13] In addition, studies have shown that just replacing some gas-powered vehicles with EVs will not be enough, and a more complete strategy should include an overall reduction in use of cars for short duration travel.[14] The relative affordability and convenience of e-bikes provides a compelling alternative for short distance transportation for everyday tasks and recreation. This influence would not necessarily be as powerful in developing countries because the push to be sustainable is often outweighed by lack of discretionary funds to spend on more expensive alternatives, therefore restricting market access until further developments in e-bike technology lower average price point.

[13] Young, (2023). *The New Electric Vehicle Push – E-Bikes.*
[14] Philips, Anable, & Chatterton, (2022). *E-bikes and their capability to reduce car CO2 emissions.*

[5] The introduction of e-bikes to the public sphere and subsequent rising popularity was expanded with improvements in e-bike technology, an increased interest in outdoor recreation due to COVID restrictions, a desire to reduce individual carbon footprints as explained above, but was also immensely aided by introductions of policy aimed at combatting climate change and subsequently increasing incentives to utilize e-bikes as a mode of transportation. In the United States, e-bike definition has been developed on a state-by-state basis, with 36 states and the District of Columbia using the three-class system, and the remaining states specifying different maximum speeds, wattage, or bike component sizing in e-bike definitions.[15] The three-class system designates Class 1 as only pedal-assisted motor with maximum assisted speed of 20 MPH, Class 2 are throttle-actuate motor with maximum assisted speed of 20 MPH, and Class 3 is only pedal-assisted motor with maximum assisted speed of 28 MPH.[16] This inconsistency in definition across states made it confusing for e-bike users to know where they could and could not use their bikes. In addition, within national parks and other federal lands, e-bikes were initially regulated under the same laws and restrictions as motor vehicles, restricting access from many desirable bike locations. In 2019, the lack of uniform regulation prompted then Secretary of the Interior David Bernhardt to order the National Park Service (NPS), Bureau of Land Management (BLM), National Wildlife Refuge System (NWS Refuges), and Bureau of Reclamation to allow e-bikes to use the same trails as those open to conventional muscle-powered bicycles.[17] The order was by followed in 2020 by the passage of general provisions in the Federal Register outlining "electric bicycle" definition and rules of use in associated lands (85 FR 69175).[18] Furthermore, recent federal policies such as the 2022 Build Back Better Act

[15] Velotric (2023), "Electric Bike Laws by State."
[16] Ibid
[17] Repanshek, (2019b). *Interior secretary moves to expand eBike access in national parks.*
[18] National Park Service, (2020a). *85 FR 69175 General Provisions; Electric Bicycles*

(H.R. 5376) and the 2021 Infrastructure Investment and Jobs Act (H.R. 3684) provided stipulations that provide credit incentive programs with bike commuter benefits and make streets safer for cyclists, respectively.[1920] The passage of HR 3684 in 2021 marked one of the largest federal investments in infrastructure of $1.2 trillion allocated over a 5 year period, geared toward expanding both communication and transportation systems, and improving domestic climate resilience.[21] One in five miles of major roadway in the United States is in poor condition, which the bill will directly address by allocating $110 billion for rehabilitation of roads and bridges with a focus on climate sustainability and safety, which largely benefits cyclists who often depend on good surface conditions to stay safe.[22] Another improvement the bill introduces to cyclists is an allocation of $11 billion to transportation safety programs, more than doubling previous funding with provisions including a $5 billion Safe Streets for All program directed at increasing pedestrian and cyclist safety through addressing individual community needs, such as providing grants for community owned utilities in need of replacement.[23] As mentioned, HR 3684 also aims to improve domestic climate resiliency, doing so through specific investment in public transportation, supporting long distance EV travel, and improving domestic power infrastructure. The bill invests $5 billion into zero-emission public school buses, with current diesel-powered model playing a critical role in expanding education access but contributing substantial pollution, particularly in communities of color and Tribal communities.[24] Regarding personal EV use, the bill invests $7.5 billion into the development of charging stations across the country's highway corridors, with additional focus on rural communities, which will ease the

[19] The White House (2021b), "The Build Back Better Framework."
[20] Congress-117th (2021). H.R. 3684 – Infrastructure Investment and Jobs Act.
[21] Ibid
[22] The White House (2021a), "Bipartisan Infrastructure Investment and Jobs Act: Updated Fact Sheet."
[23] Ibid
[24] Ibid

gradual transportation shift away from gasoline and diesel powered vehicles. Finally, the bill sought to address the country's aging power grid and annual power outage costs, committing $65 billion to build thousands of miles of new transmission lines for expanding renewable energy expansion and created a new Grid Deployment Authority to build a cleaner electric grid.[25] The 2022 passage of HR 5376 is a variety of incentives for reducing greenhouse gases, such as research grants for innovative technologies or tax credits from green investments. This legislation provides $1 billion for the US Environmental Protection Agency (EPA) and Federal Highway Administration in utilizing low-carbon materials in highway construction projects and $14.225 billion for the US General Service Administration and US Postal Service for EVs, associated infrastructure, and net-zero energy goals for associated properties.[26] The bill provides reasonable steps toward government-led decarbonization, though standards regarding the procurement of green road material should be better specified to maintain uniformity between the EPA and FHA, but otherwise provides potential growth for the EV market and further addresses bureaucratic institutional attempts to shift greener with the focus on USPS and GSA alternative transportation.[27]

[6] While looking at policies passed by Congress that improve EV and e-bike market potential, it is also important to note the effect e-bike popularity had on federal lands. As noted, initially e-bikes were acknowledged by the DOI as motor vehicles, treated the same as a car and restricted from areas allowing conventional bicycles. Since e-bikes are often beneficial to older or less able-bodied individuals for longer recreational travel, restricting their access could ultimately restrict a substantial portion of potential visitors from healthy, recreational

[25] Ibid
[26] Krupnick, (2021). *The Build Back Better Act and Green Procurement.*
[27] Ibid

opportunities. To reduce regulatory burden and simplify regulation on e-bikes in DOI lands, former Interior Secretary David Bernhardt issued an order in August 2019 (Order 3376: Increasing Recreational Opportunities through the use of Electric Bikes) to units of the Department including NPS, BLM, NWS Refuges and Bureau of Reclamation.[28] The order requires agencies provide public guidance regarding usage and regulation within 30 days, and was changed without public discourse or chance for comment.[29] Bernhardt referenced the confusion about e-bike classification causing decreased access to Federally owned lands for e-bike users, while also not specifying in his order between the three different classes and instead directing to "exempt all e-bikes … from the definition of motor vehicles."[30] The sudden change prompted public outcry among conservation groups, based on the potential for a "slippery slope" in regulation allowances and lack of public option for comment, the latter of which appeared in conflict with the Code of Federal Regulations. The order came at a period when many conservation groups were already in opposition to e-bikes on conventionally non-motorized trails, with 54 groups voicing their opinion earlier in the month in a letter to DOI, prompted by the Acadia NP ban on e-bikes on their carriage roads earlier that summer causing outcry by e-bike users who argued limited physical capability as a barrier to conventional biking.[31] The order prompted conservation group Public Employees for Environmental Responsibility (PEER) to file a lawsuit along with three other initial conservation groups (Wilderness Watch, Marin Conservation League, Environmental Action Committee of West Marin) against the DOI following Bernhardt's order. [32] The lawsuit alleges that the push through of e-bike access directly

[28] Secretary of the Interior (2019), "Increasing Recreational Opportunities through the use of Electric Bicycles – DOI Order 3376."
[29] Ibid
[30] Ibid
[31] Repanshek, (2019a). *Dozens Of Conservation Groups Oppose eBikes On Non-Motorized Trails.*
[32] Repanshek, (2019c). *PEER Sues To Overturn Expanded E-Bike Access In National Parks.*

ignores several laws and illustrates bad management of national parks, further alleging that deputy directors do not have the authority to change NPS bike regulation.[33] Due to changes in administration and scrutiny regarding the 2019 order, internal changes to e-bike regulation were made by acting NPS director Shawn Benge in June 2021, where he sent an email to NPS directors and superintendents reiterating their discretion to allow e-bikes or not.[34] Coming two years after former Interior Secretary Bernhardt's order for universal allowance of e-bikes on conventional biking trails, this was an important step in recognizing a need to individualized regulation based on specific park needs and effects associated with the particular environment. This discretion is important due to the extreme differences in geographic location and individual ecosystem of each park, with Acadia NP carriage roads more ideally built for bike travel compared others without pre-existing infrastructure.[35] However, this change was seen as a small cover-up of a larger problem by PEER, with senior council Peter Jenkins saying it shows that NPS understands there is a problem, but this is "insufficient to fix this mess".[36] The lawsuit was not settled until May 2022, when U.S. District Court Judge Contreras ruled that NPS can continue allowing e-bike access to non-motorized trails. However, the ruling came with the stipulation requiring NPS to conduct an environmental review with public comment period following to properly gauge impact e-bikes have on the park resources and other visitors.[37]

[7] This decision was both beneficial to e-bikes by providing continued support for their wider use by the public in outdoor recreation and access to national parks, but also supporting conservation groups such as PEER in improving transparency while evaluating impact. This

[33] Ibid
[34] Repanshek, (2021). *National Park Service Gives Park Superintendents Authority to Ban E-bikes*.
[35] Acadia National Park (2023), Bicycling – Acadia.
[36] Ibid
[37] Yobbi, (2022). *Judge orders Park Service to conduct environmental study on e-MTB impact.*

example of public scrutiny is an important reminder that although the need for policy change may be realistic, the process by which changes are made must adhere to some level of transparency when addressing policy that will affect the experience of other visitors in the park. As federal lands and national parks are meant to serve as public resources for recreation, their continued maintenance and care is extremely important for providing legacy value to future generations. However, the introduction of newfound e-bike popularity could be seen by conservation groups as a positive for more individuals appreciating and wanting to preserve the same areas the groups fight for. E-bikes have the potential to be utilized safely and without more destructive potential, but mitigation techniques such as public feedback and environmental impact evaluations (as decided by Judge Contreras) could both address public concerns and provide adequate evidence for or against the proposed adoption.

## CHAPTER 2: National Park Overcrowding and E-bike Use

[1] This chapter will explore the use of electric bicycles as recreational tools in national parks, where complications with further access occur, and what possible solutions for implementation might be evidenced by parks with successful use. Understanding how e-bikes are currently utilized by the public when visiting national parks gives important context for how park officials might improve access with future infrastructure, specifically when considering that individual park differences restrict what traffic mitigation techniques can be employed. With more visitors coming to national parks than ever on an annual basis, the management of park resources must be used more efficiently to control visitor experience to continue providing positive generational use. Therefore, the chapter will also explore park overcrowding mitigation, the historical context for NPS being in this predicament, and risk factors associated with consistently unchecked visitation on the natural environment. If left unchecked, NPS could fail in both founding goals set by Congress: protecting the natural ecosystem and providing access to future generations.

[2] The National Park Service (NPS) provides extensive recreational opportunities for the public in areas protected for future generational use, preserving unique landscapes and species that would otherwise disappear from public view if left without conservation efforts. Having seen the evolution of e-bike industry popularity in the 2010s, evidenced regulatory changes needed implementation to account for managing the new mode of transportation. Specifically, following the controversial 2019 order from former Interior Secretary Bernhardt, NPS land executives were required to develop visitor guidelines for e-bike use in existing roadways, regulating them the same as conventional bicycles. This chapter will further explore the programs and techniques that were developed inside NPS to facilitate a smooth transition, where

these programs triumphed in parks such as Acadia and Grand Teton, and how changes could be made in less accessible lands to help encourage future use. Along with the improvements to outdoor recreation access, drawbacks associated with e-bike usage stemming from concerns regarding their potential for larger environmental impact and intrusion for pre-existing conventional cyclist will be addressed to clarify possible mitigation of these concerns. Finally, the problem of overcrowding has become a more highlighted NPS issue in recent years with increasing visitation and current carrying capacity limitations.[38] This is extremely important because exceeding carrying capacity strains park officials' ability to enforce regulation or ensure visitor safety. The chapter will argue that increasing e-bike accessibility can simultaneously expand public recreation and health opportunities while reducing concerns of park overcrowding and public safety. Ultimately, recommendations for future programs could be used by NPS to avoid initial errors in public implementation and provide a smoother transition for the park and local areas.

[3] Initially, programs that facilitated further e-bike use were focused inside parks that were already more bike-accessible, generally those with gentler gradient carriage roads and pre-existing bike lanes and trail systems. Public implementation in these areas was more straightforward as there was a public understanding of biking etiquette in these parks and introducing a variation of this mode could be more conceivably applied. Acadia National Park (ACAD) was one of the more ideal targets for e-bike use, with their historical carriage roads and Schoodic bike paths highly utilized in the local cyclist community already.[39][40] This was the only

[38] Timmons, *Too much of a good thing: Overcrowding at America's National Parks,* 986.
[39] Acadia National Park (2023), Bicycling – Acadia.
[40] Summer Feet Cycling, (2022). *Cycling in Acadia National Park.*

national park to be created from private land donations and is one of the smallest in the country, with 45 miles of carriage roads being financed by John Rockefeller, who said "to help the people enjoy the interior of the park free from the noise and pollution of the automobile".[41] This type of attitude is why Acadia continued to be very popular for bicycling, in addition to kayaking and hiking, specifically due to the particular focus placed on non-automobile exploration, made more possible because of the smaller park size.[42] Following the 2019 Bernhardt order, NPS Policy Memorandum 19-01 was passed requiring parks to provide public regulations for e-bikes to the park compendium and allow them on roads designated for conventional bicycles.[43] Acadia adopted their policy in reference to the three class system, outlining only class 1 e-bikes were to be allowed, lowering the speed limit of both carriage roads and Schoodic bike paths from 25 MPH to 20 MPH, and limiting e-bikes from utilizing Island Explorer Buses or Bike express trailers due to load limitations.[44] This framework alleviated some concerns of cyclists who felt the inclusion of e-bike users was going to negatively impact their experience, addressing speed concerns by reducing all users limit and addressing crowding concerns by restricting e-bike transport on the park's public transport systems. Though this last portion may lend weight toward the side of excluding e-bike users, maintaining a transparent public shift initially requires gentle integration to avoid previous park recreators' concerns with the implementation. Creating distinct areas and regulations in the park greatly expands e-bike users' recreating potential, so keeping the transport systems exclusive maintains a balance so pre-existing, non-motorized recreating visitors do not feel this is as much of an intrusion. As mentioned in the previous chapter, this order was revised in 2021 by the Acting Interior Secretary Benge in an email to NPS

[41] Ibid
[42] Acadia National Park, (2022). Park Fact Sheet.
[43] National Park Service (2019b), *Electronic Bicycles – DOI Policy Memorandum 19-01.*
[44] National Park Service (2019a), *Only Class 1 e-bikes Allowed on Acadia's Carriage Roads.*

superintendents to clarify their full discretion to allow or not allow e-bikes based on park infrastructure, giving them necessary oversight for an otherwise blanket policy (19-01) that may overlook park specific needs or restrictions to access necessary for conservation.[45] Despite the 2021 clarification opening park officials' ability to restrict access, Acadia has maintained that only Class 1 electric bicycles were to be allowed not exceeding 20 MPH, with park specific emphasis placed on yielding to easily startled horses on the carriage roads.[46] Following e-bikes becoming more widely accepted, programs in the park geared toward further accessibility have also began incorporating people with disabilities.[47]. Programs in Acadia such as MDI Wheelers, made possible through trained volunteers, have utilized the carriage roads to offer free rides to visitors with physically limiting disabilities, electric assist tricycles.[48] This provides evidence that e-bikes have opened the opportunities of electric transport for more encompassing disabilities, expanding past initial marketing approaches of electric transportation to elderly and less fit consumers. By expanding the park's inclusivity to allow more people access on trails and carriage roads, the park has benefitted by hopefully reducing the use of vehicles that cause overcrowding on the roads in busy seasons.

[4] Overcrowding has been an increasing issue, from 2015-2017 national parks seeing an 11% increase in visitation, which at first glance would seem like a positive for a facility designed to garner public appreciation and increased use, however the lack of past historical preparation may be cause for concern if the visitation continues rising.[49] The two initial goals Congress set in the 1916 Organic Act for NPS was for preservation of the nature within and to provide

[45] Repanshek, (2021). *National Park Service Gives Park Superintendents Authority to Ban E-bikes*.
[46] Ibid
[47] MDI Wheelers, (2022). *Adapted Biking in Acadia National Park.*
[48] Ibid.
[49] Ibid

enjoyment of these areas for current and future generations, with Congress acknowledging the generality of these goals in 1978 by urging NPS to finalize carrying capacities and general management plans for each national park.[50] This was not followed through or pushed by the director at the time William J. Whalen III, and currently most parks have not adopted any plans or defined restrictions on visitation numbers which could pose a problem to NPS's core aims if left unaddressed.[51] On park trail use specifically, overcrowding can have detrimental effects on the environment's preservation with further erosion requiring park maintenance and creation of unofficial, visitor-made trails. This physical damage contradicts the NPS goal of environmental preservation, negatively affecting delicate ecosystems, potentially compromising individual species' continued existence. Another factor of the increased visitation is the buildup of human waste polluting the environment in areas where restrooms are unavailable or simply unable to appease demand. The additional risk of man-made pollutants compromises the other initial NPS goal of maintaining the environment for generational use, risking increasingly negative future visitor experiences by the dramatic effects trash has on disrupting the biochemistry of park flora. Obviously, this issue needs to be addressed quickly by current director of NPS Charles Sams with regulated carrying capacities observed and management plans put into place for mitigating current overcrowding. Another facet of this issue is the lack of sufficient funding to address these issues. The NPS annual budget has not kept pace with the dramatically increasing number of annual visitors, straining park resources if not corrected sooner than later.[52]Though this issue is needing to be addressed across all 62 National Parks, it is important to point out that overcrowding is a central problem in ten specific parks that oversaw 57% of all recreational

[50] Ibid
[51] Walls, Wichman, & Ankney, (2018), *Overcrowding in National Parks: Seeing the Forest for the Trees with Better Data.*
[52] Ibid

visitations in 2017; Acadia, Grand Teton, Zion, Rocky Mountains, Yosemite, Great Smoky Mountains, Yellowstone, Glacier, Olympic, and Grand Canyon.[53] This condensed visitation in more popular parks makes them focus targets for overcrowding mitigation since the irreversible environment physical effects will occur more rapidly if not addressed there. Though larger parks such as Yellowstone might be able to sustain larger crowds more adequately with pre-existing infrastructure, the proportional popularity stretches park management resources further, making the issue as prominent if not more so than smaller parks, though smaller parks prove ideal testing areas for mitigation projects. Acadia is one such smaller sized park, and with the previously mentioned infrastructure for non-vehicle exploration, the park's popularity has soared, prompting the park superintendent to implement traffic mitigation systems in 2019.[54] This took the form of a vehicle reservation system designated for the popular Cadillac Mountain location, which only contains 150 parking spaces but summer days could see 500 cars.[55] Created with the input from local population, the plan expands the public transportation for the Island Explorer buses to facilitate easier access to the park without needing to use a personal vehicle. The plan has proven successful in decreasing congestion and increasing visitor experience, even while visitation to the park has continued to increase from 2019-2021.[56] For a five-month period January to May 2021, Acadia hosted over 500,000 visitors, or a 55% increase from the same period in 2019.[57] In July 2021, Park Superintendent Kevin Schneider reported to Congress that the reservation system has contributed to a more pleasant visitor experience with less congestion, increased use of public transport, and increased biking and walking park exploration.[58] This type of plan is

[53] Ibid
[54] Schreiber, (2021a). *Acadia National Park sees big jump in visits, even compared to pre-pandemic levels.*
[55] Ibid
[56] Schreiber, (2021b). *As national parks face overcrowding, Acadia chief says new reservation system working well.*
[57] Ibid
[58] Ibid

extremely beneficial for e-bike usage in the park since decreasing vehicle congestion increases pedestrian and cyclist safety alike and  creates an incentive to engage in the parks roadways and trails, which are designed to be used by cyclists. A beneficial facet of this system is the applicability to other areas, as the stipulations for use are designating popular visitor destinations with limited existing capacity, and providing sufficient transportation alternative, potentially through local existing businesses such as in Acadia or private contracted entities such as Xanterra catering (Death Valley, Glacier, Grand Canyon, Rocky Mountain, Yellowstone, Zion).[59] However, seeing the positive effects in Acadia requires other park superintendents to evaluate scope of a project in terms of their individual park, where smaller sized parks might find more success because of the stronger oversight over smaller areas. Although smaller parks might also have the potential to expand the reservation systems to be park-wide, larger parks may instead be prompted to follow Acadia's initial example of focusing only on highly trafficked areas such as Old Faithful in Yellowstone since the need for mitigation is higher in these areas and is more feasible than park-wide implementation. Since larger parks may not have as much cycling infrastructure on roadways because of the park size, decreased traffic congestion would not initially impact the increase in cyclists as in Acadia but provide for future investment as crowds are better managed. With fewer people on the roadway in private vehicles, it will be safer for pedestrian and cyclist lanes to be expanded to more areas of the park, subsequently further incentivizing these modes of transportation as the park tries to cut down more on private vehicle usage when possible.

[59] Xanterra (2023), Travel Collection.

[5] Similar to Acadia, Grand Teton National Park has also seen dramatic increased visitation in recent years, with record breaking visitors for each month for the majority of 2021 with overall visitor numbers totaling almost 1.5 million more than 10 years ago.[60] To approach this, the park opted in 2021 to avoid dramatic park-wide actions and instead focus on gathering qualitative and quantitative data regarding the park use during the peak season, in addition to piloting several more passive mitigation techniques to gauge the applicability for future years. Beginning with visitation studies to understand visitor patterns and scope, the park used trail counters and traffic observation at highly congested or popular areas to determine future route planning or potential infrastructure.[61] As far as mitigation techniques, the park targeted the Laurance S. Rockefeller Preserve area for stricter one-in / one-out parking to decrease risks of previous overparking and increased trash. Campsites were also being overused before the park implemented a by-reservation-only system. The new system better controls the amount of both human waste and improves the individual camping experience.[62] Though visitor overflow can be an issue mitigated by more regulated direction, a build-up of human waste in areas that are not sufficiently supplied with adequate trash bins or restrooms will still be an issue for the surrounding environment, so more popular areas of the park should have additional waste facilities introduced. Apart from size, another park similarity with Acadia is the biking accessibility that Grand Teton boasts as a popular recreation for visitors, with sufficient safety lane and paved road maintenance as a focus. This is largely due to the lower gradient roadways that are more inclusive to all family members regardless of fitness restriction, which like Acadia has incentivized the mode of transport more than other parks might. The idea of a park shuttle

[60] Klingsporn, (2021). *As crowds pile into parks, official mull management options.*
[61] Ibid
[62] Ibid

was initially shut down based on projected cost and area inefficiency, but talks have remained open, specifically with the Southern Teton Area Rapid Transit (START) bus company being the potential candidate for future years.[63] Though the idea of public shuttles has been debated both in the public realm and internally, Grand Teton has initially stated the unfeasibility based on visitor travel patterns and cost. One of the main problems Superintendent Jenkins has noted with developing a shuttle plan was that there was no dominant travel pattern and visitors often drove in one entrance and out another, without a more circular travel pattern as exhibited in Acadia.[64] In a study conducted by Grand Teton in 2021, they identified the top five locations where trips to Grand Teton end (Colter Bay 12%, Jackson Lake Lodge 7%, Jenny Lake 6%, Signal Mountain Overlook 2%, and Craig Thomas Discovery & Visitor Center 3%), despite these locations only accounting for less than a third of all visitor stops.[65] The study provided evidence to the significantly dispersed nature of recreation within the park, where visitors go to many different end destinations for their trip, making a public shuttling system much harder to adequately replicate visitor experience of individually exploring in private vehicle.[66] The study also identified park overlook adjacent roadway traffic patterns to determine the areas of higher potential traffic congestion, finding that though the Jenny Lake Overlook was the third most traveled to destination, the adjacent roadway was largely the most utilized by visitors (1. Jenny Lake Overlook 41% 2. Jackson Lake Overlook 21%), providing an important argument for park road maintenance budgeting to acknowledge in future planning.[67] The study data gathered could be used to expand identified popular roadways to limit congestion and potentially phase out less

[63] Town of Jackson, WY. (2023), START Bus.
[64] Klingsporn, (2023). *Yellowstone, Grand Teton superintendents wary of shuttles.*
[65] Otak Team, Fehrs & Peers, L2 Data Collection, Inc. (2022), *Grand Teton National Park Transportation & Visitor Movement Study: Executive Summary.*
[66] Ibid
[67] Ibid

used roadways into bike or pedestrian lanes, since the pre-existing popularity of the cycling recreation in the park would only be improved by further accessibility. This type of planning might provide more developed visitor travel patterns, allowing the future planning of park shuttles without taking away from individual visitation experiences, further reducing congestion. To Grand Teton's immediate north is Yellowstone National Park, which faced similar overcrowding concerns and talks of park shuttles, but which superintendent Cam Sholly decided would not be cost effective for similar rationale to Grand Teton.[68] Similar to their smaller neighbor, Yellowstone conducted an independent shuttle applicability study and found visitors often travel through one entrance and out another, and providing transit along the 500 miles of roadway in the park is likely financially unfeasible.[69] Specifically, this study was conducted regarding the Old Faithful-Madison corridor and the Canyon area. However, the study found that though providing park transit may be too costly, the reductions in parking congestion could be related to management of access like reservation or one-in / one-out parking systems. However, transit systems were found to have benefits to supplement managed access by providing alternative visitor access, and cost efficiency and productivity were maximized when management access was paired with transit shuttle concepts.[70] This study provides context for a larger park's evaluation of mitigatory techniques which lends evidence that roadways might be better cleared by stronger parking and entrance management rather than new investment in park-wide transit. Despite the potential budgeting conflicts, the study found that shuttle transit concepts would enhance visitor experience by providing alternative access to popular destinations with limited parking. By reducing the number of private vehicles, the park could

[68] Ibid
[69] VHB, Otak Team, Fehrs & Peers, Dornbusch Associates. (2022), *Yellowstone National Park Transit Feasibility Study: Old Faithful-Madison corridor and Canyon area.*
[70] Ibid

conceivably provide more bike and pedestrian roadway access through road use restrictions or additional lanes added. However, the aforementioned complications with expansive biking infrastructure across larger parks would require any infrastructure be instead concentrated in areas of shuttle transit interest like Old Faithful and Canyon, with gateway communities like West Yellowstone also being potential areas of development should bike safety be improved by fewer cars on the roadway.[71] Park specific limitations from roadway layout and flow pattern constrict Yellowstone and Grand Teton from entertaining a transition to park-wide shuttles, but the exact opposite is seen to the south in Zion National Park. Zion has generally been a lead by example park, historically being the first park to implement many new cleaner public transport options.[72] In 2021, the park announced the move from their current 30 low emission propane buses to 26 battery-electric buses with 27 developed charging stations.[73] The park is able to both continue providing cleaner public transit and the necessary infrastructure (charging stations) to support because their road layout provides more funneled travel along one roadway, the Zion Canyon Scenic Drive, with most visitors entering and exiting through the southern entrance, in part to the visitors center and park museum being located there. Since most traffic flows only through the Zion Canyon Scenic Drive, park officials were able concentrate building of both shuttle stops and charging stations along this roadway to adequately support the visitation of the fourth most popular national park.[74] Adjusting visitors' experience is evidenced in Zion to be significantly more feasible when traffic congestion is concentrated and traffic patterns can be more predictive when people are funneled instead of more equally distributing through different entrances like Yellowstone. Furthermore, the focus on a major park roadway has further opened

[71] Ibid
[72] Zion National Park. (2021), *Zero-Emissions Shuttle Buses Join the Zion Park Fleet.*
[73] Ibid
[74] Ibid

the doors for cyclists in Zion, with less congestion allowing the building of more bicycle and pedestrian facilities in the park and in surrounding gateway communities where many visitors stay in between park days. This focus on public transportation has helped the park develop in recent years as a hotspot for e-bike usage, especially as the use of e-MTBs (mountain bikes) in other state areas like Moab rise in popularity, bringing further business to the park and gateway communities by working with private rental groups. One such group, Zion Peddler, is located right outside the main entrance and offers inexpensive (park regulation compliant) e-bikes in many different sizes to accommodate the whole family.[75] Though this specific program is not unique, the example demonstrates the importance that the park placed on congestion mitigation, since it can provide new gateway community business opportunities and an improved experience with less traffic. Though complaints of shuttle lines have been discussed to determine how to improve efficiency, largely visitor responses have been that the lower crowds have improved the experience and safety of the previously crowded narrow cliffside trail of the immensely popular Angel's Landing hike.[76] Since the park's vehicle roadways are generally focused in the southern section of the park, there are many areas available to cyclists and hikers where they can experience the park removed from any traffic annoyance or distraction. This design helps preserve the generational experience of visitors even as more people want to come see the park, since the majority of all visitors still generally stick to major park roadways, avoiding longer hikes or bike rides, leaving much of the northern portion of Zion less disturbed.[77]

[6] As shown, the necessity to reduce national park overcrowding would be the initial step for providing a better park experience and expanding bike access since current congestion

[75] Zion Peddler. (2023), Home - General Information.
[76] Jones, (2019). *How did Zion National Park become more popular than Yosemite or Yellowstone?*
[77] Ibid

often conflicts with the ability to safely introduce pedestrian walkways or bike paths at all. Until the safety of visitors engaging in non-vehicle recreation can be adequately accounted for, no measurements to expand their ability bike or walk along roadways should be taken. Park superintendents will need to gauge mitigation program applicability based on their individual park, since each may need slightly different techniques. Though different in visitation size, both Acadia and Zion saw positive visitor reactions to implementation of public transportation because their park layout prompts traffic to naturally follow along one road, exiting the same way it entered. In contrast, both Grand Teton and Yellowstone conducted separate studies to investigate a park shuttle system, but found because of their roadway flow and layout, visitors might be more inconvenienced, and the potential inefficiency would not be acceptable with the high-cost requirements. Something found in the study conducted by Yellowstone was that having stricter parking management regulations could alone adequately address congestion without the use of park transit, which is important because it is obviously more expensive to develop a new public transport system than enhancing current parking facilities. Mitigatory techniques for private vehicle use can be a one-in/one-out system for maintaining space, parking and camping reservations, and even timed entry which would act like a park entry reservation. In parks where it is applicable, the availability of public transit drastically cuts down on vehicle congestion and gives park officials more oversight in day-to-day operations during peak season. Providing more waste facilities such as wastebins and restrooms would only facilitate further benefit for visitor experience since limited availability has only been enhanced by overcrowding but should still be separately addressed. Once traffic congestion across a national park or at key popular locations is sufficiently controlled to safer levels, the park should target popular locations for improving bike accessibility since these areas will be utilized by the public. Focusing on more popular areas is

beneficial to larger parks who cannot extend enough resources to make the park more fully accessible, so this more efficiently improves broader visitor experience. As evidenced in gateway communities outside Zion and Acadia, as the overcrowding is mitigated and biking accessibility subsequently improved, rental businesses will enhance the surrounding economy and provide further biking incentive for visitors who might have not been otherwise planning on biking. Since e-biking requires less physical exertion and is more inclusive to age than conventional cycling, visitors are highly likely to engage if safety and accessibility is adequately accounted for as previously mentioned.

[7 Therefore, most of the potential complications with e-bike use in national parks can be sourced to the rising issue of park vehicle congestion and general visitor overcrowding in recent years as there appears to be a reinvigorated interest in outdoor recreation, especially from 2019-2021. Park officials should conduct similar quantitative data collection to Grand Teton in order to evaluate where mitigation is needed in the park, which will help in determining a realistic cost and scope. E-bike use is limited in many parks simply due to the park's inability to undertake large biking infrastructure investments and lack of park specific data highlighting where to increase access, especially with overcrowding being a more prevalent issue in providing benefit to both non-cyclists and cyclists alike. Ultimately, parks need to readdress the 1978 Congress request for defined carrying capacities for both employee and visitor safety, with sufficient management plans for maintaining these capacities. Being unprepared is likely the worst thing the National Park Service could do since the flow of visitation does not seem to be dwindling and protecting the park areas should always be a primary concern for park officials. Once capacity limits and management plans for these limits are in place, bike and e-bike accessibility can be further improved because the safety of the user can be controlled for, further incentivizing

public use and subsequently influencing park infrastructure decisions to reflect the value placed on non-vehicle modes of transportation.

## CONCLUSION

The inherent necessity of global responses to mitigating climate change has become more forefront to many as the dangers associated with unchecked pollution become more apparent every year. As mentioned, the risk of coastal flooding could affect 3 billion people, but the adverse effects of climate change run much deeper than relocation. Any given natural ecosystem has been developed for the climate associated with the area, with plants and wildlife similarly evolving to cope with the environment. As climate change catalyzes faster atmospheric changes annually, the dangers of destroying food chains and subsequent extinction for certain wildlife and flora becomes even more heightened. Importantly, climate change educational outreach and heightened respect for scientific observation has helped pushed the social demand for cleaner lifestyle alternatives, culminating in many advantageous green technologies becoming more commonplace across developed countries such as the United States. This social drive facilitated e-bikes' rise in popularity, which provided a short trip alternative to private car travel that was also much more cost-effective than an EV while giving moderate physical exercise for less intensive physical labor. As they become more popular, new regulations outlining e-bike use on public roads and bike paths had to be readdressed, with the federal government outlining a three-class system for identification, while allowing governors individual oversight on e-bike state laws. The e-bike industry exploded during the COVID-19 pandemic with enforced quarantining incentivizing many to engage in outdoor recreation since it provided distanced socializing and exercise, helping soothe the general lack of speaking with others and gyms closing. Due to the

reduced physical requirement, e-bikes expanded the cyclist market to individuals who had been unable or unwilling to participate in cycling, allowing many to bypass age or physical health restrictions and enjoy outings with family or friends. More individuals wanting to explore the outdoors understandably affected national park visitation numbers, re-highlighting the potential risk of park overcrowding and carrying capacity dangers. To properly preserve future generational use and park ecosystems, the need for overcrowding mitigation is a forefront conclusion, with many parks piloting, employing, or conducting studies to evaluate different methods for mitigation. The evidenced public transit success in parks like Zion or Acadia should be noted as largely due to the park roadway layout allowing more concentrated traffic flow with a common entry and exit point, whereas other parks like Yellowstone with more traffic must reconsider areas for public shuttling. E-bike access in national parks will be improved once overcrowding concerns are alleviated, since the inherent safety of initiating pedestrian or cyclist infrastructure is challenged by how busy roadways are currently. Also, designated bicycle paths, separate from vehicular traffic, has been shown to be very popular with the public and heavily utilized by both conventional and e-bike users. Other national parks across the US should conduct similar transport studies to those independently researched in Acadia, Grand Teton, and Yellowstone to better understand how different options can improve travel efficiency and visitor experience. After adequately reducing roadway congestion, bike lanes and pedestrian walkways can be expanded for more areas, increasing recreation access, and promoting e-bike use for even more visitors. Ultimately, park superintendents will be able to protect the future of NPS visitation experience and incentivize non-car travel if individual park differences are taken into account and more strategies are available from successful programs in other national parks. By improving visitor experience during a time of rising popularity, NPS can facilitate a wider public

appreciation for protecting the natural environment, adding to the urgency surrounding climate change and its impacts. E-bikes are already an important tool for expanding public cyclist demographics, but have the potential to significantly increase opportunities for health, outdoor activities and create an appreciation of public lands for recreation among a new user group, and influence a shift toward cleaner transportation that compliments the larger shift away from gas-powered vehicles.

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