Registration Code: FJL-8803

Glacier National Park: Developing Methods of Sustainability Outreach

16 October 2020

Authors:

Victoria Carreiro

William Kelly

Nathan Sarachick

Erin Venard

Report Submitted To:

Professor Frederick Bianchi and Fred Looft

Worcester Polytechnic Institute

Worcester Polytechnic Institute

Worcester, MA

For additional information or details please contact Prof. Frederick Bianchi: bianchi@wpi.edu

Abstract

This project investigated different methods of visitor outreach and education to improve Glacier National Park's (GNP) waste management system. The methods we investigated were based around the promotion of source reduction, reuse, and visitor recycling practices. Our team focused on developing recommendations for recycling resources within the park, pre-trip education, and content available on GNP's website, and created templates for printed posters and brochures for disseminating recycling and sustainability information on the ground throughout the park. We also created an infographic as well as an ArcGIS map to implement into an email-based reservation outreach system to educate visitors about recycling and sustainable practices before they come to the park. Finally, through web analytics, our team analyzed GNPs website to provide recommendations on how to include more accessible sustainability and recycling information for park visitors.

Acknowledgements

We would like to recognize and thank all the individuals that have supported us throughout our research. Due to the remote setting of our project in the wake of the COVID-19 pandemic, we would also like to thank everyone for taking the time to work and communicate with us during a challenging time for all parties under this unique set of circumstances.

First and foremost, we would like to thank Tara Carolin for her direction and leadership during the extent of our project. We would also like to give a special thanks to Jeremiah Eaton and his continuous aid and guidance in our project as the Energy Corps Sustainability Education Coordinator at Glacier National Park. Additionally, we would like to thank the following Glacier National Park Staff who were instrumental in providing us with invaluable information to help us move forward with the project: Renata Harrison, Richard Menicke, and Ginger Rigdon. We also enjoyed working with Digital Communications Specialist of the National Park Service, Megan Rybacki, for assisting us in our project.

We would also like to formally acknowledge the staff at Worcester Polytechnic Institute for giving us this opportunity and experience. We would like to express our sincere thanks to Professor Frederick Bianchi and Professor Fred Looft for their constant support and guidance and allowing us to learn and grow throughout our project.

Lastly, we would like to thank anyone who participated in our surveys and took the time to provide us with any feedback.

Authorship Page

Section	Author(s)	Editor(s)
Abstract	Victoria	Nathan
Acknowledgements	Erin	Victoria, Erin
Authorship Page	Victoria	Erin
Table of Contents	Victoria	All
Table of Figures	Victoria	Will
Executive Summary	All	All
1. Introduction	All	All
2. Background	All	All
2.1 National Park Service	Erin	Nathan
2.2 Glacier National Park	Victoria	Nathan
2.3 Process of Recycling & Diversion Rate	Nathan, Erin, Will	Victoria
2.4 Recycling Initiatives and Regulations	Nathan	Erin, Will
2.5 Recycling Programs Within Glacier	Victoria, Erin, Will	Nathan, Victoria
2.5.1 NPS Diversion Rate Goal	Victoria	Will
2.6 Psychology in Recycling	Erin, Will	Nathan
2.7 Potential Strategies to Increase Recycling	Erin	Will
2.7.1 Education/Outreach	Nathan	Victoria
2.7.2 Web Analytics	Will	Erin
2.7.3 ArcGIS	Victoria	Nathan
3. Goals & Objectives	All	All
3.1 Methods	All	All
4. Results & Discussion	All	All
4.1 Introduction	Nathan	Will
4.2 Results	All	All
4.2.1 Understanding Outreach	Erin	Victoria
4.2.2 Visitor Onsite Experience	Erin, Victoria	Will, Nathan
4.2.3 National Park Programs + Outreach	All	All
4.2.4 Visitor Online Experience	All	All
4.3 Discussion	Nathan	All
5. Recommendations	All	All
5.1 On the Ground	All	All
5.1.1 Primary Recommendations	Nathan, Victoria, Will	Erin
5.1.2 Secondary Recommendations	Erin	Victoria
5.2 Pre-Trip	Nathan	Will
5.2.1 Primary Recommendations	Nathan	Will
5.3 Website	All	All
5.3.1 Primary Recommendations	Will, Nathan	Erin, Victoria
5.3.2 Secondary Recommendations	Erin, Victoria	Will, Nathan
6. Conclusion	All	All
7. References	All	All
8. Appendices	Erin	All
Appendix A - Waste and Recycling Audit Worksheet	Erin	All
Appendix B – Web Analytics Data	Nathan	All
Appendix C – Visitor Survey	Victoria	All
Appendix D – Staff Survey	Victoria	All
Appendix E – Reservation Confirmation Email	Nathan	All
Appendix F – Updated Waste Receptacle Signage	Nathan	All

Table of Contents

Table of Figures

Executive Summary

Introduction

With the National Park Service (NPS) waste diversion goal being 50%, national parks must adapt and find new ways to prevent waste from ending up in landfills. Glacier National Park's (GNP) current waste diversion rate is at 19%, indicating that improvement is needed to be more sustainable and reach goals set by the NPS. While GNP is committed to the reduction, reuse, and recycling of waste through programs such as the Leave No Trace (LNT) initiative, and prohibiting plastic water bottle sales, there are still opportunities to improve the waste management system and help the park increase its waste diversion rate.

Improving the recycling and solid waste management system is crucial to increasing GNP's waste diversion rate, and park staff and visitors are a key component to its success. Proper disposal, reduction of material brought into the park, and reuse of materials rely on park staff educating visitors and providing timely and correct waste management information. The goal of this project focuses on education and outreach methods to inform visitors and staff on correct sustainability practices within the park, and how to help reduce, reuse and recycle waste.

Approach

To achieve our project goal, the project focused on two objectives and various methods seen in the flow chart below. As illustrated below, our methods were categorized into three sections: on the ground information located within the park, pre-trip information distributed upon reservation of park access, and information on GNP's website.

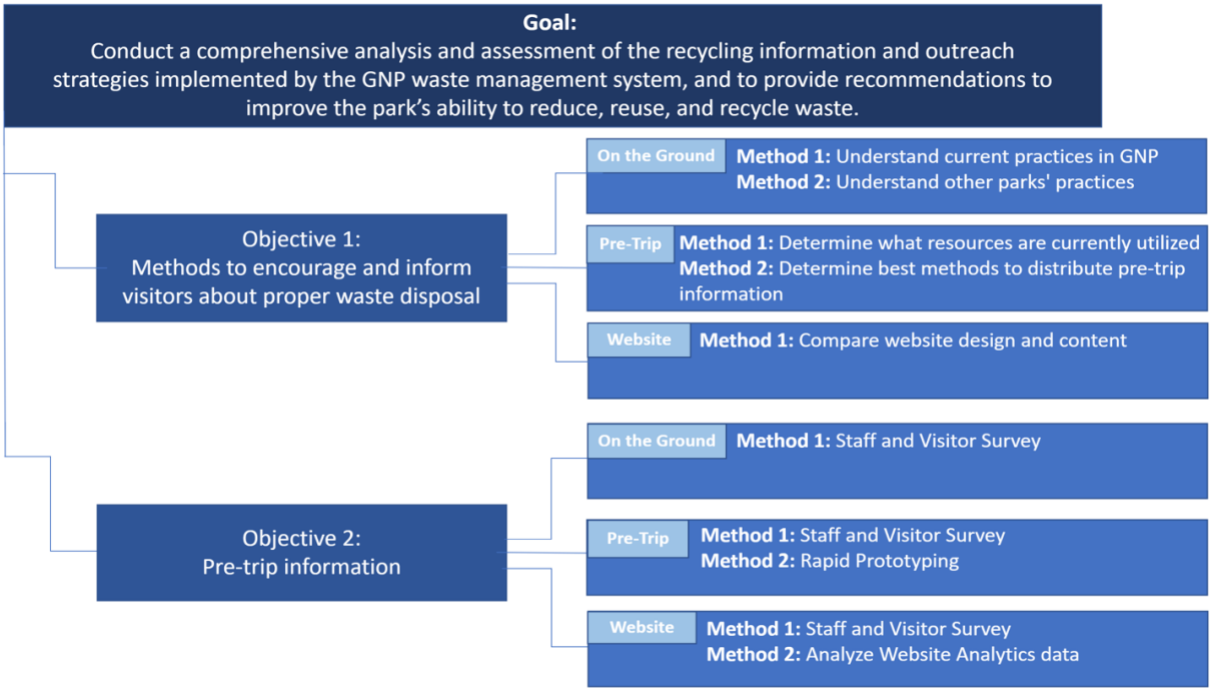


Figure ES-1. Flowchart of project goals, objectives, and methods

Results

Understanding Outreach

Our research found that consistent signage is an important ergonomic and efficient feature in promoting proper recycling and waste disposal (Wu, D., Lenkic, P., DiGiacomo, A., Ceh, P., Zhao, J., & Kingstone, A., 2018). It was also found that pictures and icons are more efficient in promoting proper disposal than solely word signs (Wu et al., 2018). Lastly, the promotion of product transformation salience can be employed in order to increase consumer recycling (Winterich, K. et al., 2019).

National Park Programs and Current Outreach Systems

To determine the existing sustainability outreach practices in place within the park, we assessed GNP's current implementation of these resources through interviews and research. It was found that GNP's on the ground sustainability outreach utilizes signage for waste receptacles, printed visitor guides, and informational booklets in the lodges.

We compared GNP's sustainability outreach systems to other national parks with high waste diversion rates. We found that parks with higher diversion rates have more outreach and available information regarding their sustainability programs. We also learned that Grand Teton, Yosemite, and Denali National Park have partnered with Subaru to implement the Zero Landfill Initiative (ZLI) to help them increase their diversion rates.

Visitor On-Site Experience

Sustainability questions are frequently asked by visitors to park staff. By conducting anonymous surveys of park employees, it was found that park staff are often asked questions regarding sustainability and recycling on a daily or weekly basis, as shown in Figure ES-2. We also determined that park staff were unsure if the answers to these questions are readily available to visitors within the park, as seen in Figure ES-2.

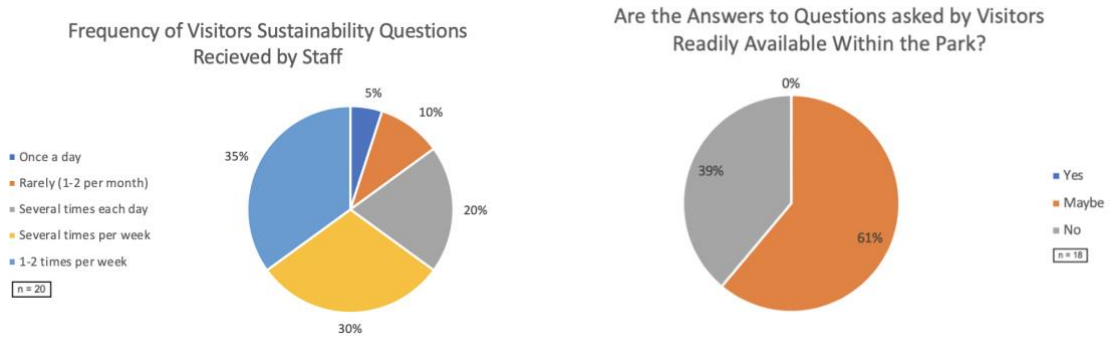


Figure ES-2. Staff survey results for frequency of sustainability questions and what content is available within the park

In addition to surveying park staff, we determined that most GNP visitors were unsure or unaware if there was information about recycling and sustainability available in the park. Note in Figure ES-3, 80% of visitors did not recognize or obtain recycling and sustainability information in GNP.

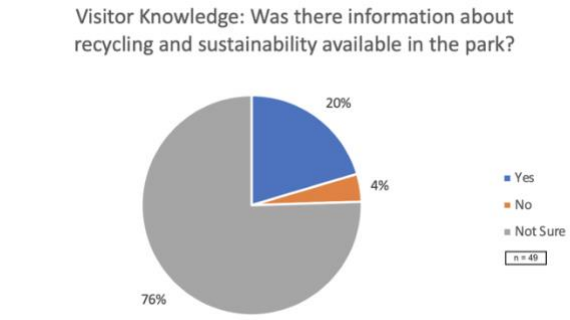


Figure ES-3. Visitor survey results for the knowledge of recycling and sustainability information available in the park.

Our research found that 40% of GNP visitors have trouble finding recycling bins or trash receptacles in the park, as shown in Figure ES-4. We also found that there is visitor confusion on proper recycling and disposal of waste in GNP, as seen in Figure ES-4.

Figure ES-4. Visitor survey results on locating waste receptacles and the ability to properly dispose of waste

Pre-Trip Information

Through research and personal communication with our contacts at the park, we found that GNP does not currently implement any pre-trip visitor outreach programs. No pre-trip resources, such as maps, park guides, or sustainability information, are given to visitors before arriving at the park. As a result, visitors are unable to plan their trip around the recycling opportunities available within the park.

Visitor Online Experience

To understand the visitor online experience with GNP's website, we utilized the same visitor survey data and Google Analytics data that was used perform a comparative analysis with four other parks with higher diversion rates. It was found that almost half of park visitors did not

spend time on the Leave No Trace, sustainability, and recycling webpages, nor did the majority know they existed, as seen in Figure ES-5.

Figure ES-5. Visitor survey results for online sustainability and recycling webpage experience

Web analytics data was collected to compare the effectiveness of multiple park's website design. Data was collected from the GNP website as well as the websites of four other national parks: Denali, Grand Teton, Yosemite, and Yellowstone. It was found through a comparative analysis that national parks with better website information, layout, and sustainability outreach had better diversion rates than GNP. In addition, the ease of navigating to sustainability pages was explored. Most pages were within 2-3 clicks from the home page, except for GNP's recycling page, which could only be reached by searching on the website. GNP's recycling page was last updated on September 29, 2016. The lack of up-to-date information and the inaccessibility GNP's recycling page from the home page may be an important factor in improving GNP's diversion rate.

By examining GNP documents and their website, it was found that little to no information about trash and recycling bins was available, including the number and locations of bins in the park. This problem reflects a lack of clear communication between GNP and its visitors regarding the park's sustainability and recycling opportunities.

Recommendations

On the Ground

Implement visitor educational sustainability and recycling information through print media

Many visitors are unaware of what can and cannot be recycled, and have difficulty finding recycling receptacles. By implementing a campaign of printed media, which includes posters and brochures, this information can be more easily accessible to visitors while in the park.

Educate staff and concessioners with park sustainability initiatives and goals

To spread information by word of mouth, we suggest educating staff and concessioners on basic sustainability goals and practices to promote sustainability. Educating full time and

seasonal staff during staff orientation would benefit both staff and visitors regarding sustainability efforts.

Pre-Trip

Implement a reservation outreach system to distribute pre-trip sustainability and recycling information

We recommend that GNP implement a reservation outreach system by which pre-trip resources can be sent out to visitors through email when they book a reservation with the park. GNP does not currently send out any pre-trip sustainability or recycling information to visitors that book reservations or purchase park passes.

Website

Provide easy navigation and accessibility to sustainability and recycling information on the GNP website

We recommend the GNP recycling webpage be made easily accessible from the homepage by putting it under the sustainability link in the "Get Involved" menu. Due to visitors not realizing the sustainability pages exist on GNP's website, we recommend also putting general sustainability and recycling information under the "Plan Your Visit" tab.

Update website features to allow for more visitor interaction

To make the webpages more interactive and informative, we recommend adding features including, but not limited to: videos, clickable banners, pictures, bulleted lists, hyperlinks to other sustainability and recycling pages, park goals, charts, data tables, and waste diversion rates. The implementation of a list entitled "How to Recycle," containing information on how different types of waste can be disposed of within the park, would also be a helpful resource to inform visitors how to dispose of waste properly.

Implement an ArcGIS sustainability map

To ensure proper waste disposal before visitors enter the park, it is recommended to implement an interactive ArcGIS map on GNP's website. This map would contain the locations of recycling and trash bins, water bottle refilling stations, visitor centers, lodges, and campgrounds.

Conclusion

In conclusion, these methods aim to mitigate the amount of waste that enters GNP, as well as minimize improper disposal of waste within the park. While recycling is an important factor in sustainable practices, we prioritized source reduction and reuse as more preferred ways to manage waste in GNP, given the logistical difficulties of recycling in Montana.

1. Introduction

The United States National Park System is continuously increasing in both size and popularity. A total of 400 national parks have been established through the US National Park Service (NPS), spread over 84 million acres across all states and U.S. territories (NPS U.S. Department of the Interior, 2016). In 2019, there were over 327.5 million visitors to all national parks, which is the third-highest number of visitors in a single year (Ziesler, P., 2020). Over the past five years, park visitation has increased by 11.9% (NPS, 2019). Glacier National Park (GNP) is the 10th most visited national park and received over 3 million visitors in 2019 (NPS, 2019).

As the number of visitors to the national parks grows, so does the need for updating park infrastructure to accommodate the increase (NPS, 2016). The increase in visitors leads to an increase in waste generated at the park, and subsequently, a greater need for the implementation of sustainable and recycling practices to ensure the waste is diverted from landfills.

GNP is committed to the reduction, reuse, and recycling of waste. To do this, the park has employed a variety of strategies which include adopting the Leave No Trace Initiative (LNT), prohibiting the sale of plastic water bottles, and offering sustainable transportation options to reduce the park's carbon footprint (NPS, 2019). Despite these measures, GNP's waste diversion rate was only about 19% in 2018 in comparison to Yellowstone's 2018 diversion rate of 63% (NPS Yellowstone, 2019). The NPS goal for all parks in 2018 was 50% (GNP Conservancy, 2018).

While improving the solid recycling and waste management system is crucial to increasing GNP's waste diversion rate, measures adopted for proper waste disposal, reduction of materials brought in, and the reuse of recyclable materials can only be successful as long as park visitors are well informed to adopt the best practices put forward by the park. With this goal in mind, visitors are more likely to reduce, reuse, and recycle if they possess the right information on how to recycle, what waste materials are accepted, and where they can dispose of each type of waste. It has been suggested that presenting visitors with up to 5-6 different sources of information on how to reduce, reuse and recycle wastes can increase the likelihood of proper waste disposal and sustainability practices (Nixon, H., & Saphores, J. M., 2009). Proper signage, convenient locations, and different sources of information are helpful in the promotion of recycling to visitors (Mateer, T. J., Taff, B. D., Miller, Z. D., & Lawhon, B., 2020). Printed and online resources, as well as face-to-face communication, are potential strategies to inform visitors on the recycling system implemented in GNP and potential sustainability practices to implement (Nixon, H., & Saphores, J. M., 2009). Adjusting the type of content in a recycling message can also be effective in encouraging visitors to recycle. While appealing to a person's emotions and guilt can improve the likelihood of recycling, it was also found that informing

people about how the product can be reused in the future may be even more productive (Delaney, R. 2019).

The goal of this project was to conduct a comprehensive analysis and assessment of the recycling information and outreach strategies implemented by the GNP waste management system, and to provide recommendations to improve the park's ability to reduce, reuse, and recycle waste. The current study intends to identify methods GNP could adopt to encourage and inform visitors on proper recycling and sustainability practices as well as develop a pre-trip resource to implement the findings and educate GNP visitors. This investigation and implementation of sustainability strategies is imperative to continuing GNP's conservation efforts and to protect its environment.

2. Background

2.1 National Park Service (NPS)

Operated by the U.S. government, the NPS is at the forefront of preserving and promoting the history, culture, and environment of the United States. The NPS also contributes to the furthering of education for future generations through educational programs, as well as conservation efforts such as promoting discussions of the impacts of climate change on protected areas (U.S. Department of Interior, 2015). Building communities, spreading education, and preserving land and culture are the major contributions made by all national parks across the United States.

2.2 Glacier National Park

Located in northwestern Montana, GNP is on the Canada–United States border. Established by Congress on May 11, 1910, GNP is the 10th national park created in the United States. In 1932, GNP was merged with Canada's Waterton Lakes National Park to become the Waterton-Glacier International Peace Park, the world's first international peace park (NPS, 2016).

GNP is named after its prominent glaciers and known for its peaks and forests. The park is home to a variety of wildlife, including the bald eagle, gray wolf, wolverine, cougar, and especially grizzly and black bears. Efforts to ensure a clean environment and support habitats with diverse wildlife have been adopted, attracting many visitors to GNP (NPS, 2016).

GNP receives millions of visitors throughout the year. During 2019, over 3 million people visited the park, with two-thirds of the visitors coming in the summer months of June, July, and August (Figure 1; NPS U.S. Department of the Interior, 2020). As expected for a region that hosts millions of visitors, the regions surrounding the park earn significant revenue from visitors traveling to GNP (see Figure 2). Overall, in 2019, the nearly three million visitors to GNP spent an estimated 344 million dollars in local gateway regions while visiting the park and local areas (NPS Social Science, 2018). As shown in Figure 2, hotels, restaurants, and groceries were the top 3 revenue sources for local businesses.

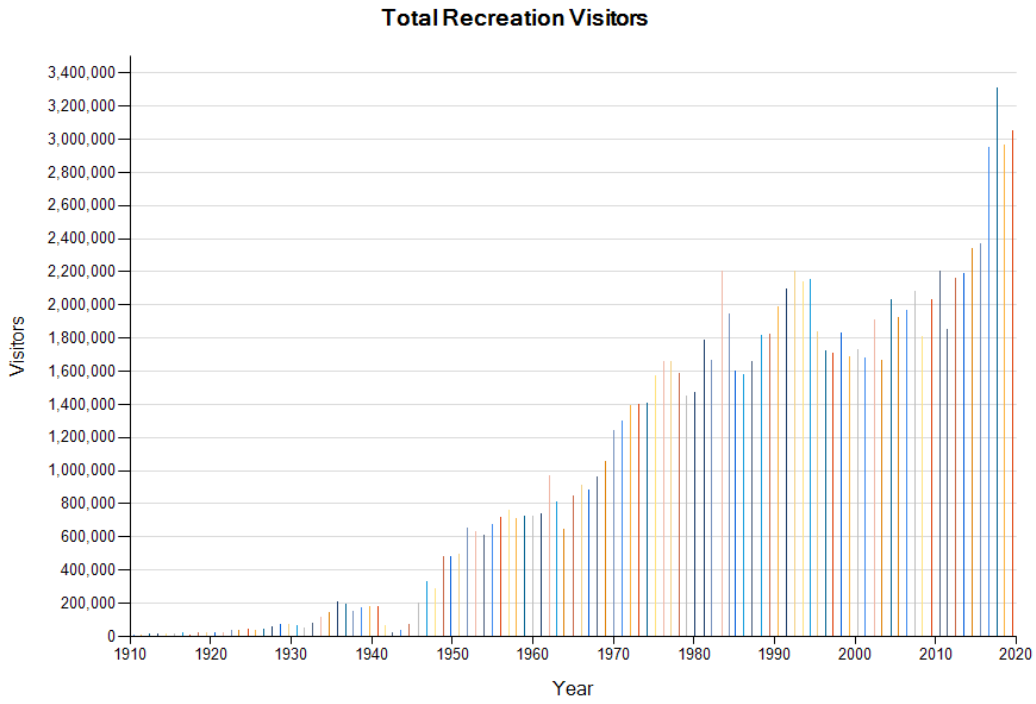


Figure 1: Annual GNP recreation visits from 1911 to 2019

(NPS U.S. Department of the Interior, 2020)

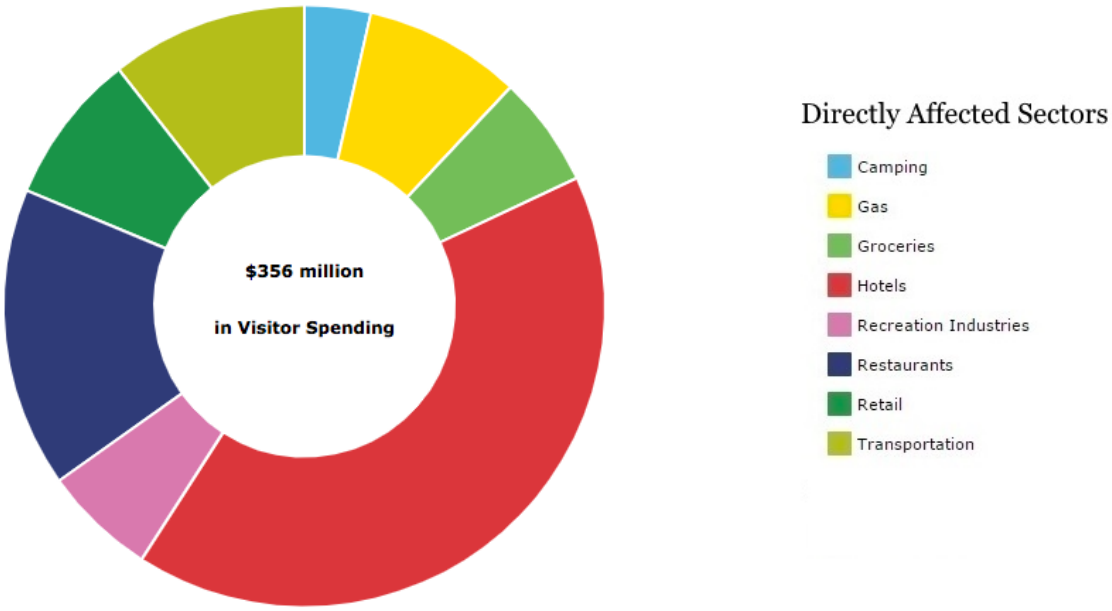


Figure 2: Total amount of visitor spending in local regions while visiting GNP in 2019

(NPS Social Science, 2018)

2.3 The Process of Recycling and Diversion Rates

Recycling is the process of repurposing old waste products to manufacture new products, preventing the waste from ending up in a landfill. This prevention of waste into landfill is also known as a diversion rate. While recycling was practiced for centuries due to shortages of goods during wartime periods, it reached the national level starting in the 1960s to conserve energy and resources and to decrease dependence on landfill space. The National Environmental Policy Act, passed by Congress in 1969, marked when recycling became a part of the conservationist national agenda (U.S. EPA., 2005). In 1970, recycling became part of a national waste management policy when the Resource Recovery Act was enacted as an amendment to the Solid Waste Disposal Act of 1965 (U.S. EPA., 2005). As municipal solid waste generation started to rise exponentially, the Resource Recovery Act was created to divert this waste from landfill by advocating for recycling (U.S. EPA., 2005).

Despite this, recycling was not an appealing process for many throughout the 1970s. For solid waste management organizations, it was a disturbance to their operation and their sanitary conditions (U.S. EPA., 2005). Additionally, recycling was thought to be a nonviable option due to little economic gain (U.S. EPA., 2005). To increase interest, incentives were given through the promise of federal assistance for the marketing and technical issues that would arise when recycling municipal solid waste (U.S. EPA., 2005). Advocacy became crucial due to the voluntary nature of recycling both for businesses and on an individual level. Widespread recycling efforts began in the United States when The Environmental Protection Agency (EPA) was established in 1970 and advocated for further environmental concerns (U.S. EPA., 2005). By 1980, the country's first curbside recycling program was created in Woodbury, New Jersey (Eschner, K., 2017).

To understand the challenges of recycling, it is important to first understand how it works, as well as understand how to quantify the effectiveness of recycling using data. One method of doing this is to conduct a waste audit, which involves breaking down the composition of a waste stream into its different categories and comparing them. This data can then be used to determine the waste diversion rate and gain a deeper understanding of the recycling needs for a given waste stream.

Various recycling processes are involved with different types of waste (e.g., paper, plastic, and glass). Each process requires specialized facilities, staff, and equipment. This can sometimes create limitations in what kinds of waste products can be recycled in areas that lack access to the necessary infrastructure.

The following is a brief description of the recycling process (Figure 3) for each type of waste and the diversion rate process:

Paper - Before being processed, paper is sorted into five different categories: corrugated cardboard, mixed paper (magazines, phonebooks, mail, etc.), newspaper, high grade deinked

paper, and pulp substitutes. After paper is sorted, it is shipped to a paper mill, where it is shredded and broken down into fibers by a chemical process. The resulting pulp is filtered to remove adhesives and ink and then pressed into the final product (Sukalich, 2016). Mixed paper recycling is currently offered within GNP.

Plastic - There are seven types of recyclable plastic. Denoted as #1-#7, these are polyester, high-density polyethylene, PVC, low-density polyethylene, polypropylene, and polystyrene, respectively. Number #7 plastic is reserved for miscellaneous types, such as mixed or bioplastics. Plastics must be sorted and washed before being processed, and each type is processed differently. During the processing, plastic products are shredded into small pellets that are melted and extruded into raw material that is ready to be used in the production of new plastic products (Compactor Management Company, n.d). Most plastics of types 1 and 2 are currently being accepted for recycling by GNP and shipped to a company called Valley Recycling to be processed.

Figure 3: Recycling Process Flowchart

(Association of Plastic Recyclers, 2020)

Metals - Like other recyclable goods, collected metals must first be sorted before they can be processed. Sorting is done by separating steel with a magnet, while aluminum, copper, and other metals are separated by hand. The sorted metals are shredded, melted, and cast into ingots. The ingots are then rolled into sheets that are used in the production of new goods, such as aluminum cans (Goldberg, B., 2015). GNP accepts aluminum recycling from visitors, which is then sent to Pacific Steel & Recycling.

Glass - While some glass materials are not recyclable (e.g., mirrors, ceramics, heat resistant glass cookware, and lightbulbs), most types of glass are recyclable. At a glass processing center, glass products are cleaned, sorted, and crushed into a fine raw material called glass cullet. The cullet is melted down to make new products or be sold for use in other applications (Paynter, M., 2018). Glass recycling in GNP is limited to park staff only, meaning visitors can only dispose of glass in trash bins. The recyclable glass is sent to Flathead Recon to be recycled.

With the differences between recyclable materials in mind, data collection occurs through the process of a waste audit. By identifying the amount and type of waste generated in an organization, a waste audit is used to create a baseline for comparison to determine the effectiveness of a waste management system. Information obtained from an assessment of waste stream characteristics can determine an organization's current waste diversion and recycling rates. Such an assessment can also provide insight into visitor practices on proper waste management. There are no recent assessments conducted on waste stream characteristics in GNP (Eaton, J., 2020). The waste audit process is explained based on a template developed by the non-profit organization, Recycle Across America. It begins with the organization of the waste into different categories such as organics, recyclables, and trash, weighing each respectively (see Appendix A) (Recycle Across America, n.d.). Gathering this information can help locate popular bin locations and help understand visitor behaviors, thereby seeing where improvements to the existing recycling program can be made. Finally, conducting audits can help lower organizational spending by decreasing waste disposal costs as well as re-prioritize purchasing (U.S. EPA., 2016).

2.4 Recycling Initiatives and Regulations

In 2016, the National Parks Conservation Association (NPCA) developed a plan, called the Zero Landfill Initiative (ZLI), to significantly reduce waste in three pilot parks: Denali National Park, Grand Teton National Park, and Yosemite National Park (NPS., 2017). Its goals include reducing the waste generated in parks and recyclable materials from reaching landfills. This goal was carried out by understanding visitor behaviors in order to identify and implement strategies that reduced the amount of waste generated within parks.

Since starting the initiative in 2016, the three parks have managed to collectively reduce the waste going to landfills by 32% (Hevel-Mingo, K., 2018). Four million pounds of waste was either composted or recycled. The reduction also occurred due to conversion from paper to online maps of recycling locations, as well as the reuse of bags and bottles (Hevel-Mingo, K., 2018). In addition to these three national parks, Yellowstone National Park also has a strong recycling program; in 2018, composting and recycling initiatives were undertaken by park staff, visitors, and partners, diverting 51.6% of waste from landfills (NPS, 2019).

In the United States, there are no federal laws that mandate recycling. Recycling laws, such as bans on hazardous waste disposal and mandatory recycling requirements, are generally put in place by local and state governments. Only 22 states have at least one mandatory recycling requirement, with Montana being the only state that does not have any laws or requirements for the disposal of hazardous waste (Northeast Recycling Council, 2017). While the federal government does not impose recycling mandates at the national level, all federal agencies, which include the NPS, are required to implement a recycling and waste prevention program.

Although recycling is not mandatory in Montana, the 1991 Montana Integrated Waste Management Act established a policy of source reduction and prevention of environmental impacts. The Montana Integrated Waste Management Act is illustrated in Figure 4. It is based on a hierarchy of waste management priorities, beginning with (1) source reduction, (2) reuse, (3) recycling, (4) composting, and (5), landfill and incineration (Montana Department of Environmental Quality, 2018).

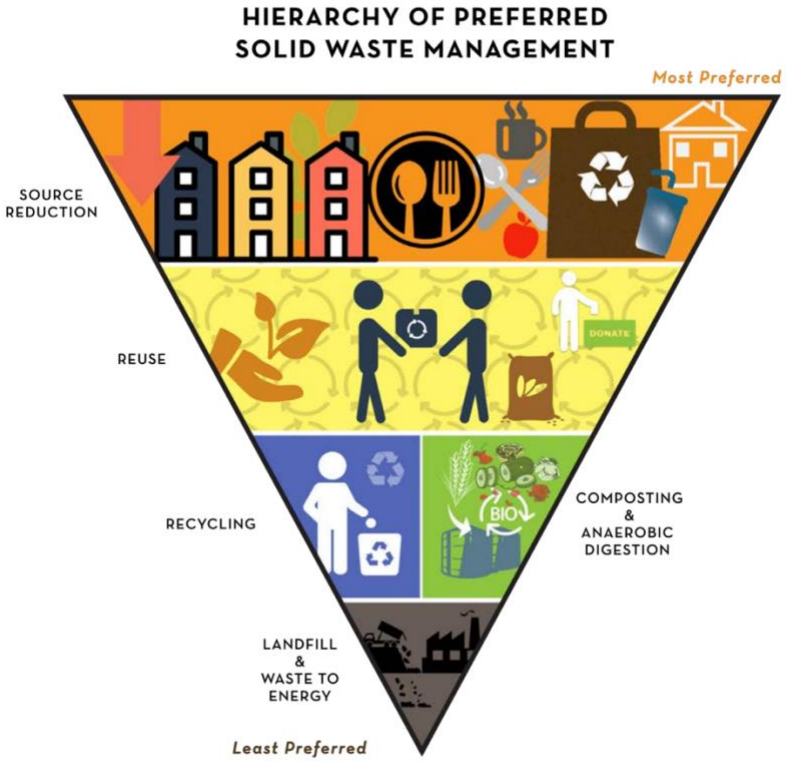


Figure 4: Preferred Methods of Solid Waste Management
(DC Department of Public Works, 2017)

2.5 Recycling Program Within GNP

GNP's recycling and waste management program focuses on efforts to reduce, reuse, and recycle waste generated by park visitors. Despite this focus, in 2018, only 19% of GNP's waste was diverted from landfill, which is more than 45% lower than the NPS annual waste diversion goal of 65% (NPS, 2020). Additionally, the GNP sustainability plan, which outlines the park's sustainability goals, includes objectives such as enhancing messaging throughout the park, improving visitor facing recycling, and implementing a new sustainability position within the park (NPS, 2020). Moreover, the park plans to reduce 30% of the greenhouse gas emissions per mile traveled for vehicles and increase the recycling of electronics and hazardous waste to promote solid waste diversion (NPS, 2020).

However, there are several issues facing GNP and its plan to increase waste diversion rates. One is the availability of composting. GNP currently does not offer composting in the park, other than for staff at the lodges in partnership with Xanterra Travel Collection, a company associated with the NPS (GNP, 2016). When compared to Yellowstone National Park's diversion of 18% of waste away from landfills through composting in 2017 (NPS: U.S. Department of the Interior, 2017), GNP has no composting system, which contributes to a significant amount of waste that is not being diverted within GNP. GNP also faces the issue of glass recycling, as the only glass recycling contractor left the area in 2018. A new company called Flathead Recon has since been accepting small amounts of glass recycling from GNP staff at a rate of $0.25 per pound (NPS, 2020).

Currently, the park recycles mixed paper, cardboard, and aluminum. Other items such as batteries, CFL light bulbs, and bear spray can be recycled in the park, but there are limited collection locations in the park for these streams due to the difficulty in recycling them (NPS, 2020). Recycling in GNP is particularly complicated as the recyclables within the eastern part of the park must be transported to the western side via the Going-to-the-Sun-Road. The five major campsites located in the eastern part of the park results in a large amount of waste being generated in the east, with no easy way to dispose of it unless it gets to the western portion of the park. As recyclable materials are collected in different parts of GNP (Figure 5), a more streamlined system needs to be in place.

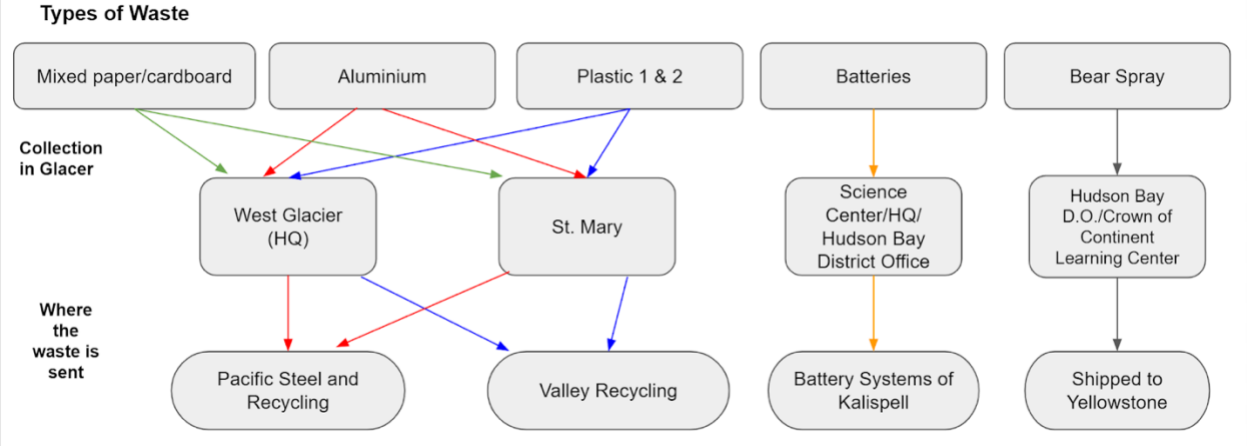


Figure 5: Current flow of waste within the park and where it is sent.

(*Recycling Guide for 2020*, 2020)

GNP focuses not just on recycling, but also engages in other environmentally conscious programs, such as the Leave No Trace initiative (NPS, 2019). The purpose of this national initiative is to protect the nation's natural lands and reduce the carbon footprint through guidelines designed for visitors to follow within the park. The guidelines include encouraging visitors to use reusable dishes and water bottles, along with eco-friendly means of travel such as biking, walking, and utilizing the park's free shuttle (NPS, 2019). Another initiative in GNP, which stems from the LNT program, is to make sure that visitors are responsible for their disposal of waste brought to campsites and establishing a "pack it in pack it out" policy for waste. Irresponsible waste disposal, such as littering, creates a hazard towards the environment and can lead to damaging effects regarding wildlife (NPS, 2019).

2.5.1 NPS Diversion Rate Goal

To increase the current rate of diversion of solid waste from 18% toward the NPS goal of 50%, the park strives to improve recycling and waste management (GNP Conservancy, 2018). The park has non-interactive maps containing amenities and hiking trails, including toilets, backcountry campgrounds, creeks, roads, and trails, but does not have an interactive map locating existing recycling bins (Figure 6; NPS, 2016).

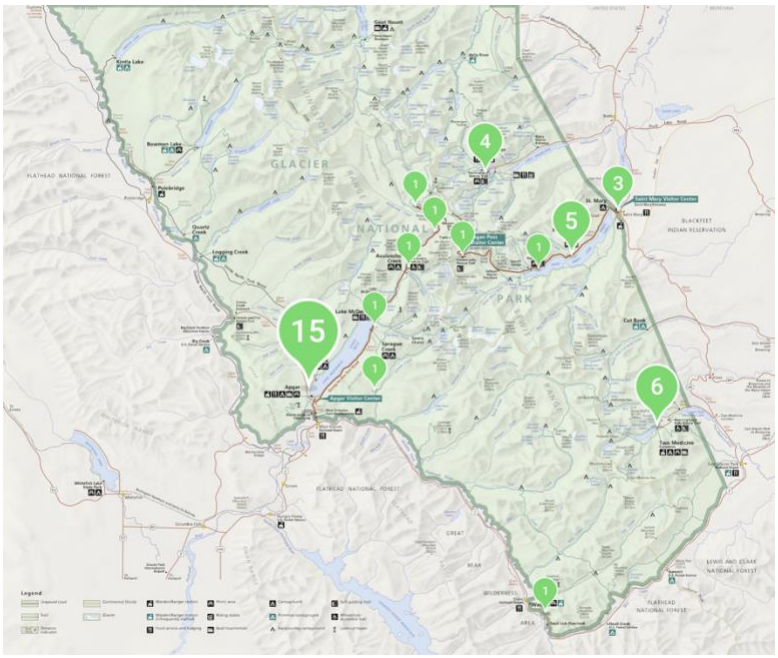


Figure 6: Current locations of 41 of the 43 recycling bins in GNP

(Glacier National Park Map, 2019)

2.6 The Psychology of Recycling

An effective waste disposal system can function only if the users are utilizing the system properly. To encourage good recycling practices, understanding the motivations and challenges of the users is important. Doing this would also help understand the motives behind people's choice not to recycle, providing insights on how to effectively change people's actions. Additionally, utilizing specific studies that evaluate visitor behaviors within national parks will allow us to make recommendations to improve individual waste disposal choices in GNP.

The first step in persuading people to adopt and persist in responsible behaviors is understanding why they behave a certain way. People recycle because they feel a sense of responsibility to care for their environment. However, there are several barriers that can prevent people from recycling. These barriers can be put into three categories: (a) individual-based - laziness and lack of care outweigh concerns, (b) responsibility - are environmental concerns a person's responsibility or is it that of others, and (c) practicality - the issue of personal physical limitations (lack of storage space and time) (Nixon, H., & Saphores, J. M., 2009). By overcoming these barriers, individuals will be more likely to recycle. The individual must be able to recognize that recycling is an important commitment.

Several conceptual frameworks can help clarify these behaviors of people. For example, The Theory of Planned Behavior (TPB) provides a framework for understanding and predicting human behavior. It addresses three aspects of human behavior: attitude, subjective norms, and perceived behavior control (PBC) (Miller, Z. D., Lawhon, B., Taff, B. D., Schwartz, F., &

Newman, P., 2019). Attitude suggests whether the activity is pleasant or unpleasant. Subjective norms measure a person's perception of the appropriateness of the performance of a behavior. Lastly, perceived behavior control measures whether someone thinks they can execute the behavior. This explains how people behave based on their interests and the amount of effort needed to execute the task. In a study conducted on recycling motivators, planned behavior control was found to be the strongest predictor of recycling behavior (Onel, N., & Mukherjee, A., 2017).

While getting individuals to change their actions is a challenge, it is possible to increase recycling behaviors when they are given the right information. A study conducted on identifying strategies to promote recycling indicated that individuals who are given information by five and six sources were 3.73 and 4.44 times more likely to recycle, respectively (Nixon, H., & Saphores, J. M., 2009). Thus, the most effective way to promote recycling is through the presentation of multiple sources of information.

Recycling messaging can also contain various types of information. Some types of messages are designed to appeal to a person's emotions; this kind of message is an attempt at persuading through guilt to get them to recycle and can be effective in proper disposal. However, other research suggests that messages pertaining to the future of recyclable objects is a more effective way to promote recycling (Delaney, R. 2019). In 2019, Boston College did a study during a football game tailgate. Half the crowd was given a general recycling message while the other half were given a message detailing how the recyclable products can be used in the future (Delaney, R. 2019). It was found that those given a message regarding the future were 38% more likely to recycle than those given a general recycling message (Delaney, R. 2019).

While much of these efforts and observations have been made on recycling in general, very few studies and programs examine the psychology of recycling among visitors in national parks. Those that do examine the psychology of recycling within national parks rely on the Zero Landfill Initiative (ZLI) for their data. For example, in a study by Miller, Lawhon, Taff, Schwartz, & Newman (2019), variables associated with TPB as well as self-efficacy, difficulty, and moral norms were considered as factors influencing intentions of visitor's behaviors in the three ZLI parks: Yosemite National Park, Grand Teton National Park, and Denali National Park (Miller et al., 2019). This study found that two behaviors were significant in the prediction of behavioral intention – the convenience of recycling practices and moral norms regarding proper recycling, meaning a visitor's perception of what is socially appropriate for recycling practices (Miller et al., 2019).

Another study using ZLI data was focused on predicting the factors that influence proper waste disposal. The study utilized variables such as group size, perceived gender of the user, presence of children in the group, interaction with the receptacle sign, confusion about how to properly dispose of the waste, and proper disposal of waste (Mateer, T. J., Taff, B. D., Miller, Z.

D., & Lawhon, B., 2020). It was found that group size and gender do not significantly determine proper disposal (Mateer et al., 2020). However, the presence of children in the group, visitor interaction with the signs such as taking a pause to read them, and confusion on how to properly dispose of the waste significantly determined the practice of proper waste disposal or a lack of it (Miller et al., 2019). The study found that individuals with children were 1.51 times more likely to dispose of waste properly (Mateer et al., 2020). Only 31.2% of visitors interacted with the recycling signage. However, those that did were 1.25 times more likely to properly dispose of the material. Lastly, 91.2% of visitors did not appear confused about proper waste disposal. Those that did not appear confused were found to be 2.68 times more likely to dispose of the waste responsibly (Mateer et al., 2020).

Considering the findings of previous research, there are many factors to motivate incoming visitors to engage in waste management and sustainability efforts. These factors include targeting children for proper waste disposal, interaction with signage, and minimal confusion on available recycling amenities. Taking advantage of visitors' ethical obligations and guilt likely associated with the future generation and sustainability can be employed throughout the promotion of disposal (Mateer et al., 2020). Similarly, utilizing well-designed signage is another approach to increasing proper waste disposal. Such signage should be clear, easy to grasp, and readable. This includes positive reinforcement in advertising as an effective strategy for proper recycling. Overall, providing information on different aspects of a person's surroundings and knowledge can greatly influence visitors' likelihood of proper disposal. By understanding the behavioral intent and actions of visitor recycling practices, different programs and recycling techniques can be chosen as effective strategies.

2.7 Potential Strategies to Increase Recycling

Through correspondence with project sponsors at GNP, there are several key areas established which need improvement within the park. These areas include the availability of recycling information for park visitors as well as the lack of outreach and education for recycling in the park and online. The following section is an overview of recycling strategies that have been identified as potential ways to address these key areas.

2.7.1 Education/Outreach

The understanding of human behavior can inform the employment of technology to improve recycling. As mentioned previously, the lack of information can result in poor recycling practices. Through education, people can be informed about the recycling program in GNP. Pamphlets, online resources, and word-of-mouth can inform individuals about proper waste disposal. Yellowstone NP works closely with concessioners to develop strategies to inform the visitors on the impact of their purchases, as well as point them towards an eco-friendly option (NPS U.S. Department of the Interior, 2011). To better inform visitors on proper waste disposal,

GNP can also provide maps, paper, or online, to indicate where bins are located and what waste is accepted at each location.

Online resources, such as webpages and social media platforms, can be used to educate visitors about ways in which they can support the park's sustainability goals. These resources can also be used as effective tools for visitor outreach. The use of social media can distribute messaging and information across a wide, targeted audience, and can also be used to gather valuable data about these demographics using surveys. Qualtrics is a platform used to create surveys that can be easily shared online; through the use of Qualtrics, survey data can be collected from park staff, as well as park visitors, and evaluation of this data can reveal which areas of knowledge are currently lacking in the park's outreach efforts, and solutions can then be developed accordingly.

2.7.2 Web Analytics

By compiling waste management and sustainability information into one accessible location on GNP's website, visitors would be more likely to see this information when planning a trip to the park. However, the web analytics of the website's recycling and sustainability pages must be analyzed to determine if those specific webpages are heavily trafficked or not to understand how effective the outreach is. Using Google Analytics, all the website's trafficking data can be seen. This includes the number of users and sessions, the duration users stayed on the page, where the website was being accessed from, and the path of the user through the website pages, among other data. The analysis of this data will help determine if adding information to the website will be effective in getting the information out to visitors, as well as see what the busiest parts of GNP's website are in order to locate the best spot for recycling and sustainability information.

2.7.3 ArcGIS

Along with the recycling and sustainability information on GNP's websites, interactive maps through the ArcGIS platform are a way to increase outreach and available information. ArcGIS is used to create and manage data, which can inform map creation. Specifically, ArcGIS Online is a collaborative web system that allows the user to create and share multiple types of content. This content includes maps, scenes, apps, layers, analytics, and data. Information such as the locations of recycling bins, water-bottle filling stations (Figure 7), and general aspects of the park, such as campgrounds and lodges, can be transposed into an ArcGIS map to allow for easy accessibility of resources. Additionally, future park sustainability plans can be determined and implemented into an ArcGIS map such as locations for electric vehicle charging centers, and propane refilling stations for the future. By utilizing ArcGIS in maps, GNP has a tool to better inform visitors of important aspects of the park as well as to increase proper waste management.

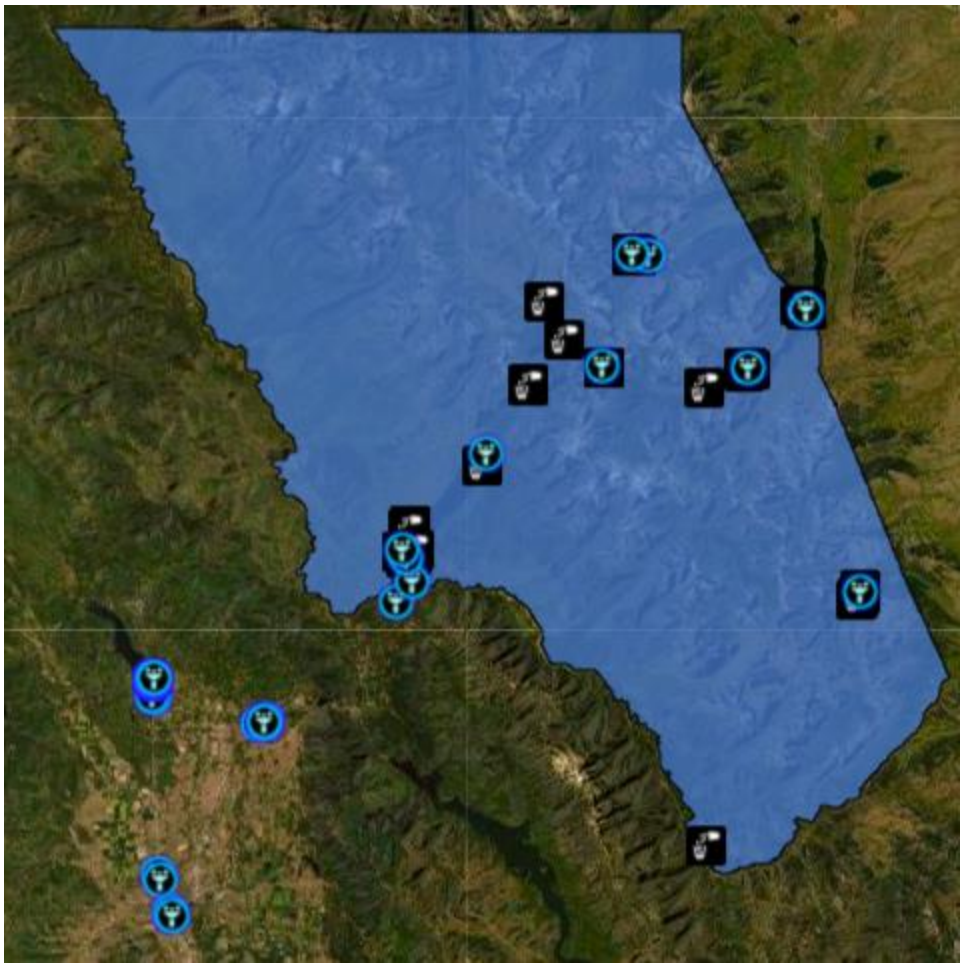


Figure 7: Location of the water-bottle filling stations and recycling bins in GNP (Glacier National Park Promotes Water Bottle Filling Stations to Reduce Plastic Waste, 2019)

3. Goals and Objectives

The goal of this project was to conduct a comprehensive analysis and assessment of the current recycling information and outreach systems for the GNP waste management system and, subsequently, to develop a set of specific recommendations to help improve the park's ability to reduce, reuse, and recycle waste. To achieve this goal, the project focused on two objectives and their corresponding research questions:

1. Identify methods GNP could adopt to encourage and inform visitors on proper recycling and sustainability practices.
    a. What are the current practices implemented by GNP to promote pro-environmental behaviors both in GNP and online?
    b. What motivates people to recycle?
    c. What are successful programs about advertising recycling and proper waste disposal?
    d. What are the best ways to distribute pre-trip information?
2. Develop a pre-trip resource to educate visitors on GNP recycling and sustainability practices.
    a. Is the current GNP recycling and sustainability outreach system an effective method for promotion/education?
    b. In what ways can the current GNP online information be improved?
    c. What is the critical information that visitors should have before visiting GNP and make the most impact on park recycling efforts?
    d. How can a pre-trip resource be developed to encompass the needs of GNP?

The following section describes the methods that we proposed to use to address the two objectives and their associated research questions.

3.1 Methods

<u>Objective 1:</u> Identify practices that GNP can adopt to encourage and inform visitors on recycling and proper waste disposal.

What are the current practices implemented by GNP to promote pro-environmental behaviors both in GNP and online?

To make recommendations for improvement, we understood the current practices implemented by GNP to promote pro-environmental behaviors both in GNP and online. This includes park management plans, foundation documents, and other data. With this information, we developed an understanding of GNP's efforts to publicize its current recycling program. Moreover, we conducted personal interviews with Tara Carolin, the Director of Crown of the Continent Research, Ginger Rigdon, as well as surveying park staff. Through interviews and surveys, we received information that was not provided through GNP's online resources.

What motivates people to recycle?

To better understand the improvements needed in the park, we needed to understand what motivates people to recycle. Investigating the motivations for visitors' recycling behaviors helped to identify the best ways to inform the public on recycling practices in GNP. This required us to analyze research documents on pro-environmental behaviors towards recycling through content analysis. This allowed us to explore visitor perceptions on recycling as well as understand the impacts of recycling on visitors. Information on what prevents visitors from properly disposing of waste, whether due to promotion, signage, or location, was obtained through content analysis.

What are successful programs about advertising recycling and proper waste disposal?

By focusing on comprehensive documents of successful recycling programs, valuable information on pro-environmental strategies was obtained. These strategies included promotion, education, and website design. Research on comprehensive solid waste management plans was done in order to identify evidence-based practices to increase waste diversion rates. For example, background research was conducted on the strategies and effectiveness of the Zero Landfill Initiative (ZLI), which had been adopted by Denali, Yosemite, and Grand Teton National Parks (NPS., 2017). This allowed us to formulate our strategies based on their best practices. Information regarding promotion and design helped the team develop a plan on how to enhance the availability of sustainability information outside of the park before visitors arrive. The utilization of ZLI documents and other established plans based on Montgomery County, MD, or Phoenix, AZ which were determined successful by the EPA, allowed us to make inferences to determine effective methods to adopt in GNP.

What are the best ways to distribute pre-trip information?

The best ways to distribute pre-trip information were established through a comparative analysis of other parks and successful sustainability plan in conjunction with park visitor and park staff surveys. This analysis was performed to learn the best way to communicate pre-trip information to visitors. This study involved the use of academic journals and articles to understand pre-trip information, resources, and how to advertise recycling in a positive and effective manner. This allowed us to proceed with multiple options for resource development. Surveys distributed both to park staff and park visitors also collected data regarding the best method to distribute pre-trip information, along with what the most important content to include is. These options were evaluated in conjunction with a GNP visitor and staff needs assessment to understand the target audience.

<u>Objective 2:</u> Develop a pre-trip resource to educate visitors on GNP recycling and sustainability practices.

Is the current GNP recycling and sustainability outreach system an effective method for promotion/education?

To recommend and develop a pre-trip resource for GNP to increase sustainability awareness, we first acknowledged the effectiveness of the current outreach system. Data from 2018 and 2019 were collected through web analytics of multiple pages from the following national park's websites: Glacier, Denali, Grand Teton, Yosemite, and Yellowstone. This data included page views, number of unique user sessions, bounce rates, as well as the average time users spent viewing certain pages. Analysis of this data allowed us to quantifiably compare the effectiveness of GNP's sustainability outreach to that of other parks. By cross-analyzing the outreach methods of GNP with these other parks, we were able to identify aspects that may result in higher web traffic on some park's websites compared to others. Additionally, this data was compared to the park's visitation numbers from 2018 and 2019 to identify correlations between web traffic and the number of visitors to the parks.

In what ways can the current GNP online information be improved?

A needs assessment was conducted to gain a deeper understanding of specific areas that need to be improved regarding the availability of recycling information at the park. By surveying park rangers and other employees, we collected comprehensive data specific to the issues at GNP. This survey allowed us to find out what questions were most frequently asked by park visitors regarding recycling and highlighted which areas of communication needed the most improvement. Additionally, we were able to obtain information on the pre-trip resources currently available to visitors and the limitations which can be improved further.

To understand how the online information GNP currently has can be improved, website analytics data for recycling, sustainability, and other webpages from several parks (Denali, Grand Teton, Yosemite, and Yellowstone) were examined. This data was analyzed along with the content and format of each page from each park through comparative analysis. The statistics were studied concurrently with the webpage format and content. We were then able to find correlations between traffic, time spent, and the rate at which users leave a page and the features that a webpage has. This determined which park had the most effective sustainability outreach online. This information was then applied to GNP's pages to optimize the traffic flow and the time spent.

What is the critical information that visitors should have before visiting GNP and make the most impact on park recycling efforts?

Using survey data and cross-analysis, we developed an understanding of what information GNP needs for an improved resource to inform prospective visitors of sustainability at GNP. Survey data from visitors and staff were used to determine what pre-trip information reaches visitors as well as what critical pre-trip information is missing. This allowed us to determine GNP's outreach needs to increase its sustainability efforts.

Relevant webpage content and features from other national park's websites were also gathered and compared to that of GNP's website to gain a deeper understanding of the effectiveness of online sustainability outreach. We collected information regarding the number of hyperlinks present in a page, the use of bullet points, how the information is presented, clickable banners, videos, and pictures. We also considered how navigable the pages are from the website's home page. The other parks—Denali, Grand Teton, Yosemite, and Yellowstone—have very high waste diversion rates compared to other parks. All these parks, except for Yellowstone, are part of the Zero Landfill Initiative, and subsequently, have a strong online presence in terms of promoting their sustainability programs. A cross-analysis of the data from these parks with data from GNP was used to find correlations between online outreach strategies and higher diversion rates in the parks.

How can a pre-trip resource be developed to encompass the needs of GNP?

To develop a pre-trip resource to encompass all the needs of GNP, rapid prototyping was conducted. Rapid prototyping is a technique used to create a model for which a product concept can be pitched. For our pre-trip resource, rapid prototyping with the inclusion of the analyzed survey data and ArcGIS was created. We prototyped an interactive online resource that includes the locations of recycling bins, which materials are accepted, trash receptacles, water bottle refilling stations, electric vehicle charging centers, campgrounds, as well as planned future projects in the park. Additionally, the utilization of known strategies to increase proper waste disposal was implemented as well through the analyzed case studies, content analysis, survey data, and comparative analysis. These research methods were used as tools to create a pre-trip resource prototype.

4. Results and Discussion

4.1 Introduction

In this section we discussed our findings, their significance, and the recommendations we have developed based on conclusions drawn from data and research. Our results include survey data from both park staff and visitors, visitor feedback, web analytics, and comparative analysis between GNP's website and the websites of other parks with higher diversion rates. Using these findings, we were able to develop recommendations for each of the following categories: (1) On the ground, focused on recycling education methods for visitors at GNP, (2) Pre-trip, focused on outreach resources for visitors planning a trip to the park, and (3) Online, focused on making sustainability and recycling information more available and informative to users of the park's website. Each category is broken down into primary and secondary recommendations based on which ones we believe will be more effective at improving recycling in GNP.

4.2 Results

4.2.1 Understanding Outreach

To understand the design and structure of the recycling outreach, we determined the best visual aspects of signage to promote recycling based on a study discussing the design of waste disposal signs and how it can influence waste disposal behavior. Specifically, it was found that the consistent signage is an important ergonomic and efficient feature (Wu, D., Lenkic, P., DiGiacomo, A., Ceh, P., Zhao, J., & Kingstone, A., 2018). The lack of consistency can cause confusion and increased improper sorting (Wu et al., 2018).

Another study focused on understanding what type of waste disposal information should be presented and how it should be presented. The effects of how complex, concrete, or familiar the signs were determined visual characteristics that could be utilized to predict the performance of waste sorting (Wu et al., 2018). Through multiple experiments with signs displaying words, different types of images, as seen in Figure 8, it was found that pictures and icons are more efficient in promoting proper disposal than solely word signs, with 75.9% accuracy for pictures and 75.2% accuracy for icons while words only had 70.2% (Wu et al., 2018).

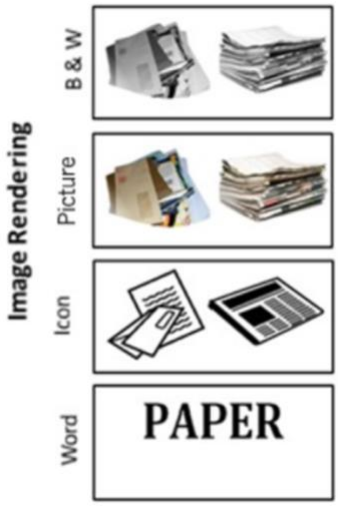


Figure 8: Example of each image rendering for signs
(paper waste category) (Wu et al., 2018)

It is also understood that increased sorting efficiency means improved accuracy and reduced response time, proper disposal, and a potential lowering of ecological footprint (Wu et al., 2018). The higher the proper disposal, the more reduction in contamination in waste streams, e.g. composting, recycling, and garbage disposal. Less contamination means more waste diverted from landfill and more reusable materials. Lastly, as seen in Figure 9, adding prohibited items did not improve or influence proper disposal decisions (Wu et al., 2018).

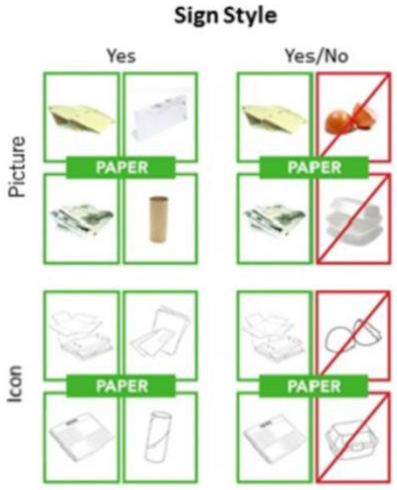


Figure 9: Example of each sign style depending on image
rendering and prohibition of items (Wu et al., 2018)

Other research found that in order to increase consumer recycling, the promotion of product transformation salience can be employed. Product transformation salience can be defined

to help consumers consider the future of recyclables and how they can become new products. Promoting product transformation salience can inspire consumers to aid in achieving the shared goal and recycle more (Winterich, K., Nenkov, G., & Gonzales, G., 2019).

Six studies were conducted to test the legitimacy of the transformation of recyclable into new products and their effects (Winterich, K. et al., 2019). In one study, it was found that participants who saw a recycling message involving the recycled material being turned into the same product recycled more than those that reviewed a generic recycling message with no transformation details, as seen in Figure 10 (Winterich, K. et al., 2019). When participants were asked to dispose of scratch paper, those that got a transformation message about it being recycled into more paper or turning into a different product such as a guitar, recycled 80.5% and 79.1%, respectively (Winterich, K. et al., 2019). That is almost 30% more than those who received the generic message without product transformation at 50.9% (Winterich, K. et al., 2019).

Figure 10: Examples of a control group, product to same product transformation, and product to different product transformation salience advertisements (Winterich, K. et al., 2019)

Additionally, a second study was conducted in which 87.7% of participants recycled when a company had advertisements regarding products made from identified recycled items (Winterich, K. et al., 2019). The participants that viewed advertisements for products that solely mention the company's involvement in recycling practices recycled only 71.7% of the time (Winterich, K. et al., 2019). The fourth study followed tailgating fans. It found that tailgating fans recycled 58.1% of their waste when relayed the message of what products the recyclables could be turned into for future use (Winterich, K. et al., 2019). In comparison, only 19% of fans recycled their waste when told only what could be recycled (Winterich, K. et al., 2019). Lastly, an audit was conducted within two university residence halls waste collection station. One floor contained signage which included information on products created from recyclables, while the other floor did not. It was found that 51.5% and 62.9% of the waste going to the landfill could have been recycled, respectively

(Winterich, K. et al., 2019). This suggests that the messages involving transformation caused an increase in recyclable material being placed in recycling bins (Winterich, K. et al., 2019).

One study measured the effects of multiple marketing and awareness strategies to reduce recycling and waste in the residence halls of the University of Wisconsin-Whitewater. The study examined passive marketing strategies, educational programming, social media, and Eco-Representatives (Eco-Reps) ambassador program and their impact on waste minimization. They found that the most effective strategy was their Eco-Rep Program. The Eco-Reps were sustainability ambassadors within the residence halls, and had responsibilities such as three program events, three poster campaigns and bi-weekly meetings to update their progress with the Sustainability Coordinator (Marks., K., 2013). It was found that Eco-Reps were extremely successful in increasing the percentage of recycling comparative to the total waste as well as recycling behavior (Marks, K., 2013). Compared to the past three years, there was an 11.6%, 0.31%, and 6.03% increase in recycling, trash, and total waste respectively for the Eco-Rep program (Marks, K., 2013). The control group was found to have a 7.39%, 3.51%, and 5.29% increase in recycling, trash and total waste respectively compared to the last three years (Marks, K., 2013). They found the Eco-Reps and their methods created a decrease in the amount of trash within and the sustainability ambassador strategy was most effective in minimizing their waste.

4.2.2 National Park Programs and Current Outreach Systems

To determine the existing sustainability outreach practices in place within the park, we assessed GNP's current implementation of these resources through interviews and research. It was found that GNP's on the ground sustainability outreach utilizes signage for waste receptacles, printed visitor guides, and informational booklets in the lodges.

Recycling and trash receptacles throughout the park contain signage with guidelines on what types of waste can and cannot be recycled in them. GNP is in the process of updating this signage in cooperation with Recycle Across America, and the new designs are shown in Appendix F (Eaton, J., 2020).

Printed visitor guide booklets are handed out at the park entrance and contain some sustainability information regarding the preservation of the park as well as locations of recycling bins and water filling stations. However, it was determined that of the 15 water refilling stations throughout the park, only seven areas are specified where they can be located. Six locations are mentioned for locating recycling bins, but the guide does not specify the total number of bins in the park (43). The guide also contains a map of the park, but it does not contain the locations of recycling bins or water filling stations. In addition to this, each room in the park lodges contains an informational booklet provided by Xanterra. This booklet has a page regarding sustainability, which outlines Xanterra's sustainability goals and includes a brief section of recycling guidelines and practices.

National parks with high waste diversion rates have successful recycling and sustainability programs. Grand Teton, Yosemite, and Denali National Parks have partnered with Subaru to implement the Zero Landfill Initiative (ZLI) to help them all increase their diversion rates. This is done through different means of promoting sustainability and recycling, as well as increasing its capacity to recycle waste (Miller et al., 2019).

With funding from the ZLI, Grand Teton has created multiple projects spread throughout the park. This includes a composting pilot program, new recycling infrastructures, a partnership with Teton County Integrated Solid Waste and Recycling, as well as an art installation to visualize park recycling data (Grand Teton National Park, 2020). Grand Teton also provides information on how to make your trip as sustainable as possible with a "Green Your Visit" page. This page includes tips for a "green" visit and ways to create a zero-waste picnic (Green Your Visit, 2020).

Corresponding with Grand Teton's successful sustainability and recycling programs, they also contain a "What Do I Do With...?" page. This page allows visitors to search for a specific item and the page will state how to properly dispose of the waste. It also provides information on where in the park the item can go (Teton County Wyoming, 2020). For example, Figure 11 provides information on different types of plastics and whether it is a recyclable or trash.

PLASTICS

Where to Recycle

Type of Plastic	Where to Recycle
Black Trash Bags	Trash
Bubble Wrap	Recycle With Grocery Bags
Buckets/Tubs	Trash
Plastic Bottles Number 1	Recycle
Plastic Bottles Number 2	Recycle
Plastic Food Containers Number 1	Trash
Plastic Number 3 through 7	Trash
Plastic Food Wrap	Recycle With Grocery Bags
Plastic Packaging	Recycle With Grocery Bags
Sandwich Bags	Recycle With Grocery Bags
Styrofoam	Trash

Figure 11: Grand Teton "What Do I Do With...?" Page for Plastics

Yosemite focuses on providing information to park visitors on their progress with the ZLI. Yosemite plans to build on park infrastructures including replacing "Half-Dome" shaped trash and recycling bins, adding more water-filling stations, expanding collection of compostable waste, and educating visitors on how to recycle and how to reduce waste coming into the park (NPS Yosemite, 2017). Furthermore, Yosemite provides information to park visitors on how to be a "Yosemite Zero Hero". This includes leaving excess packaging behind, use refillable water

bottles, use rechargeable, dispose of trash and recycling properly, and don't abandon unneeded gear (NPS Yosemite, 2017).

Denali has implemented a Zero-Landfill Youth Ambassadors Program to encourage students and educate them about zero waste practices and how they can help in their own schools and communities (Denali Education Center, 2020). Composting and recycling programs, art, as well discussion with local businesses emerge from the waste reduction efforts made by the Denali Zero-Landfill Ambassadors (Denali Education Center, 2020). It was found that word of mouth and the ambassador approach are effective in reaching others about zero waste initiatives and increased recycling rates (Marks, K, 2013).

Yellowstone, while not a part of the ZLI, works with surrounding communities in efforts to recycle large quantities. In addition, Yellowstone works closely with concessioners to hand out brochures containing sustainability information. The park staff at Yellowstone is also trained to promote sustainability by word-of-mouth (EPA, 2006). Figure 12 shows that Yellowstone also has an eco-map depicting several major park areas and what sustainability features are in each area. Yellowstone attributes its sustainability success to collaboration with surrounding communities, educating visitors, an enthusiastic staff, and widespread availability of bins (EPA, 2006).

Figure 12: Ecomap of popular areas in Yellowstone National Park

(Yellowstone National Park Lodges, 2014)

As a result of more information being available to visitors, Denali, Yosemite, Grand Teton, and Yellowstone all have higher diversion rates than that of GNP, as shown in Figure 13.

Figure 13: Diversion rates of Denali, Grand Teton, Yosemite, Yellowstone, and Glacier National Park

Another program we researched was Phoenix Arizona's Recycle Right program. The city of Phoenix contains a recycling page to educate people on how to recycle properly. The page contains a Recycle Right Wizard and a Waste Sorting Game. The Recycle Waste Wizard allows

you to select a city in Arizona and type in the item you need to dispose. Depending on the item, the program will tell you whether it is recycled or belongs in the trash. It also provides times for curbside pickup as well as where you can dispose of the item (City of Phoenix, 2020). For example, Figure 14 provides information on how to recycle plastic bottles in the city of Phoenix. Another aspect of the page is their Waste Sorting Game. The game's objective is to sort items either into the recycling, trash, transfer station, or green organics bin to clean up your park. It consists of five different levels, and upon completing each level, you have the option to add a component to your park (City of Phoenix, 2020). The game can be used for children to educate them on proper waste disposal.

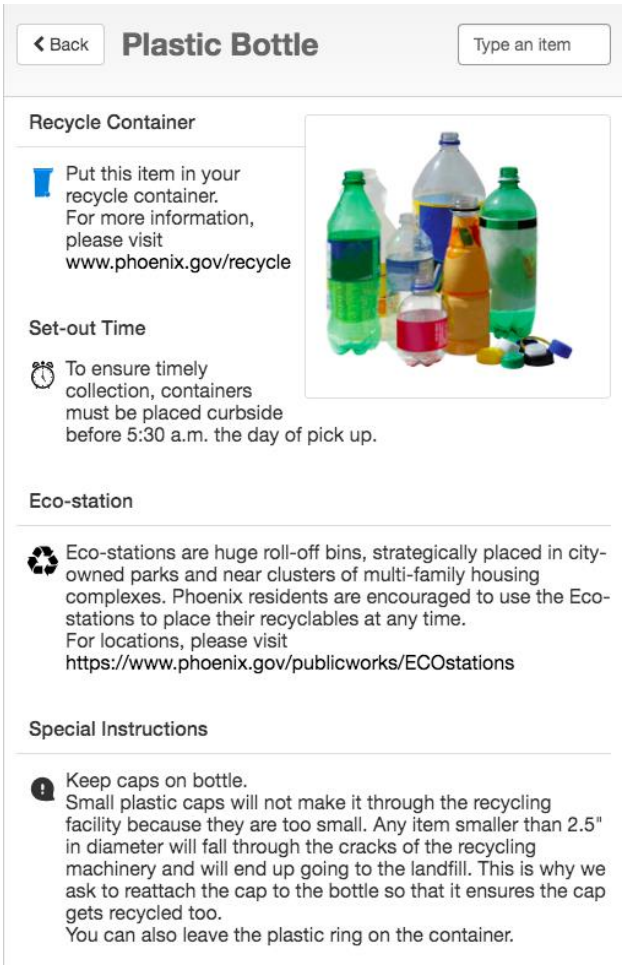


Figure 14: Phoenix, Arizona: "Recycle Right Wizard"

4.2.3 Visitor On-Site Experience

We collected data on visitor recycling and sustainability experiences both onsite and online at GNP, as well as logistics of personal trip planning using an anonymous survey (See Appendix C). Additionally, Figure 15 shows a social media post by the Official Glacier National Park Facebook page, which was sent out to ask visitors an open-ended question about their

experiences with recycling in the park and information on the GNP website. We also utilized a second anonymous survey to collect data about park staff onsite experiences with sustainability and recycling within the park as well as their interactions with visitors about the topics of sustainability and recycling (See Appendix D).

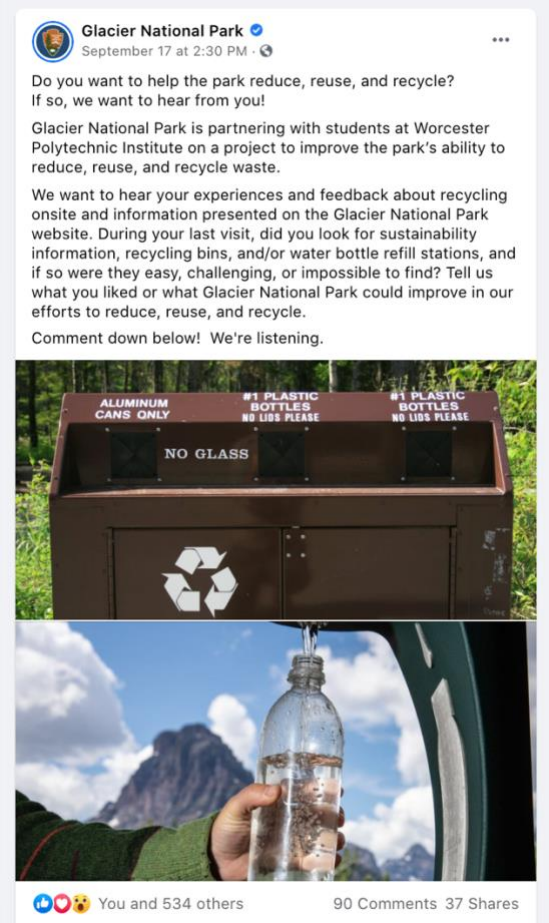


Figure 15: GNP Official Facebook Page Feedback Post

By utilizing the anonymous visitor survey data, a question was asked to determine what park visitors would like to see in terms of recycling. The question was, "Do you have any suggestions to make the recycling process easier for visitors at Glacier National Park?" Out of 18 respondents, six of them thought adding more recycling and trash bins would be beneficial. Additionally, three visitors wanted better labeling on recycling bins and another three visitors thought educating visitors on proper waste disposal would be beneficial.

In addition to the visitor survey, we utilized an anonymous staff survey. We posed the same question to the staff of "Do you have any suggestions to make the recycling process easier for visitors at Glacier National Park?" As a result, five out of the 17 participants believed better labeling in the park is needed as well as four out of the 17 agreed with visitors that more recycling and trash bins are needed.

By utilizing GNP's Facebook page, we were able to obtain information from visitors about helping the park reuse, reduce and recycle. The post asked the question "During your last visit, did you look for sustainability information, recycling bins, and/or water bottle refill stations, and if so, were they easy, challenging, or impossible to find?" and asked people to respond in the comments. From the post, we received 90 comments from visitors asking questions as well as providing insightful comments and suggestions for the park. As a result, many visitors did not know about water-bottle refilling stations and found it difficult to locate recycling bins. Some suggestions included having more recycling bins as well as recycling options, such as glass and cardboard recycling.

Sustainability questions are frequently asked by visitors to park staff weekly and can be reduced through improved website design and outreach both inside and outside the park. By conducting anonymous surveys of park employees, it was found that park staff are often asked questions regarding sustainability and recycling on a daily or weekly basis. As shown in Figure 16, 65% of park staff receive questions 1-2 times or several times per week, and 20% are asked several times each day. It was found that 90% of park staff who took the survey receive sustainability questions at a rate of at least 1-2 times per week.

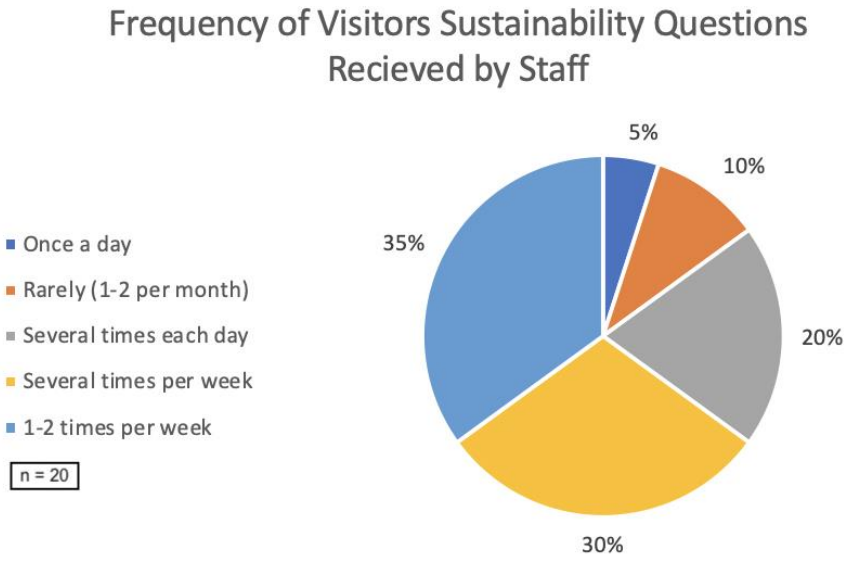


Figure 16: Staff Data: "How often are you asked questions by visitors regarding trash, recycling, and sustainability?"

GNP staff are unsure about the type of sustainability information being advertised within the park. There is a disconnect between the staff and what type of information is on the ground within the park. The question "Is this information available in the park?" was asked. The staff were unsure if the answers to the questions are readily available to visitors within the park. From the survey, it shows that 39% of staff answered No, and believed the information was not available at the park, while 41% of staff said Maybe. Note from Figure 17 that zero percent of

staff said Yes to the question, meaning that no one was certain if all the information was available to visitors within the park. With the high frequency of sustainability questions that get asked by visitors to park staff, there is a way to mitigate the lack of knowledge and information both for visitors and staff. By improving and increasing the outreach system and promotion to relay the current recycling and sustainability information that is present within the park.

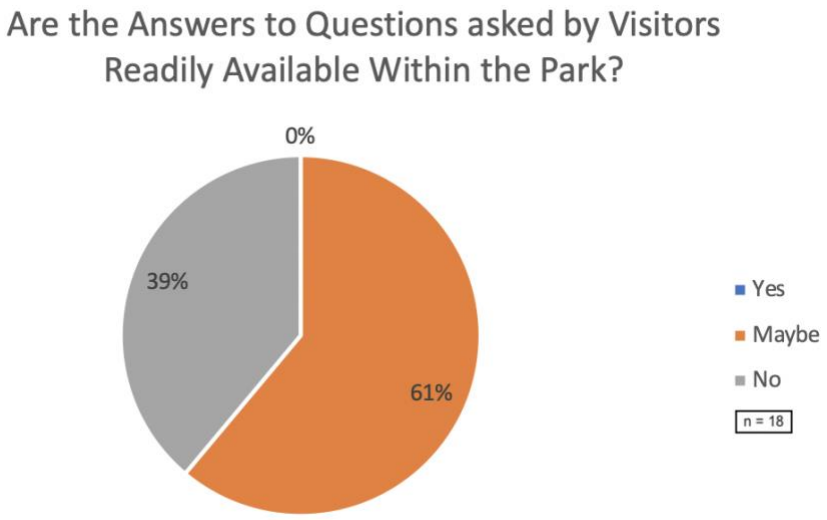


Figure 17: Staff survey data on recycling and sustainability in the park.

Most GNP visitors were unsure or unaware if there was information about recycling and sustainability available in the park. Figure 18 shows a summary of the results from a question asking visitors, “Was there information about recycling and sustainability available in the park”. Answers consisted of either Yes, No, or Not Sure. Note that while 20% of visitors did recognize information about recycling and sustainability available within the park, 76% and 4% of visitors were either unsure or believe there is no information available in the park regarding recycling and sustainability, respectively. This means that 80% did not recognize the presence of any information about recycling or sustainability within GNP. This shows a lack of information and a lack of effective sustainability and recycling promotion, as it suggests the information is unrecognizable to many visitors.

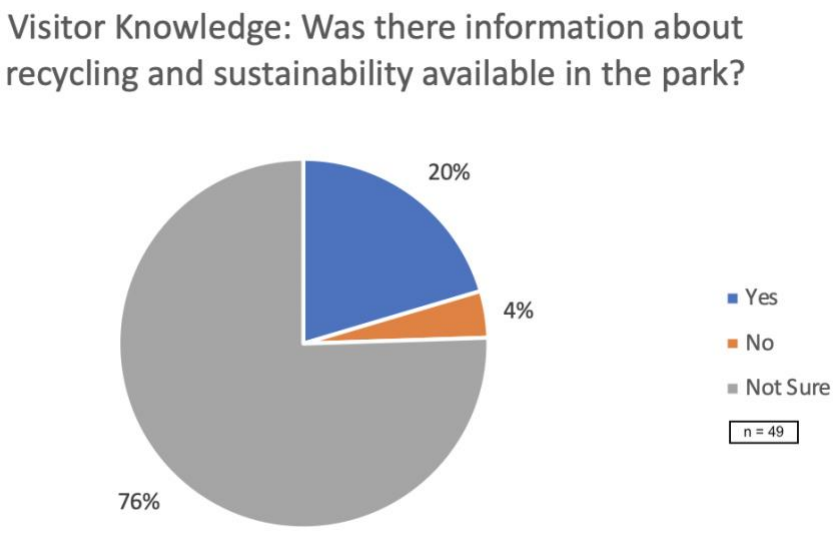


Figure 18: Visitor survey on recycling and sustainability information in the park

GNP visitors bring in recyclables that are not available to recycle within the park. Through the visitor survey, we received information on what recyclables are brought into GNP. The posed question was, "What kinds of recyclables did you bring into the park?" with a list of 7 different kinds of recyclables. According to Figure 19, 33 participants brought paper in the park, another 15 brought in cardboard, and 12 participants brought in glass. GNP does not have recycling for paper, cardboard, or glass available to park visitors. Plastic was the highest brought in the park at 40, and although GNP has plastic recycling, it is very limited.

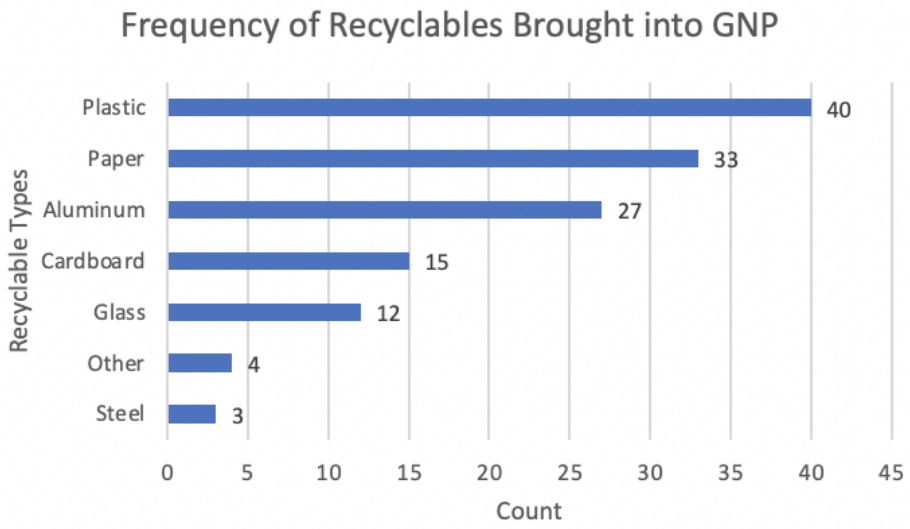


Figure 19: Visitor Survey: "What kind of receptacles do you bring into the park?"

GNP visitors have trouble finding recycling bins or trash receptacles. A question that was significant in determining the ease of visitor facing recycling bins was asked. The question was, “Did you have any trouble finding trash receptacles or recycling bins in the park?” with 48 respondents either answering Yes or No. Figure 20 shows that of the respondents, 40% answered Yes. This means that 40% or 19 out of 48 visitors from the visitor survey had trouble finding trash receptacles or recycling bins in the park. Having a map available with the location of recycling and trash receptacles would allow visitors to dispose of waste by knowing where to dispose of waste.

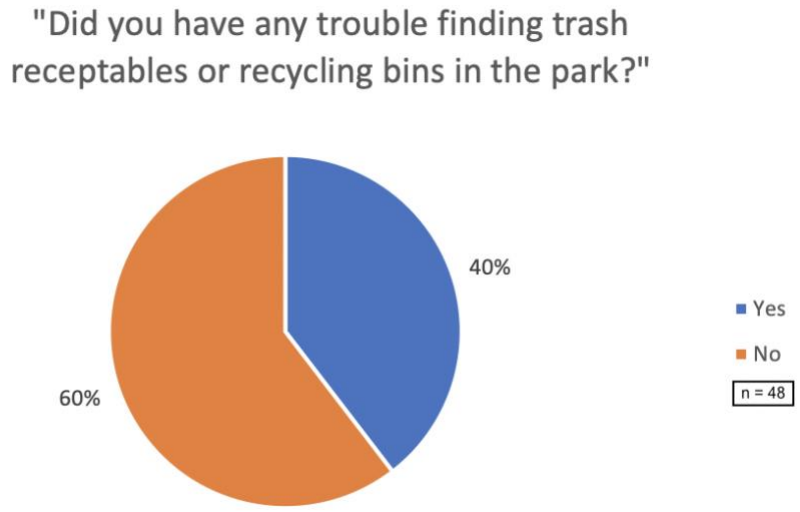


Figure 20: Visitor Survey: Accessibility of recycling bins according to visitors

There is visitor confusion on proper recycling and disposal of waste in GNP. A question was posed to the visitors: “Were you able to properly dispose of waste?” The responses available were Yes, No, Sometimes, and Not Sure. Figure 21 shows that of the 49 respondents, while 29 visitors were able to properly dispose of waste, four visitors were not, 12 visitors were able to sometimes, and four visitors were unsure if they were able to correctly dispose of waste. This makes up 41% of visitors who were unable to or did not have enough information to recognize if what they disposed of was proper. With contamination being a key issue disrupting proper recycling, this is a concern knowing 25% were sometimes able to dispose properly, meaning they also have the potential to contributing to contamination as well as the 8% who were not sure. While consistent signage has recently been implemented as well as the location of recycling bins, there are still improvements to be made to the system.

Figure 21: Visitor Survey: Insight on proper waste disposal in the park

4.2.4 Visitor Pre-Trip Outreach

Through research and personal communication with our contacts at the park, we found that GNP does not currently implement any pre-trip visitor outreach programs. We purchased an individual park pass to discover what information would be sent to us upon purchase. The only information we received was an email receipt confirming the purchase, which is shown in Appendix E. No pre-trip resources, such as maps, park guides, or sustainability information, were contained in the email. This means that visitors to GNP are given no advance information about how to plan their trip in a sustainable way.

4.2.5 Visitor Online Experience

Almost half of park visitors do not spend time on the Leave No Trace, sustainability, and recycling webpages, nor do the majority know they exist. By examining the anonymous visitor survey data, it was found in Figure 22 that 49% of visitors who utilized the GNP website did not spend any time on the recycling or sustainability pages that were linked to the survey for them to view. This is coupled with the fact that the recycling webpage is inaccessible unless searching for “recycling” specifically. A large percentage of people may not be able to find the recycling page due to this. Additionally, Figure 23 shows that of those who did not spend any time on the recycling or sustainability webpages, 91% did not know that the recycling or sustainability webpages existed at all. This gives evidence that the webpages are not easily accessible within the website.

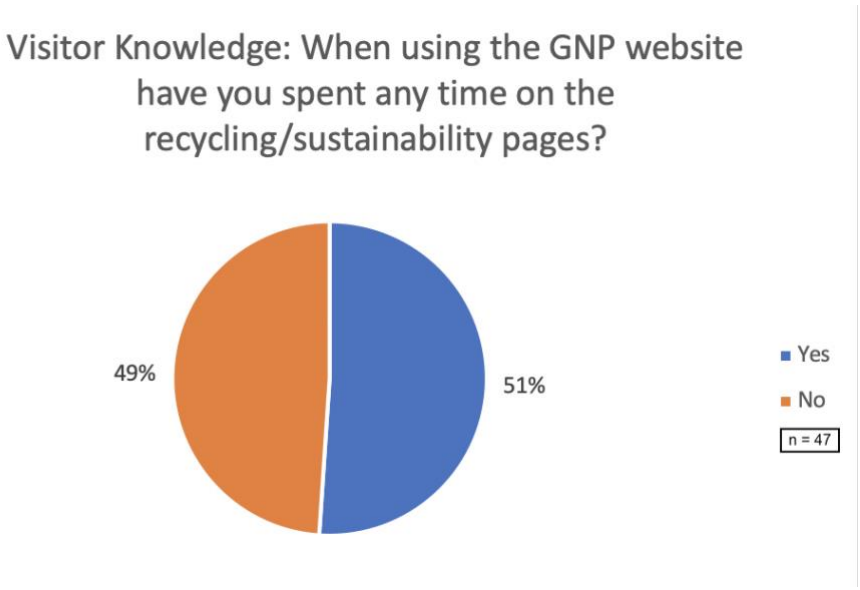


Figure 22: Visitor Survey: Insight on use of GNP recycling and sustainability webpages

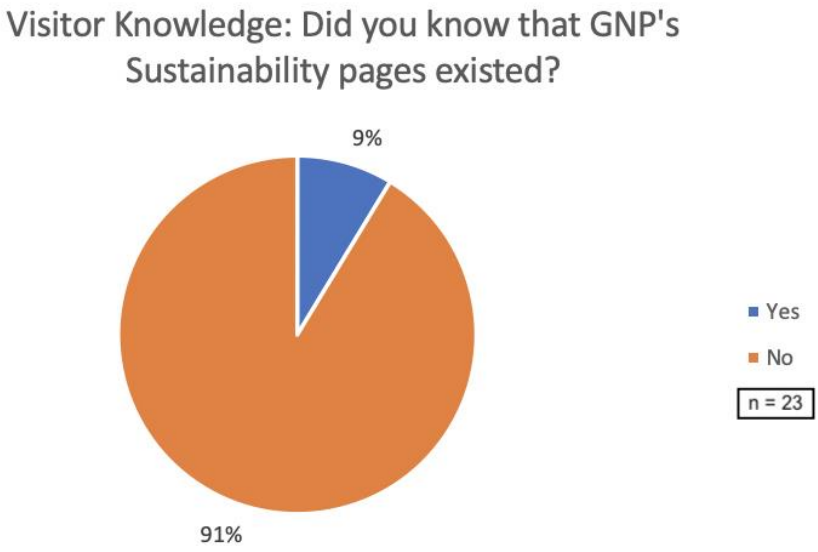


Figure 23: Visitor Survey: Insight on knowledge of GNP's sustainability webpages

Web analytics data was collected to compare the effectiveness of multiple park's website designs. To gain an understanding of how visitors interact with the park's online resources, data was collected from the GNP website as well as the websites of four other national parks: Denali, Grand Teton, Yosemite, and Yellowstone. This data was collected via Google Analytics and included the following datasets for several pages on each park's website:

Unique Users - Represents the total number of unique IP addresses that have accessed a specific page.

Sessions - Represents the number of times a user entered the website and viewed more than one page before exiting.

Page Views - Represents the total number of times a specific page was viewed, including multiple views by the same user.

Bounce Rate - Represents the percentage of users that entered the website onto a specific page, then exited the website from that same page without further interacting with the website.

Exits - Represents the number of times a user ended a session by leaving the website from a specific page.

Exit Rate - Represents the percentage of users that exit the website as a whole from a specific page. Calculated by dividing the number of exits by total page views.

Avg. Time Spent on Page - Represents, in seconds, the average time users spend lingering on a specific page.

All web analytics data was compiled into graphs and is shown in Appendix B. In addition to the data given to us by GNP, we also calculated the Exit Rate for each page and created graphs comparing unique users and page views, as well as visitation statistics and web traffic. These datasets were analyzed to determine the rate at which users re-visit each page, and to investigate a possible correlation between the visitation numbers of the parks and the number of people viewing the website.

Analyzing the qualitative data acquired through Google Analytics allowed us to see which park's pages had the best data results. Comparing the features of the page with the quantitative data allowed us to draw conclusions on why one park's webpage may have higher traffic or lower exit/bounce rates. Through the comparison of qualitative data from Google Analytics and the observations of several park webpages (GNP, Denali NP, Yosemite NP, Grand Teton NP, and Yellowstone NP), we were able to correlate the park's diversion rates with the effectiveness of their sustainability webpages. Websites were compared using website features, data from Google Analytics, and park diversion rates. When analyzing the features of a webpage, we looked at:

- Number of hyperlinks present
- How the information was presented
- Videos
- Interactive banners
- How many clicks it takes to get from the home page to that specific page

For the webpage on sustainability, Denali NP had a lower exit rate compared to GNP (37% to 43%), and Grand Teton had a bounce rate 3% lower than GNP's. Also, when comparing

the recycling pages, it was found that Grand Teton's recycling page has a 10% lower exit rate, as well as a bounce rate 11% lower than GNP's. It was found that national parks with better website information and layout, along with better sustainability outreach, had better diversion rates than GNP. Looking at the features and layout of each sustainability page and recycling page shows that when compared to GNP, other parks have more interactive and informative information available. Videos, infographics, interactive banners, and charts are shown on other parks' sustainability pages, which can contribute to the lower bounce rates and exit rates (See Figures 24 and 25).

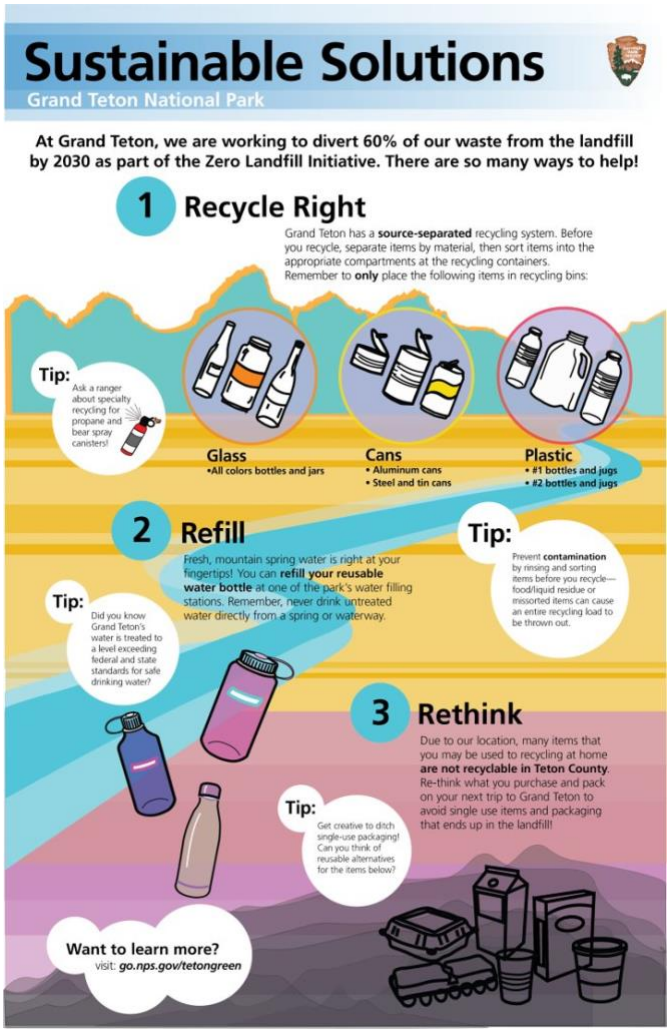


Figure 24: Infographic from Grand Teton's sustainability page

(Grand Teton National Park, 2019)

Figure 25: Interactive banner and ZLI Video on Denali NP's sustainability age

(Working for a Greener Denali, 2018)

GNP's webpages display information, but with a lack of interaction with the site visitor. Yellowstone's sustainability page includes tables breaking down waste types and disposal, along with a pie chart depicting the breakdown of waste contributing to the highest diversion rate of any national park (see Figure 26).

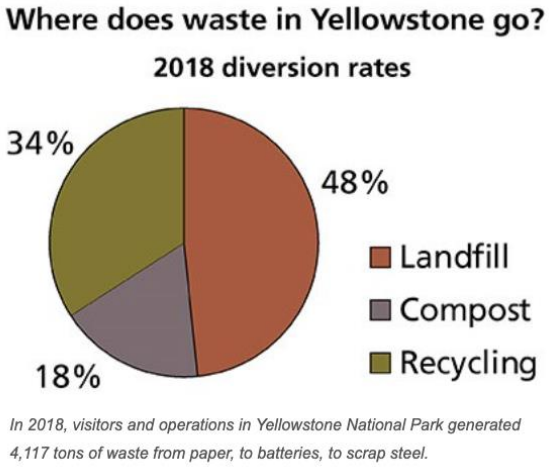


Figure 26: Pie chart of Yellowstone's Waste Diversion

(Yellowstone National Park, 2019)

In addition, the ease of navigating to sustainability pages was explored. Most pages were within 2-3 clicks from the home page, except for GNP's recycling page. The recycling page could only be reached by googling or searching on the website. As a result, there is very little traffic going through this page. With no hyperlinks to the recycling page in other pages, very few people can find the page, let alone obtain information from it.

GNP's recycling page was last updated on September 29, 2016. The site being last updated over four years ago could be another contribution to GNP's lower diversion rate, as Yellowstone's pages were last updated in December 2019 and Grand Teton's in June 2020. Several other parks we studied stated updated goals for the future, as well as past achievements. Yellowstone also included updated charts and tables displaying information on their waste breakdown and diversion for the previous year. The lack of current information and not being able to access GNP's recycling page from the home page may be an important factor in improving GNP's diversion rate.

Critical information such as the location of trash bins, and recycling bins, and refilling stations that visitors should have before visiting GNP are not easily available to visitors. The information regarding visitor waste disposal is not clear and concise online. By examining GNP documents and the website, it was found that there was no information about trash bins: the number of trash bins, or the location of the trash bins. The website only specifies six places where water filling stations are located: on the recycling webpage and sustainability webpage (National Park Service, 2020). The information on water filling stations is only accessible through a drop-down option asking "How can I use less plastic" on the sustainability webpage (National Park Service, 2020). The recycling webpage displays the water filling station information more obviously, however this webpage is not accessible unless specifically sought after and is not available from the main page (Glacier National Park, 2016).

This is a similar situation to the recycling bins. On the recycling webpage, it is said that recycling bins for #1 and #2 plastic and aluminum are placed "near the entrance of every campground and other high-use park facilities" (Glacier National Park, 2016). This reflects the unclear and nonspecific information about recycling and sustainability.

4.3 Discussion

The limitations of recycling make source reduction and visitor outreach a priority. Through research on the limitations of commercial recycling, and the controversies surrounding it, we determined that it would be most effective to focus our project on developing methods of visitor outreach with the goal of source reduction.

As of 2014, one-third of recycled materials in the US were exported abroad to be processed—the majority of which was sent to China (Albeck-Ripka, 2018). However, in 2018, China implemented a new policy, called National Sword, banning the import of many types of plastic and paper waste. Since the ban, the market for recycled waste has been drastically

shrinking, making it increasingly difficult for commercial recyclers to process the waste they collect. In the first two months of 2018, US recycling exports to China fell by 35% (Albeck-Ripka, 2018). Much of the waste that would otherwise have been exported for processing and recycling is now being sent to landfills instead. Republic Services, one of the largest waste managers in the US, sent 2,000 tons of paper to landfills in that two-month time frame (Albeck-Ripka, 2018).

Another issue that has been highlighted in recent years is known as aspirational recycling. Without knowledge of proper recycling practices, people can inadvertently contaminate large quantities of recyclable waste through improper disposal, resulting in whole loads being sent to the landfill instead (Sullivan, 2019). In the US, 25% of all recycling is contaminated when it is put in the bin because of a general lack of knowledge of what can and cannot be recycled (Semuels, 2019).

These new limitations begin to raise questions about the effectiveness of recycling, and about what happens to recyclable waste after it is put in the bin. Even the waste that is still able to be exported to other countries since China's ban is not guaranteed to be recycled; many of the countries that accept the new demand for waste imports have high rates of "waste mismanagement," which includes the burning or accumulation of waste in open, unregulated landfills. (Franklin-Wallis, 2019).

With these limitations in mind, we decided to focus the scope of this project on visitor education and outreach with the goal of source reduction, in other words, preventing waste from entering the park in the first place, and therefore reducing the environmental impact regardless of what would happen to the waste after ending up in the recycling bin.

5. Recommendations

5.1 On the Ground

5.1.1 Primary Recommendations

Implement visitor educational sustainability and recycling information through print media

As indicated by the survey data from park staff and visitors, there is a deficit of recycling and sustainability information available on the ground in the park. Many visitors are unaware of what can and cannot be recycled, and have difficulty finding recycling receptacles. By implementing a campaign of printed media, which includes posters and brochures, this information can be more easily accessible while in the park. Printed media can include information on recycling guidelines, proper waste disposal practices, as well as educational resources such as the LNT program. Posters can be placed around the park in high-traffic areas, including lodges, retail locations, and visitor centers, in order to passively present the messaging to as many visitors as possible. Brochures can include similar information tailored to giving visitors a convenient resource for recycling information that they can carry with them throughout the park. Brochures can be distributed at the park entrance to visitors or left in park lodges and visitor centers to be picked up.

Educate staff and concessioners about park sustainability initiatives and goals

To spread information by word of mouth, we suggest educating staff and concessioners on basic sustainability goals and practices to promote sustainability. Spreading information face-to-face can be one of the most effective ways to educate people on proper waste disposal and adds another means for sustainability information to be spread to park visitors. Educating full time and seasonal staff during staff orientation would benefit both staff and visitors regarding sustainability efforts. Following Yellowstone's sustainability success, having clear and consistent goals across all park staff and concessioners is necessary to communicate goals to park visitors.

5.1.2 Secondary Recommendations

Create and implement a Sustainability Youth Ambassador Program within GNP and the community

There are currently no educational programs about sustainability or recycling established within GNP. According to survey and Facebook comments, educating visitors young is important to those that have visited and wasn't to help the park reduce, reuse, and recycle. In order for GNP to be a leader in the zero-waste effort and increase recycling practices, it is recommended to implement Sustainability Youth Ambassadors. Visitors with children were found to be 1.51 times more likely to properly dispose of waste, as determined by one study examining the psychology of recycling among visitors in national parks using ZLI data (Mateer

et al., 2020). It would suggest that the implementation of Sustainability Youth Ambassadors would increase youth knowledge, proper disposal, and recycling rates. GNP would need to collaborate with Denali National Park, where GNP can learn from the current Zero-Landfill Youth Ambassadors Program. This program would create local community engagement through youth education on recycling, composting programs, and waste reduction (Denali Education Center, 2020). Additionally, this program will encourage sustainable art and business relations within the community. By creating youth interaction with the park, this should also establish parental participation, and the potential to foster positive waste reduction dialogue and reinforcement of its importance.

Implement sustainability and recycling education activities into the Junior Ranger Program

It is recommended that GNP implement sustainability activities into the Junior Ranger Program. There are no established ranger-led sustainability programs or educational activities available. This recommendation would increase direct outreach through recycling, sustainability, and waste reduction, both internally and externally. It will allow for Junior Rangers to continue their mission to "Explore, Learn, and Protect" their national parks by educating themselves on the possible ways to reduce waste and helping both the park and the environment improve. This would mean the park must create a ranger-led program and add activities into the established Junior Ranger booklet involving specific sustainability, recycling, and waste-free information. Activities could include a scavenger hunt involving different materials and where they can be properly disposed of as well as finding specific sustainable facilities, refilling stations, and solar panels. Additionally, an activity guiding visitors on how to pack a waste free lunch could be implemented. Lastly, the creation of a recycling sorting game specific to the park's waste regulations could be an established activity. The completion of these activities will result in participants receiving the Glacier Junior Ranger badge.

Implement Recycling Phone App and Search Engine

To inform visitors about the location of recycling bins throughout the park, we suggest implementing a recycling phone app. Similar to the app Maplets, the recycling phone app can allow you to download offline maps that you can access whenever and wherever. This app uses GPS locations to help plan trips and pinpoint locations throughout a national park. Furthermore, you can upload maps into the system to find other extremities in the park. This can include a map of recycling bins, water refilling stations, visitor centers, lodges, and campgrounds.

In addition to Maplets, to increase proper waste disposal throughout the park, it is recommended that GNP implement a recycling search engine through an app. Like Grand Teton's "What do I do with...?" page and Phoenix Arizona's "Recycle Right Wizard," GNP can implement a search engine that allows visitors to dispose of waste throughout the park. The search engine can allow visitors to search for a certain item they want to dispose of, and it will

tell the visitor whether the item is recyclable or trash as well as where those bins are located throughout the park.

5.2 Pre-Trip

5.2.1 Primary Recommendations

Implement a Reservation Outreach System to distribute pre-trip sustainability and recycling education

GNP does not currently send out any pre-trip sustainability or recycling information to visitors that book reservations or purchase park passes. This is an untapped avenue of sustainability outreach; we recommend that GNP implement a reservation outreach system by which pre-trip resources can be sent out to visitors when they book a reservation with the park. This could take the form of an email containing recycling and sustainability information, an infographic, and links to other sustainability resources, such as the ArcGIS sustainability map. The ArcGIS map will use GPS locations and include recycling bins, water refilling stations, and other extremities for visitors to know beforehand of where to dispose of their waste.

5.3 Website

5.3.1 Primary Recommendations

Provide easy navigation and accessibility to sustainability and recycling information on the GNP website

We recommend first that the GNP Recycling webpage be made easily accessible from the homepage by putting it under the sustainability link in the "Get Involved" menu. This is necessary as the webpage is currently inaccessible from the park's home page. Also, we suggest creating a new tab under the "Basic Information" tab in the "Plan Your Visit" menu, titled "Before You Go," with information on what to bring, general recycling knowledge, and the Leave No Trace Initiative. Due to some visitors not realizing the sustainability pages exist on GNP's website, we recommend putting general information under the "Plan Your Visit" tab. The "Plan Your Visit" page receives much more traffic than the sustainability page so putting information here would be more likely to be seen by website visitors. General sustainability information should be put under "Basic Information", while more in-depth information should be added to the existing sustainability page under the "Get Involved" tab.

Update website features to allow for more visitor interaction

To make the webpages more interactive and informative, we recommend adding features including, but not limited to: videos, clickable banners, pictures, bulleted lists, hyperlinks to other sustainability and recycling pages, park goals, charts, data tables, and waste diversion rates. The implementation of a list entitled "How to Recycle," containing information on how different

types of waste can be disposed of within the park, would also be a helpful resource to inform visitors how to dispose of waste properly.

Implement an ArcGIS Sustainability Map

Our survey results and Facebook comments indicate that visitors found it difficult to locate recycling bins and trash receptacles throughout the park. Through web analytics, it was found that GNP's websites do not include a map of recycling bins or water bottle refilling stations available for visitors. In order to ensure proper waste disposal before visitors enter the park, it is recommended to implement an interactive ArcGIS map on GNP's website. This map would contain the locations of recycling and trash bins, water bottle refilling stations, visitor centers, lodges, and campgrounds. On the map, visitors would be able to click on each bin and find out what types of recyclables are accepted at that location, such as aluminum cans or plastic water bottles.

5.3.2 Secondary Recommendations

Implement updated sustainability and recycling content to the GNP website

Currently, the sustainability and recycling content on the GNP website is less comprehensive than that of other national parks with higher web interaction. Information on the recycling page has not been updated since 2016, meaning there are no current goals, achievements, or updated practices present on the webpage. There is not much of a focus on communicating sustainability practices in the context of trip planning. We recommend the "Plan Your Visit" section of the GNP website be reevaluated and redesigned to include recycling resources. These resources could include a "Before You Go" section linked under the "Plan Your Visit" section. This page would present recycling information for prospective visitors to GNP such as what can and cannot be recycled in the park, as well as guidelines on what they should pack with them on their trip to the park. Additionally, links to the ArcGIS sustainability map (with recycling bin and water refilling locations) and sustainability infographic could be embedded.

Inform visitors of the pro-environmental practices and regulations that are vital to preservation and helping GNP's waste management system

Based on the lack of recycling and sustainability outreach, it is recommended that GNP develop a sustainability infographic to increase pro-environmental promotion online. This infographic will provide clear and concise information specifically about how to recycle right, reuse, refill, and reduce waste within the park. It will contain content describing the waste management hierarchy and any other pertinent regulation information into an easily digestible visual. This infographic will be placed on the Sustainability webpage for trip planning as well as being attached to the mailer, which will be sent to visitors who have reserved park passes in advance.

6. Conclusion

As part of the National Park System (NPS), GNP has a responsibility to uphold the values that the NPS shares, including the preservation of the natural and cultural environment, education, and sustainability. Therefore, it is imperative that they continue to implement sustainable practices and programs, both internally and externally in GNP.

With the goal of improving the waste management system of GNP by diverting more waste from landfills, our project focused on developing passive and active methods of visitor outreach and education. These methods aim to mitigate the amount of waste that enters GNP, as well as minimize improper disposal of waste within the park. While recycling is an important factor in sustainable practices, we prioritized more preferred ways to manage waste, such as source reduction and reuse. To assess the needs of GNP's sustainability outreach, we collected survey data of visitor and staff experiences as well as web analytics data from other parks with higher diversion rates. This data was used in conjunction with a comparative analysis of those park's recycling programs to develop our recommendations.

The project focused on developing three primary avenues of recycling and sustainability outreach for GNP: resources within the park, pre-trip education, and content available on GNP's website. Templates for printed posters and brochures were created to be used in and around the park to passively spread recycling and sustainability information on-site. An infographic template was also created to promote this information online. This infographic was designed to be implemented on the park website as well as sent via email to visitors before they come to the park in a reservation outreach system. ArcGIS was also utilized to create an interactive map allowing visitors to see where water refilling stations and recycling bins are located, along with information about what can be recycled at each site and nearby trash bins. Finally, we recommended that GNP's website be updated to include more accessible sustainability information and resources for those planning a trip to the park.

7. References

Association of Plastic Recyclers. (2020, July 30). *Plastic Non-bottle Container Flowchart.* https://plasticsrecycling.org/education/recycling-beyond-bottles/non-bottle-containers/recycling-journey-of-a-plastic-non-bottle-container

City of Phoenix. (2020). *Residential Recycling.* https://www.phoenix.gov/publicworks/residential-recycling

DC Department of Public Works. (2017). *District of Columbia Solid Waste Diversion Progress Report Fiscal Year 2017.* Washington DC: https://dpw.dc.gov/sites/default/files/dc/sites/dpw/page_content/attachments/Solid%20Waste%20Diversion%20Report%20FY%2017-%20.pdf

Delaney, R. (2019). *Researchers Discover an Easy Way to Get People to Recycle.* https://www.bc.edu/content/bc-web/schools/carroll-school/news/2019/gergana-nenkov.html

Denali Education Center. (2020). *Denali Zero-Landfill Youth Ambassadors Program*. https://www.denali.org/zerolandfill/denali-zero-landfill-youth-ambassadors-program/

Eaton, J. (2020, April 24). Personal Communication

Environmental Protection Agency (EPA). (2006). *Recycling on the Go Success: Yellowstone National Park Recycling Program.* Retrieved from https://archive.epa.gov/wastes/conserve/tools/rogo/web/pdf/yellowstone.pdf

Eschner, K. (2017, November 15). *How the 1970s Created Recycling as We Know It.* Smithsonian Magazine. https://www.smithsonianmag.com/smart-news/how-1970s-created-recycling-we-know-it-180967179/

Glacier National Park. (2016). *Recycling*. https://www.nps.gov/glac/getinvolved/recycling.htm

Glacier National Park (2020). *Sustainability.* https://www.nps.gov/glac/getinvolved/sustainability.htm

GNP. (2016, July 1). *Giving Back at Glacier.* Xanterra Travel Collection. https://www.xanterra.com/stories/parks/giving-back-at-glacier/

GNP Conservancy. (2015, June 30). *Glacier Park Bear Management Fund*. https://glacier.org/project/glacier-park-bear-management-fund-protecting-bears-and-visitors-in-real-time/

GNP Conservancy. (2018). *Preservation*. https://glacier.org/preservation/

Goldberg, B. (2015, September 25). *A Guide to Metal Recycling*. Capital Scrap Metal LLC. https://www.capitalscrapmetal.com/interesting-scraps/a-guide-to-metal-recycling/

Grand Teton National Park. (2019). *Sustainability: Recycle Under the Range.* NPS. Retrieved from https://www.nps.gov/grte/getinvolved/sustainability-grand-teton.htm

Grand Teton National Park. (2020). *Zero Landfill Initiative.* NPS. Retrieved from https://www.nps.gov/grte/getinvolved/zero-landfill-initiative.htm

Hevel-Mingo, K. (2018, August 24). *Working to Significantly Reduce Waste at National Parks.* National Parks Conservation Association. https://www.npca.org/resources/3243-working-to-significantly-reduce-waste-at-national-parks

MTN News. (2019, June 16). *Glacier National Park Promotes Water Bottle Filling Stations to Reduce Plastic Waste.* https://www.kbzk.com/news/outdoors/2019/06/16/glacier-national-park-promotes-water-bottle-filling-stations-to-reduce-plastic-waste/

Marks, K. (2013). *The Effects of Different Marketing and Awareness Strategies on Recycling and Waste Minimization in the Residence Halls.*, 1-29. Retrieved from https://www.uww.edu/Documents/housing/sustainability%20newsletters/Solid-Waste-Research.pdf

Mateer, T. J., Taff, B. D., Miller, Z. D., & Lawhon, B. (2020). *Using Visitor Observations to Predict Proper Waste Disposal: A Case Study from Three US National Parks*. *C*urrent Research in Environmental Sustainability. https://doi.org/10.1016/j.crsust.2020.01.001

Miller, T. A., & McCool, S. F. (1994, August 1). *The Glacier National Park Visitor Use Study*. https://scholarworks.umt.edu/cgi/viewcontent.cgi?article=1265&context=itrr_pubs

Miller, Z. D., Lawhon, B., Taff, B. D., Schwartz, F., & Newman, P. (2019, April 1). *Identifying Strategies to Reduce Visitor-Generated Waste in National Parks of the United States: The Zero Landfill Initiative.* Applied Environmental Education & Communication, 1-14. https://doi.org/10.1080/1533015X.2019.1588179

Montana Department of Environmental Quality Waste Management & Remediation Division Waste & Underground Storage Tank Management Bureau. (2018, October). *Integrated Waste Management Plan*. https://deq.mt.gov/Portals/112/Land/SolidWaste/Documents/docs/IWMP2018.pdf

Mozo-Reyes, E., Jambeck, J. R., Reeves, P., & Johnsen, K. (2016, November). *Will They Recycle? Design and Implementation of Eco-Feedback Technology to Promote On-the-Go Recycling in a University Environment.* Resources, Conservation & Recycling, 114, 72-79. https://doi.org/10.1016/j.resconrec.2016.06.024

National Park Service. (2020). *Glacier Visitor Guide*. Glacier National Park Conservancy

Nixon, H., & Saphores, J. M. (2009). *Information and the Decision to Recycle: Results from a Survey of US Households.* Journal of Environmental Planning and Management: Governing Waste, 52(2), 257-277. https://doi.org/10.1080/09640560802666610

Northeast Recycling Council. (2017, May 1). *Disposal Bans & Mandatory Recycling in the United States.* https://nerc.org/documents/disposal_bans_mandatory_recycling_united_states.pdf

NPS. (2019). *Glacier National Park Map*. http://npmaps.com/glacier/

NPS GNP Montana. (2019, March 15). *Leave No Trace.* https://www.nps.gov/glac/planyourvisit/leavenotrace.htm

NPS GNP Montana. (2016, October 17). *Hiking Many Glacier*. https://www.nps.gov/glac/planyourvisit/hikingmanyglacier.htm

NPS. (2020). *Green Your Visit.* Retrieved from https://www.nps.gov/grte/getinvolved/green-your-visit.htm

NPS. (2020). *Recycling Guide for 2020*. Glacier National Park: U.S. Department of the Interior.

NPS Social Science. (2018, April 25). *Visitor Spending Effects - Economic Contributions of National Park Visitor Spending.* https://www.nps.gov/subjects/socialscience/vse.htm

NPS. (2020). *Sustainability Plan: Sustainability Strategic Framework and Tracking Sheet*. Glacier National Park: U.S. Department of the Interior.

NPS U.S. Department of the Interior. (2016, October). *Foundation Document Glacier National Park.* https://www.nps.gov/glac/learn/management/foundation-document.htm

NPS U.S. Department of the Interior. (2006, May 25). *Glacier National Park Environmental Management Plan.* https://www.nps.gov/glac/learn/management/upload/EMS-Glacier-NP-5-06.pdf

NPS U.S. Department of the Interior. (2020). *GNP Total Recreation Visitors.* https://irma.nps.gov/STATS/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20Graph%20(1904%20-%20Last%20Calendar%20Year)?Park=GLAC%20https://www.nps.gov/subjects/socialscience/vse.htm

NPS U.S. Department of the Interior. (2016). *Green Parks Plan Advancing Our Mission Through Sustainable Operations.* https://www.nps.gov/subjects/sustainability/upload/NPS-Green-Parks-Plan-2016.pdf

NPS U.S. Department of the Interior. (2017). *Sustainability Report 2017: Yellowstone National Park.* https://www.nps.gov/yell/getinvolved/upload/YELL-Sustainability-Report-2017.pdf

NPS U.S. Department of the Interior. (2011). *Yellowstone's Vision for Sustainability.* https://www.nps.gov/yell/learn/management/upload/whole_doc.pdf

NPS. (2020, March 10). *Visitation Numbers.* https://www.nps.gov/aboutus/visitation-numbers.htm

NPS Yellowstone (2019, December 19). *Recycling and Waste Diversion.* https://www.nps.gov/yell/getinvolved/recycling.htm.

NPS Yosemite. (2017, August 23). *Zero Landfill Initiative.* https://www.nps.gov/yose/getinvolved/zlf.htm

Onel, N., & Mukherjee, A. (2017, September 12). *Why Do Consumers Recycle? A Holistic Perspective Encompassing Moral Considerations, Affective Responses, and Self-interest motives.* Psychology & Marketing, *34*(10), 956-971. https://doi.org/10.1002/mar.21035

Paynter, M. (2018, July 24). *How to Recycle Glass at Home the Right Way.* https://www.budgetdumpster.com/blog/how-to-recycle-glass/

Recycle Across America. (n.d). *Three Steps to Creating a Successful Recycling Program.* https://www.recycleacrossamerica.org/nationalparks

Sukalich, K. (2016, July 1). *Everything You Need to Know About Paper Recycling*. Earth911. https://earth911.com/business-policy/business/paper-recycling-details-basics/

Tsai W, Chou W, Laic C. *An Effective Evaluation Model and Improvement Analysis for National Park Websites: A Case Study of Taiwan.* Tourism Management. 2010;31(6):936-952. https://www-sciencedirect-com.ezpxy-web-p-u01.wpi.edu/science/article/pii/S0261517710000178.

U.S. Department of Interior. (2015, August 15). *A Call to Action.* https://www.nps.gov/calltoaction/PDF/C2A_2015.pdf

U.S. EPA. (2016). *Managing and Reducing Wastes: A Guide for Commercial Buildings.* https://www.epa.gov/smm/managing-and-reducing-wastes-guide-commercial-buildings

U.S. EPA. (2017). *National Overview: Facts and Figures on Materials, Wastes and Recycling.* https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

U.S. EPA. (2005). *Social Marketing for Recycling in Ohio* https://archive.epa.gov/wastes/conserve/tools/localgov/web/pdf/oh_social-marketing.pdf

U.S. EPA. (2019, November) *Success Stories in Recycling.* https://www.epa.gov/sites/production/files/2019-11/documents/americarecyclessuccess_2019.pdf

Winterich, K., Nenkov, G., & Gonzales, G. (2019). *Knowing What it Makes: How Product Transformation Salience Increases Recycling.*, 21-37. Retrieved from https://doi.org/10.1177/0022242919842167

Working for a Greener Denali. (2018). Retrieved from https://www.nps.gov/dena/getinvolved/sustainability.htm

WPI Green Team and Office of Sustainability. (2019, April 11). *8th Annual Waste Audit.* Worcester, MA: Worcester Polytechnic Institute. https://www.wpi.edu/sites/default/files/inline-image/Offices/Sustainability/8th%20Annual%20Waste%20Audit.pdf

Wu, D., Lenkic, P., DiGiacomo, A., Ceh, P., Zhao, J., & Kingstone, A. (2018). *How Does the Design of Waste Disposal Signage Influence Waste Disposal Behavior?* Journal of Environmental Psychology., 1-9. Retrieved from https://doi.org/10.1016/j.jenvp.2018.07.009

Wynkoop, M. (n.d.) Commercial Composting "Green Washing" and Echo Labels. http://www.worldcentric.org/images/newsletter/Compostable%20vs%20%20Biodegradable.pdf

Yellowstone National Park Lodges. (2014). Yellowstone National Park Ecomap. Retrieved from https://www.yellowstonenationalparklodges.com/assets/Yellowstone-Ecomap-4.25.14-.pdf

Yellowstone National Park. (2019). *Sustainability*. Retrieved from https://www.nps.gov/yell/getinvolved/sustainability.htm

Ziesler, P. (2020). *Statistical Abstract 2019.* National Park Service U.S. Department of the Interior. https://irma.nps.gov/Datastore/DownloadFile/637876

8. Appendices

Appendix A - Waste and Recycling Audit Worksheet

Waste and Recycling Audit Worksheet

Objective:

- to determine composition and quantities of waste being generated
- to measure the effectiveness of existing waste management systems
- to collect baseline data for measuring the effectiveness of waste minimization strategies.

Audit Location:

Location:

Bin Breakdown:

- Type of Waste Collected:
- Bin Capacity:
- Location of Bins:
- How often are the bins emptied?:

What do we need to know before we begin?

1. When does the custodial staff take out recycling and trash?
2. Who is the hauler?
3. What materials does the hauler collect?
4. Does the hauler allow materials to be placed in plastic liners and bags?
5. When do they remove the dumpsters?

Important:

- No documents can be read or removed from the sorting area.
- For the sake of accuracy, do not notify employee or visitors of the audit to ensure they do not change their behaviors

Materials Needed:

- Thick Gloves (Gardening/Work Gloves)
- Latex Gloves
- Tarp/Plastic Covering
- Folding Tables
- Scales
- Pencils/Pens
- Audit Sheets
- Phone with picture taking capabilities

Schedule of Tasks:

- Collect all bins
- Transport to the sorting area
- Collect/Record data
- Clean Area
- Return Bins

Waste Audit Procedures:

SAFETY FIRST!
Make sure to put on your PPE (gloves, goggles, face shield, coverall etc.) before beginning. Inspect all items carefully before handling. Be especially careful not to handle broken glass or anything sharp. If you see anything looking vaguely like a hypodermic syringe, stop sorting that bag and let your supervisors know right away!

A NOTE ON PRIVACY....Discretely look away...
While it's likely that you may read what is written on papers tossed into the trash, we don't have the authorized consent to read it. Please be respectful of someone else's information.

Wash Hands...
Make sure to wash your hands thoroughly with soap and hot water after you leave the waste audit site for your health and safety.

BEFORE SORTING

1. Fill out all fields of the top portion of each form.
2. Each bin audited will have a label on it. Enter bin location and type on the form.

FOR RECYCLING BINS

1. Take picture of the inside of the bin.
2. Estimate volume occupied by materials.
3. Weigh the bin; record number. (NOTE: Record weight to the nearest tenth of a pound, for example, 1.0 pound, 12.7 pounds, 102.9 pounds).
4. Dump contents of bin onto the table; weight the empty bin; subtract the weight of the empty bin from the weight of the full bin to find out the weight of materials; record that number.
5. Sort the contents of the bag by corresponding categories; Take a picture
6. Place the items into the bucket. Take a picture of each item. Weigh the items on the scale and log the weight, minus the weight of the bucket. If there are no items in a given category, place a zero for that category weight.
7. Place the items in the corresponding recycling/trash bins.

FOR TRASH BINS

1. Take picture of the inside of the bin.
2. Estimate the volume of the bag.
3. Weigh the entire bag and record the total weight on the top of the form. (NOTE: Record weight to the nearest tenth of a pound, for example, 1.0 pound, 12.7 pounds, 102.9 pounds).
4. Place bag on the sorting table. Untie bag or rip open if necessary. If any hazardous, putrescent (i.e. smelly) or infectious waste is present, set bag aside, re-close, and tell the event coordinator/staff that the bag is bad. *We do not audit bags from the bathroom; just record the total weight and volume.
5. Sort the contents of the bag by corresponding categories; take a picture
6. Place the items into the bucket. Take a picture of each item. Weigh the items on the scale and log the weight, minus the weight of the bucket. If there are no items in a given category, place a zero for that category weight.
7. Place the items in the corresponding recycling/trash bins.

AFTER SORTING

1. Clean up your area and ensure the surrounding floor is free of debris.
2. Place your gardening gloves in the bucket and throw the latex gloves away.
3. When finished, give the completed form to the designated volunteer.
4. Wash your hands thoroughly and checkout by the Check-in booth when you leave, thank you!!

Waste Audit Form (print as many as needed)

Waste Audit Template					
Study Area					
Date					
Floor/Building/Room #					
Bin Location					
Bin Type					
Bin/Bag Weight (lbs.)					
Bin/Bag Volume (full bag, ½, ¼)					
Bucket Weight (lbs.)					
Data Collection Table for Bin Contents:					
SEPARATION CATEGORIES	**Weight (lbs.)**	**% of Volume**	**SEPARATION CATEGORIES**	**Weight (lbs.)**	**% of Volume**
White Office Paper			Compost Materials		
Mixed Paper			Food Packaging		
Corrugated Cardboard			Hazardous Waste		
Metal Cans			Electronic Waste		
Glass Bottles			Remaining Trash		
Plastics			Other		
Additional Notes:					
Name of Collectors:					

Separation Categories:

WHITE OFFICE PAPER
OK- printed white office paper ONLY! (Color ink OK)
No- glossy paper, magazines, journals, colored paper, envelopes, newspaper, brochures, post-its, food paper(cups or wrappers), personal hygiene material (napkins, tissues, paper towels) etc.

MIXED PAPER
OK- notebooks, notepads, backing to pads, glossy paper, magazines, journals, shoe/shirt boxes, cereal boxes, chip/paper board, colored paper, envelopes, newspaper, file folders, old textbook, brochures, post-its, etc.
NO- white office paper, cardboard, carbon paper, food paper, napkins, tissues etc.

CORRUGATED CARDBOARD
OK- cardboard with wavy material in it (ex. shipping boxes)
NO- shoe boxes, waxy material, cereal boxes, toilet paper rolls, pizza boxes, etc.

METAL CANS
OK- aluminum cans, tin cans, steel cans (labels OK)
NO- aluminum foil, take out containers, paint or stain cans, aerosol cans, etc.

GLASS BOTTLES
OK- all colors of glass
NO- mirrors, light bulbs, chemical containers, vases, broken glass.

PLASTICS
OK- #1-7 bottles and jugs (water, soda, milk jugs)
NO- film plastic, transparencies, take out non-plastic containers.

COMPOST MATERIALS
OK- leaves, food, napkins, organics, wood, houseplants, potting soil, compostable cups.
NO- recyclables listed above.

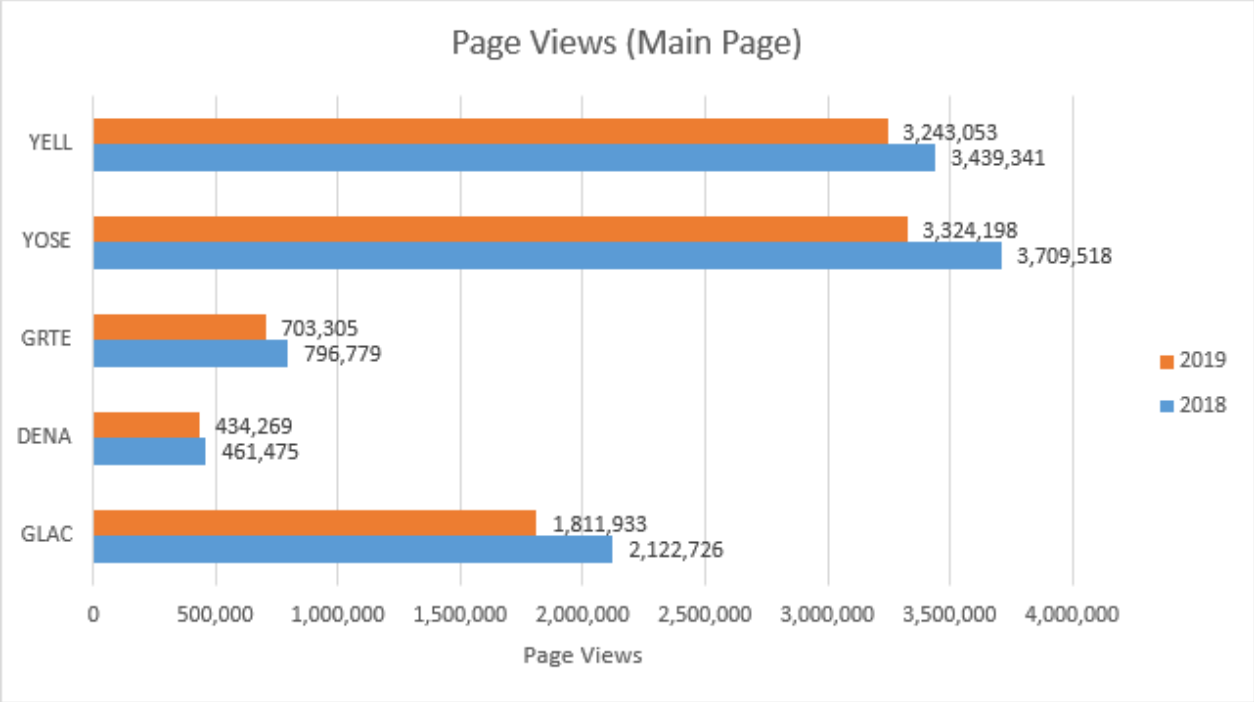
FOOD PACKAGING
OK- beverage containers (paper, Styrofoam and plastic cups) pizza boxes, straws, aluminum foil, condiments, plastic wrappers, frozen and fast food wrappings, plastic utensils, to-go containers, food packaging.
NO- recyclables.

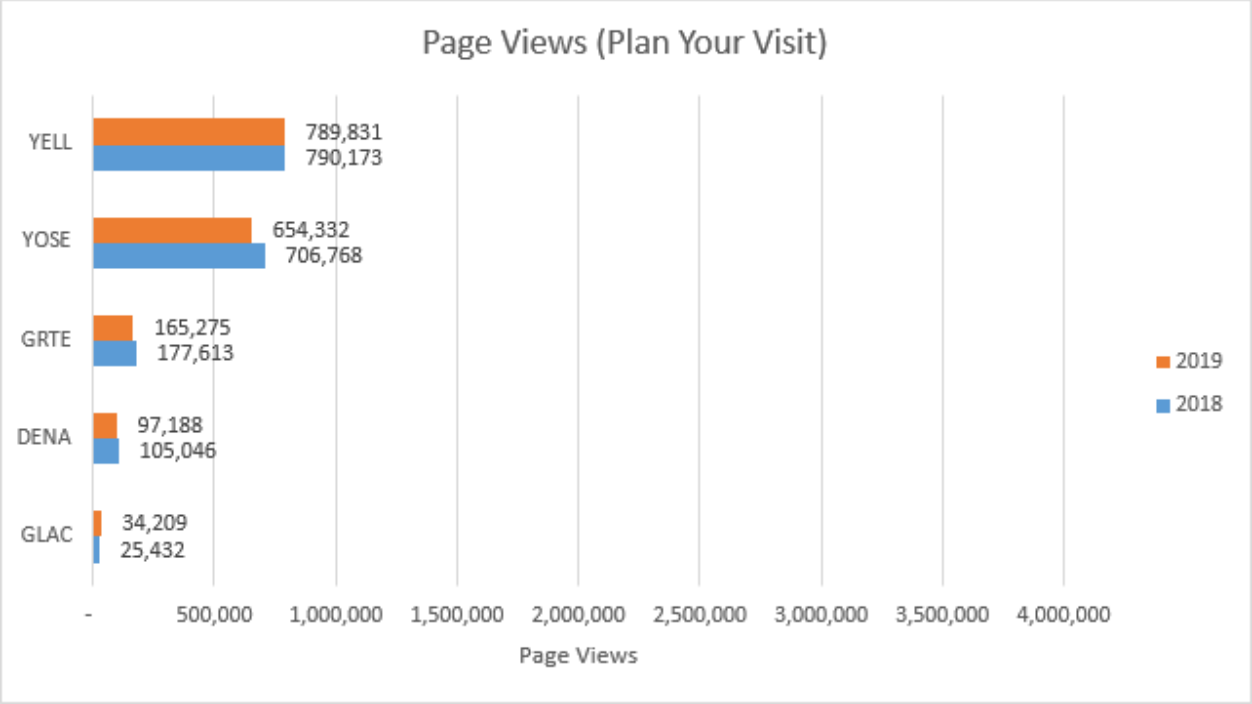
HAZARDOUS WASTE
OK- paint, paint thinners, photography chemicals, thermometers, thermostats, drain cleaners, pool chemicals, aerosol cans, pesticides, antifreeze, fertilizer, acids, gun powder, fireworks, etc.
NO- big appliances, regular batteries (go to trash).

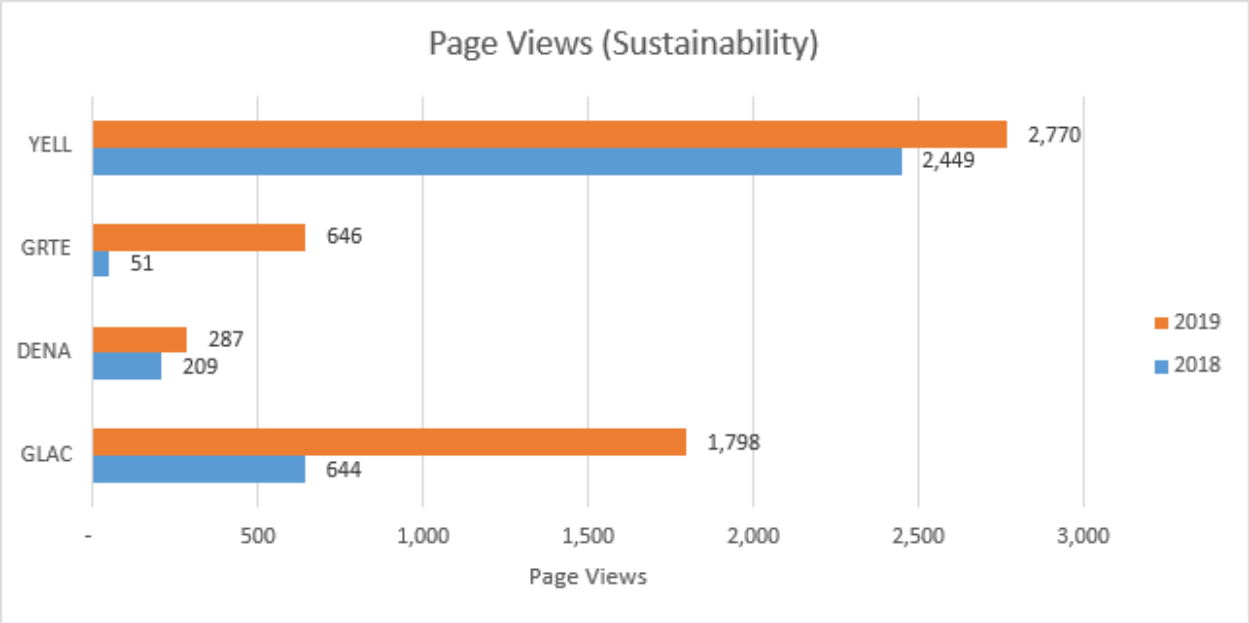
ELECTRONIC WASTE
OK- rechargeable batteries, laptop/button batteries, computer monitors/parts, CPUs, TVs, printers, scanners, stereos, radios, VCRs, DVDs, phones, pagers, power tools, small kitchen appliances (microwaves, toaster oven), beauty appliances (hair dryer),

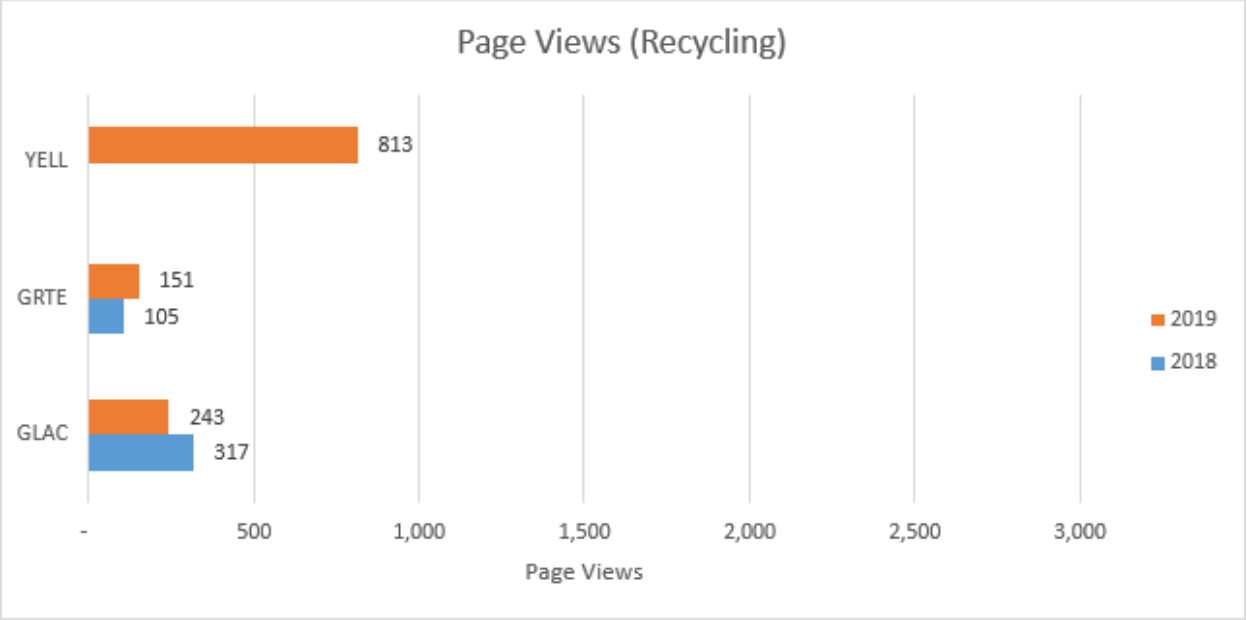
REMAINING TRASH
Any non-recyclables and non-compostables

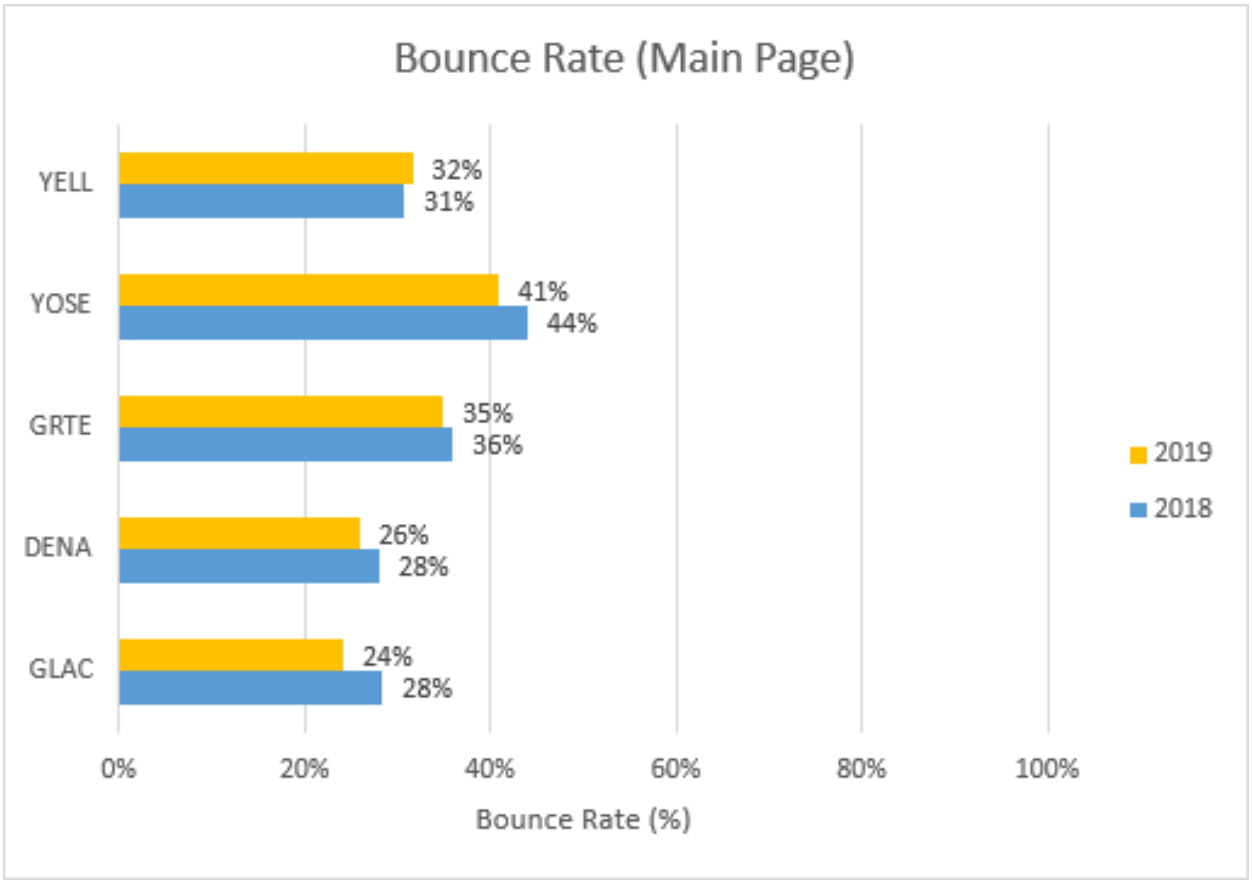
Appendix B – Web Analytics Data

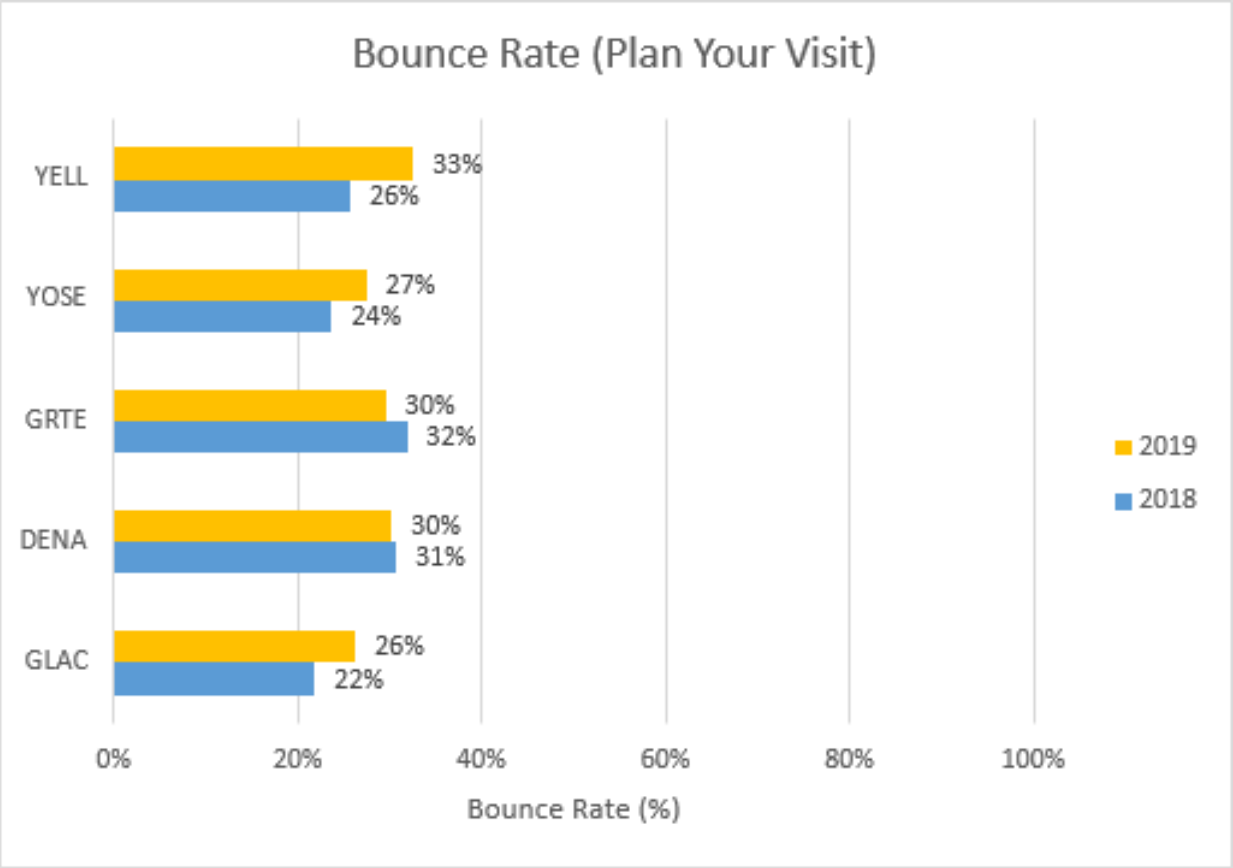


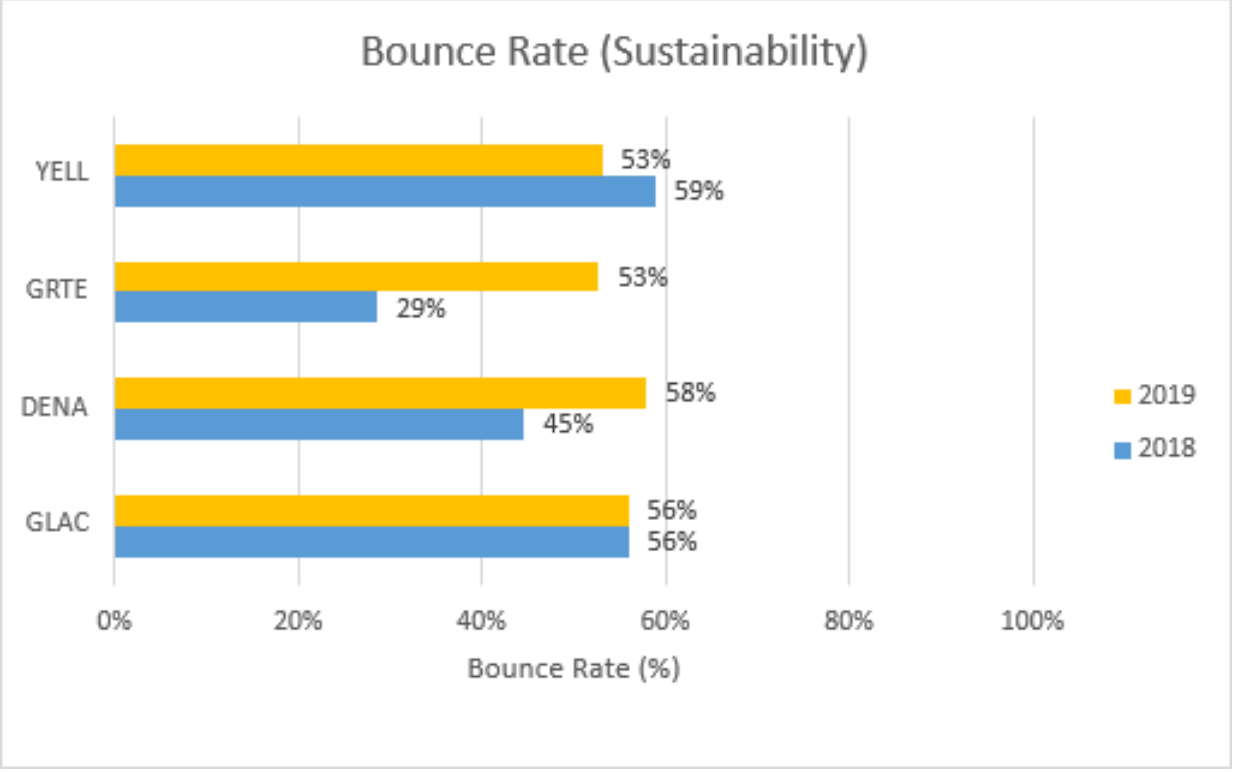


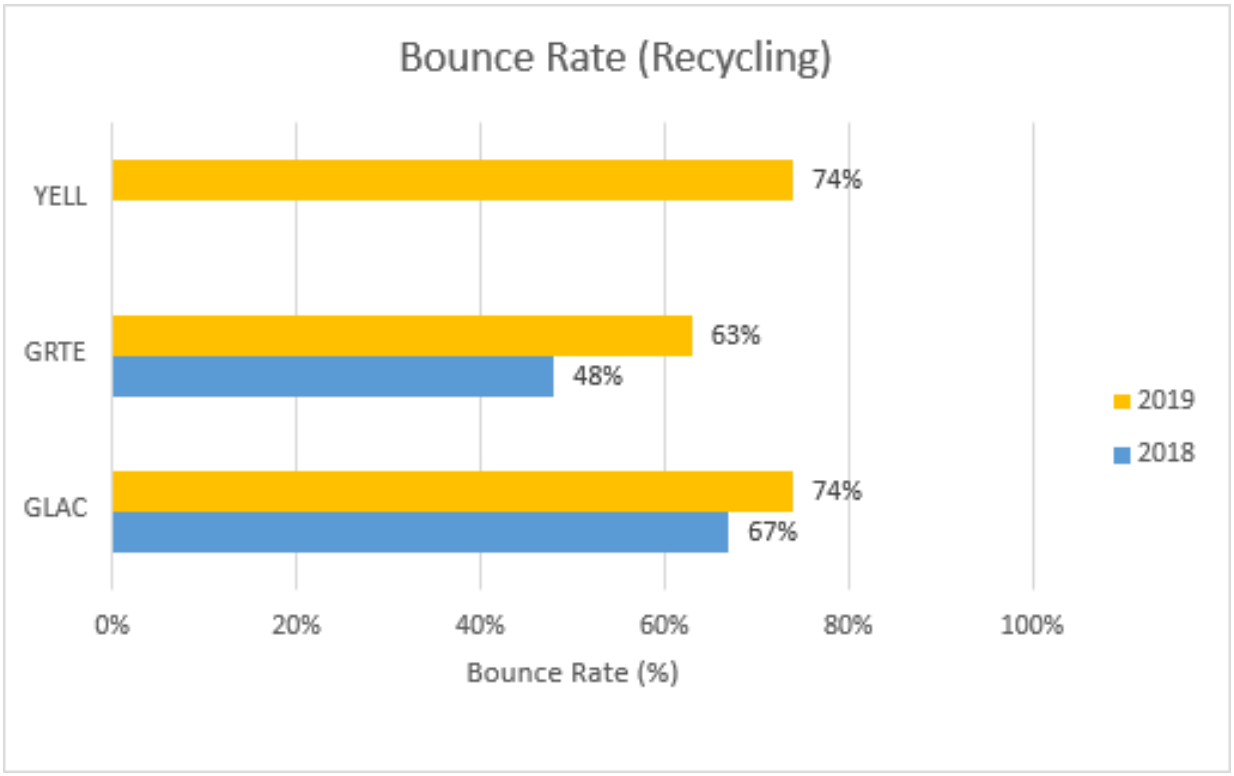

Page Views (Sustainability)
YELL
GRTE
DENA
GLAC
2,770
2,449
646
51
287
209
1,798
644
2019
2018
-
500
1,000
1,500
2,000
2,500
3,000
Page Views

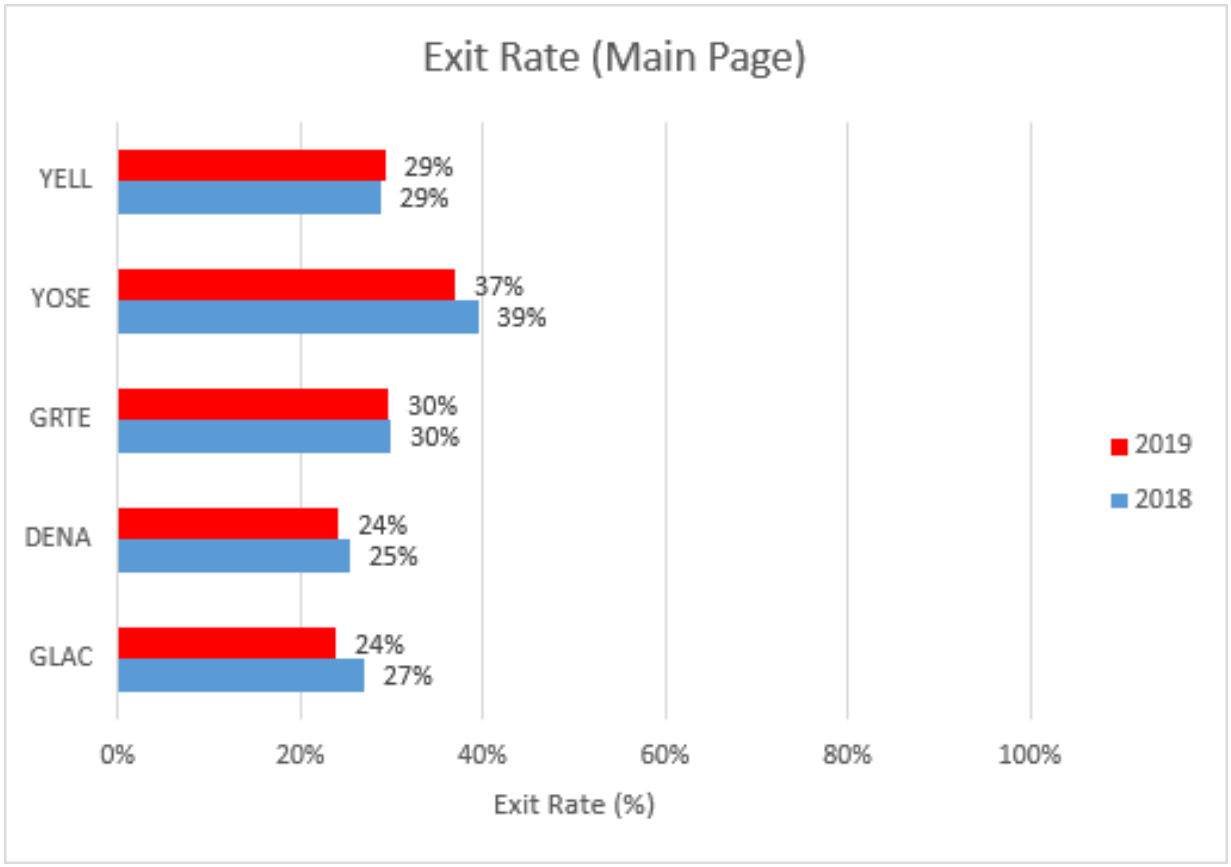

Page Views (Recycling)
YELL
GRTE
GLAC
813
151
105
243
317
2019
2018
-
500
1,000
1,500
2,000
2,500
3,000
Page Views

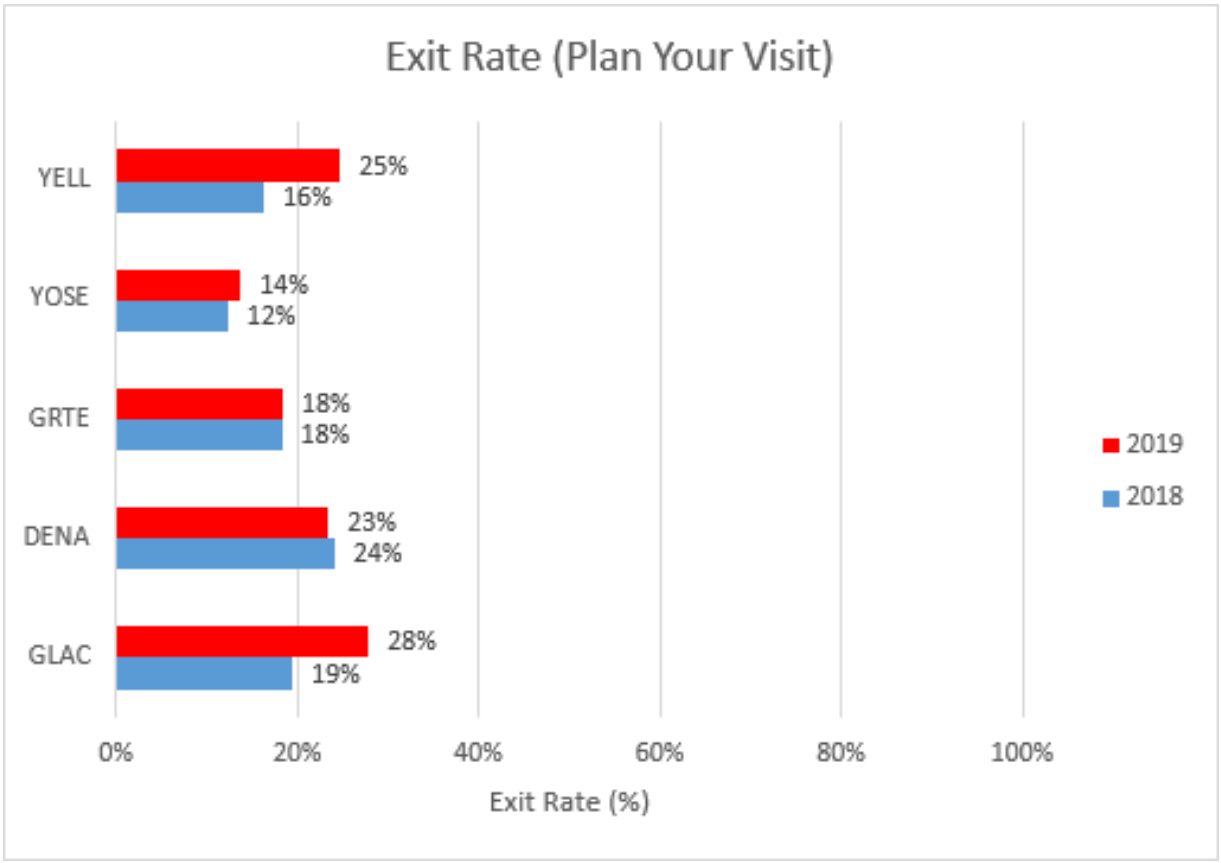

Bounce Rate (Main Page)
YELL
YOSE
GRTE
DENA
GLAC
32%
31%
41%
44%
35%
36%
26%
28%
24%
28%
2019
2018
0%
20%
40%
60%
80%
100%
Bounce Rate (%)

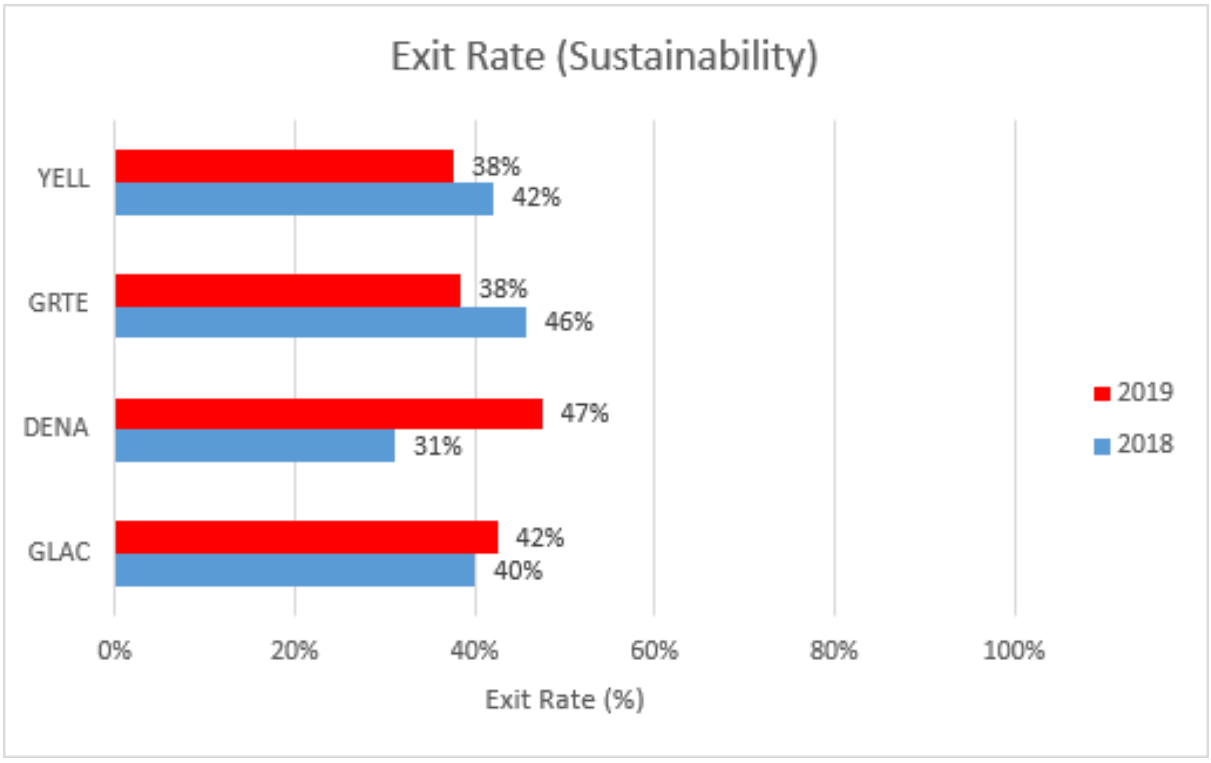

Bounce Rate (Plan Your Visit)
YELL
YOSE
GRTE
DENA
GLAC
33%
26%
27%
24%
30%
32%
30%
31%
26%
22%
2019
2018
0%
20%
40%
60%
80%
100%
Bounce Rate (%)

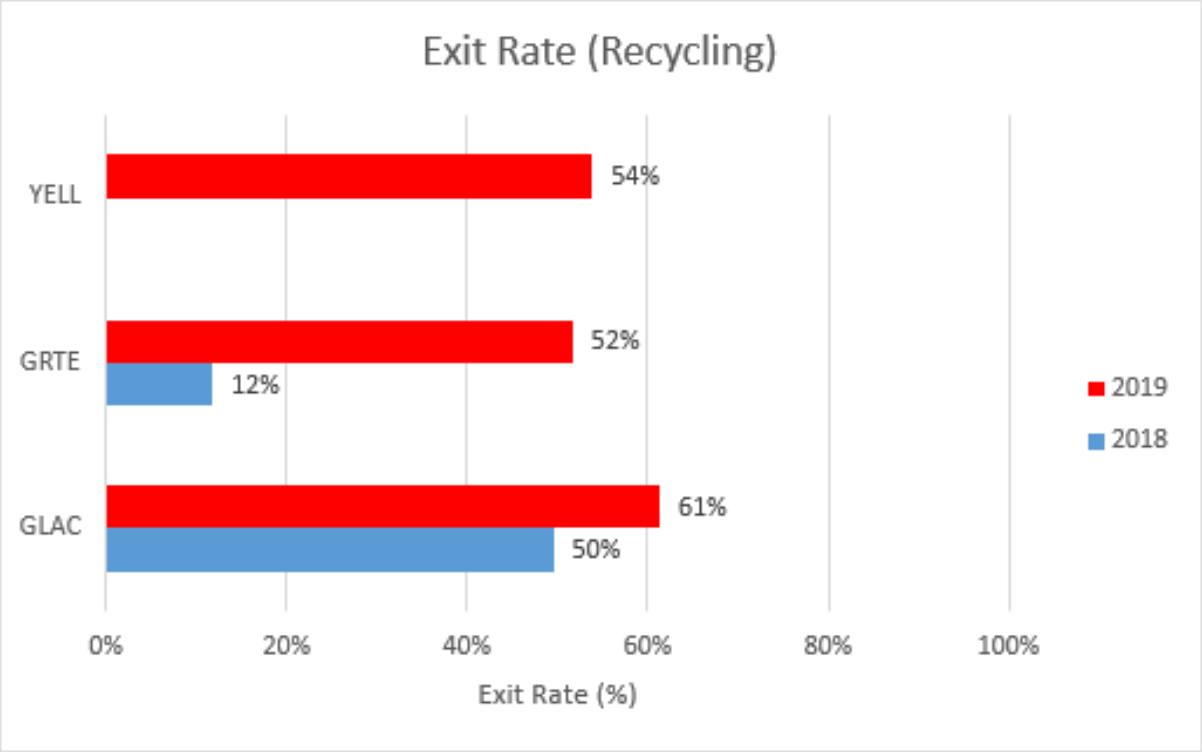

Bounce Rate (Sustainability)
YELL
GRTE
DENA
GLAC
53%
59%
53%
29%
58%
45%
56%
56%
2019
2018
0%
20%
40%
60%
80%
100%
Bounce Rate (%)

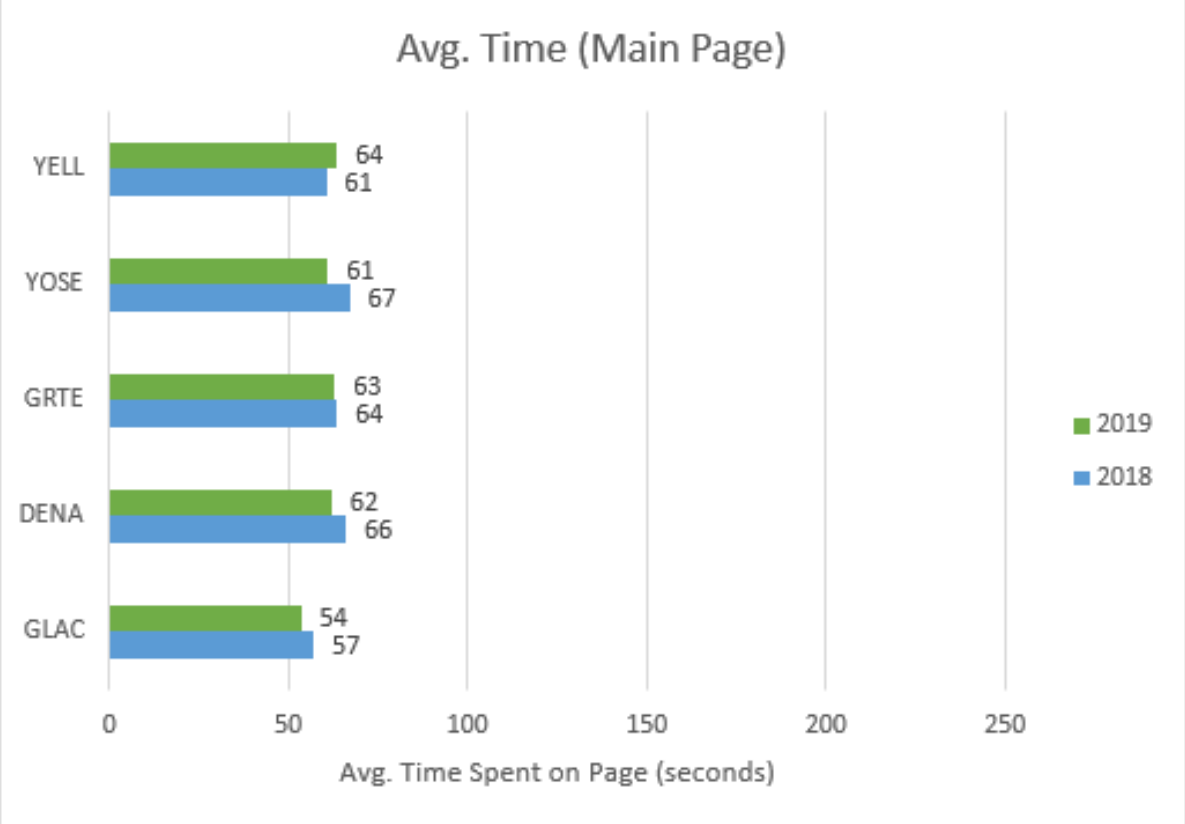

Bounce Rate (Recycling)
YELL
GRTE
GLAC
74%
63%
48%
74%
67%
2019
2018
0%
20%
40%
60%
80%
100%
Bounce Rate (%)

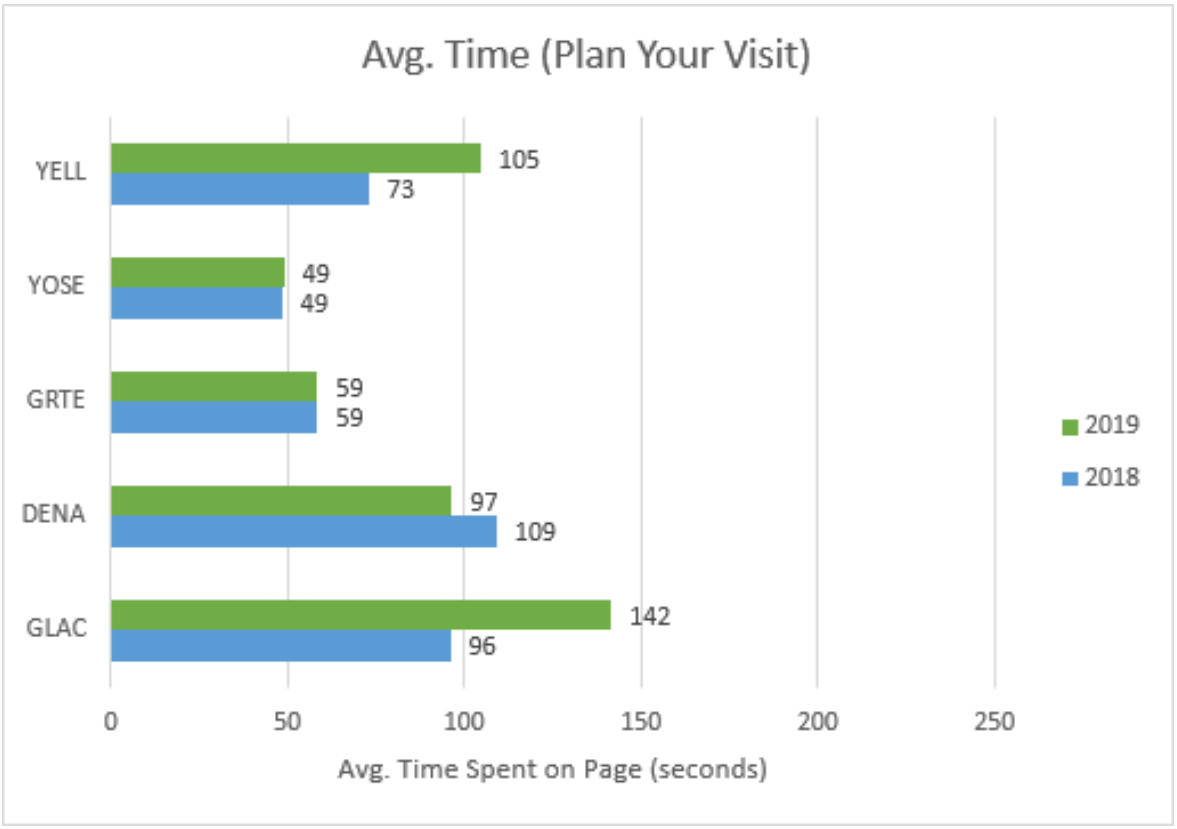

Exit Rate (Main Page)
YELL
YOSE
GRTE
DENA
GLAC
29%
29%
37%
39%
30%
30%
24%
25%
24%
27%
2019
2018
0%
20%
40%
60%
80%
100%
Exit Rate (%)

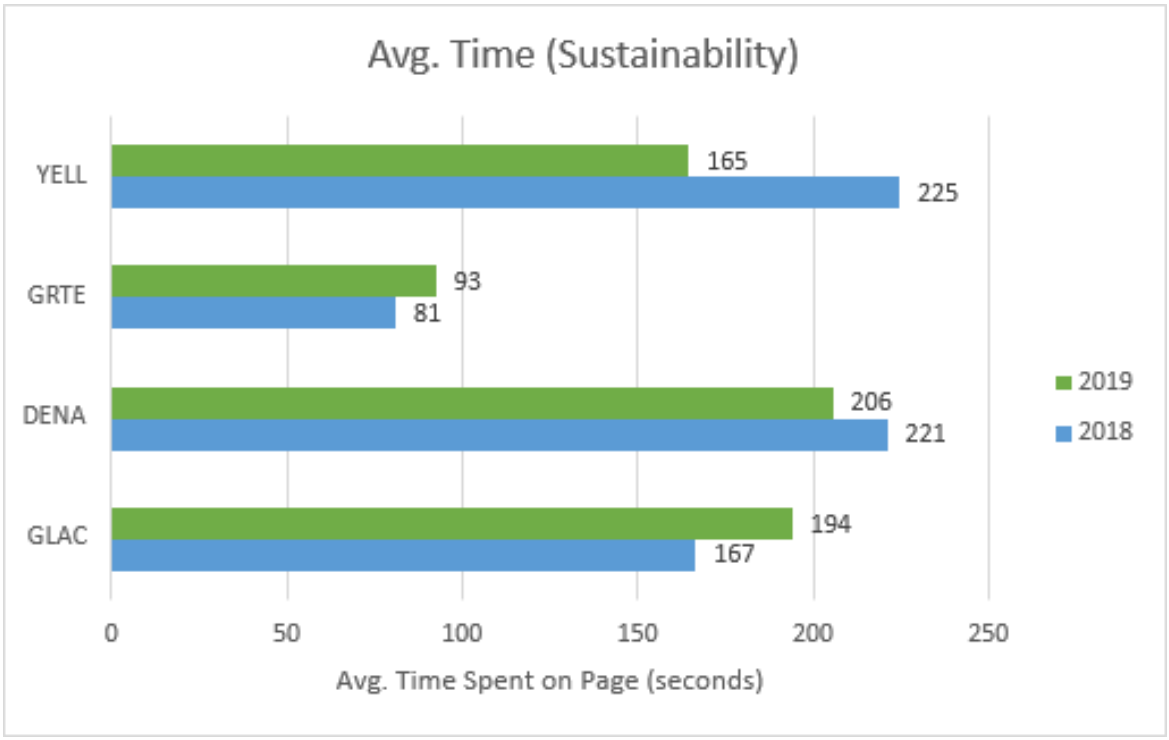

Exit Rate (Plan Your Visit)
YELL
25%
16%
YOSE
14%
12%
GRTE
18%
18%
DENA
23%
24%
GLAC
28%
19%
2019
2018
0%
20%
40%
60%
80%
100%
Exit Rate (%)

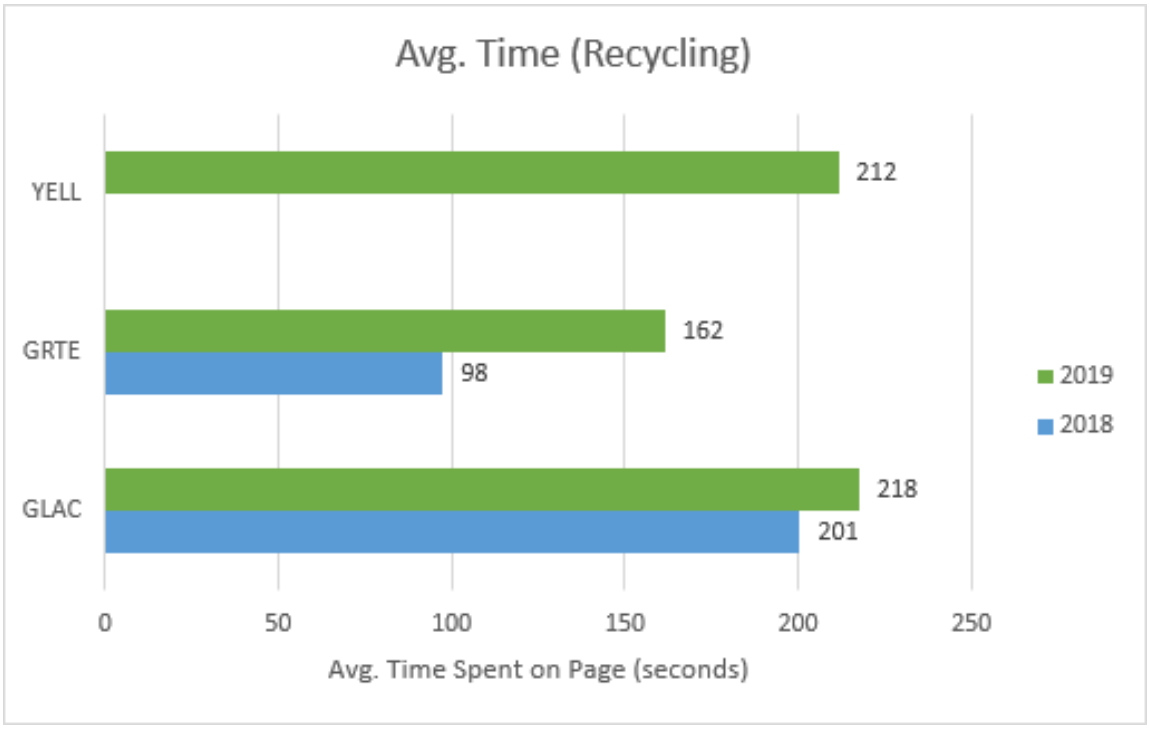

Exit Rate (Sustainability)
YELL
38%
42%
GRTE
38%
46%
DENA
47%
31%
GLAC
42%
40%
2019
2018
0%
20%
40%
60%
80%
100%
Exit Rate (%)

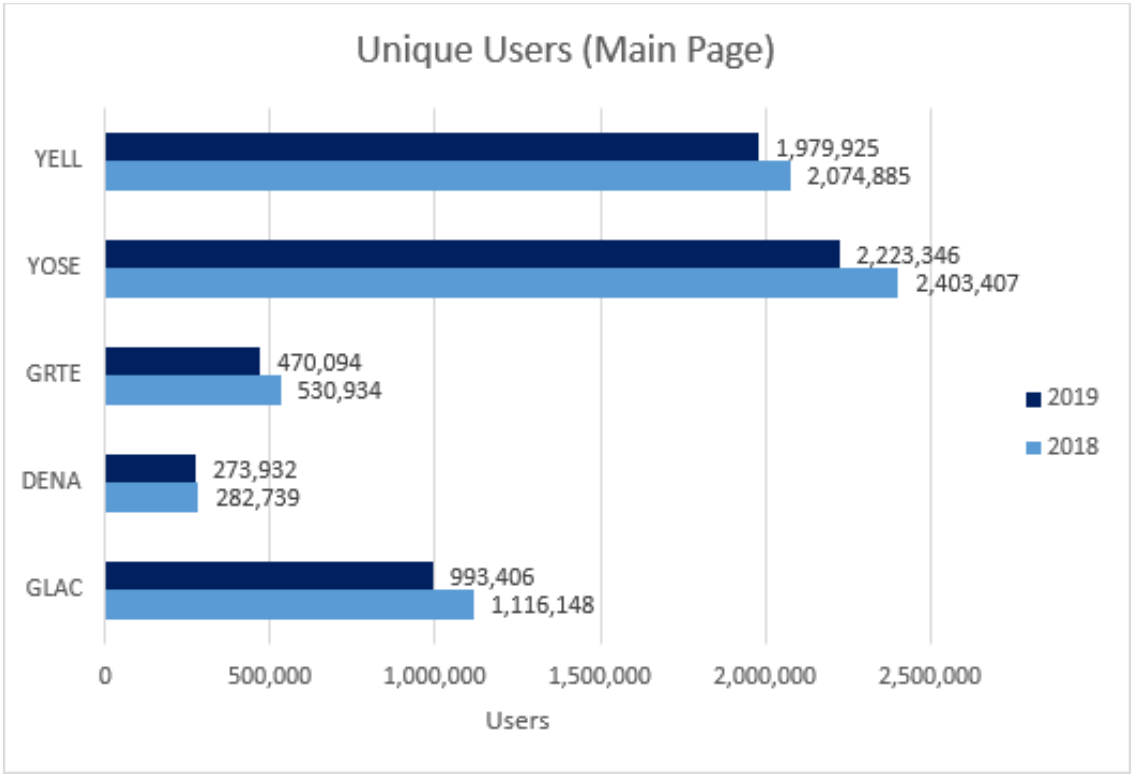

Exit Rate (Recycling)
YELL
GRTE
GLAC
54%
52%
12%
61%
50%
2019
2018
0%
20%
40%
60%
80%
100%
Exit Rate (%)

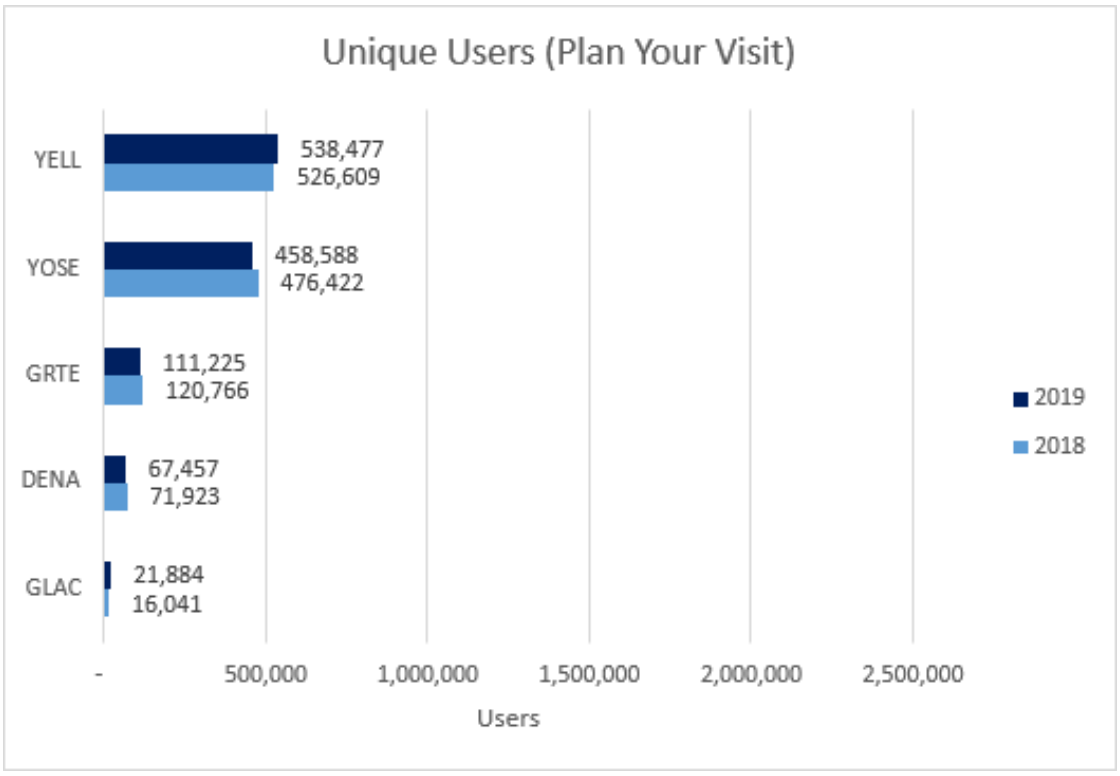

Avg. Time (Main Page)
YELL
YOSE
GRTE
DENA
GLAC
64
61
61
67
63
64
62
66
54
57
2019
2018
0
50
100
150
200
250
Avg. Time Spent on Page (seconds)

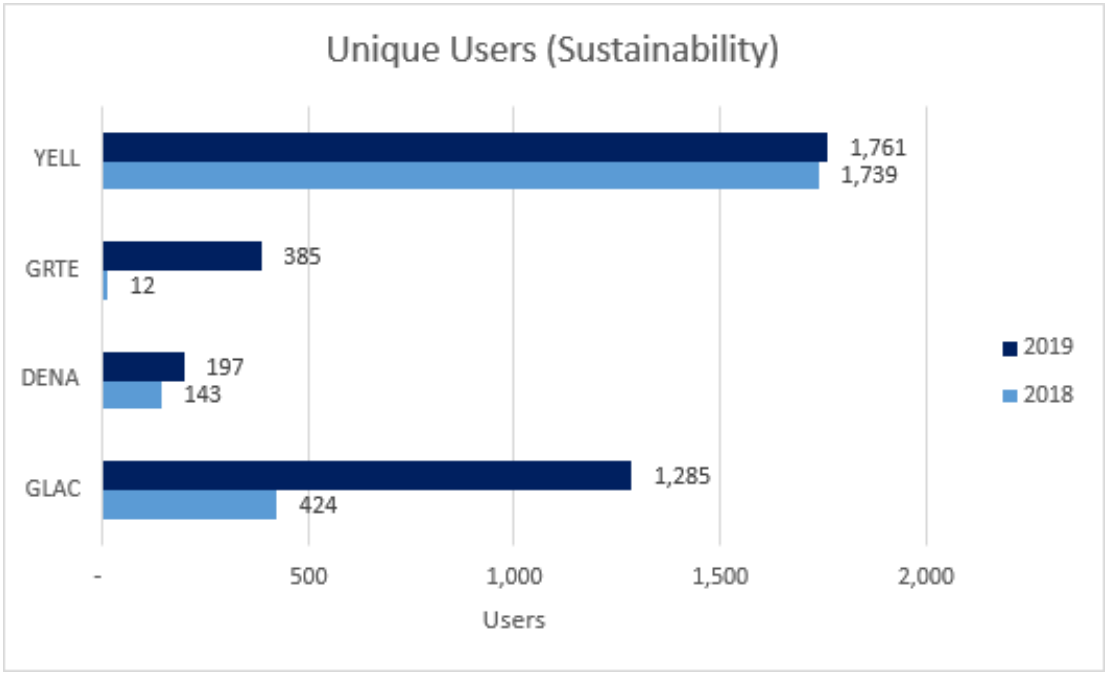

Avg. Time (Plan Your Visit)
YELL
105
73
YOSE
49
49
GRTE
59
59
DENA
97
109
GLAC
142
96
0
50
100
150
200
250
Avg. Time Spent on Page (seconds)
2019
2018

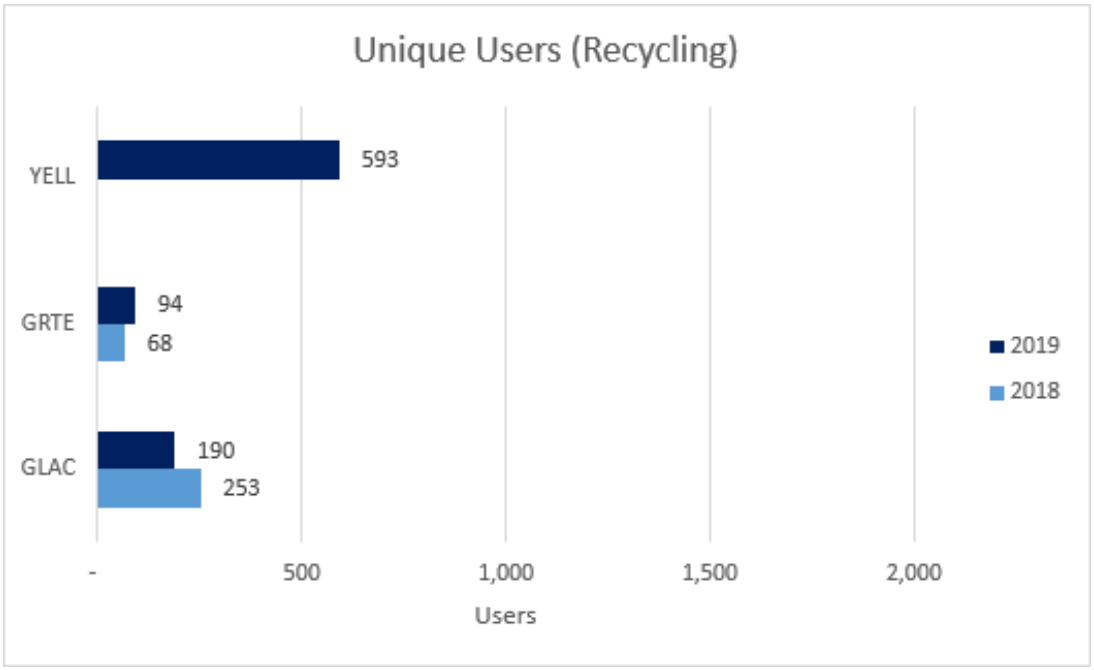

Avg. Time (Sustainability)
YELL
165
225
GRTE
93
81
DENA
206
221
GLAC
194
167
0
50
100
150
200
250
Avg. Time Spent on Page (seconds)
2019
2018

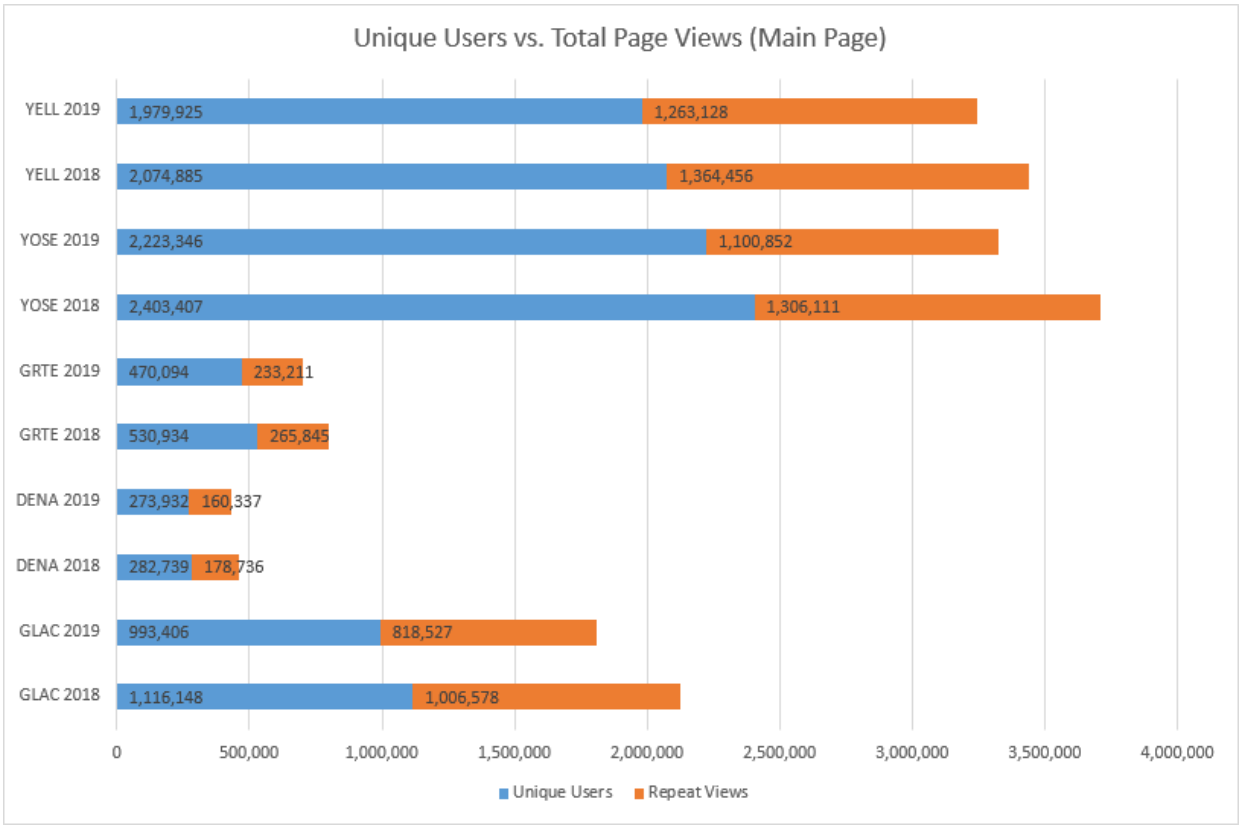

Avg. Time (Recycling)
YELL
GRTE
GLAC
212
162
98
218
201
2019
2018
0
50
100
150
200
250
Avg. Time Spent on Page (seconds)

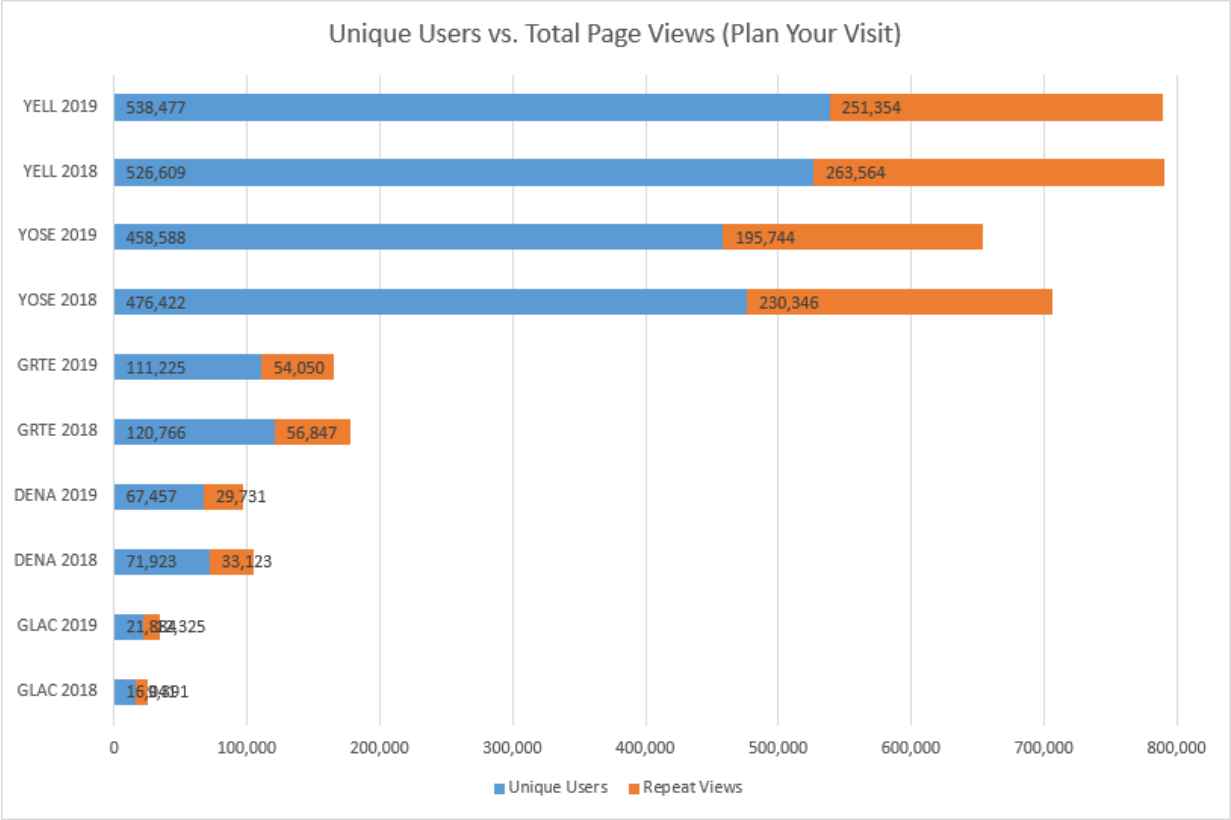

Unique Users (Main Page)
YELL
YOSE
GRTE
DENA
GLAC
1,979,925
2,074,885
2,223,346
2,403,407
470,094
530,934
273,932
282,739
993,406
1,116,148
2019
2018
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
Users

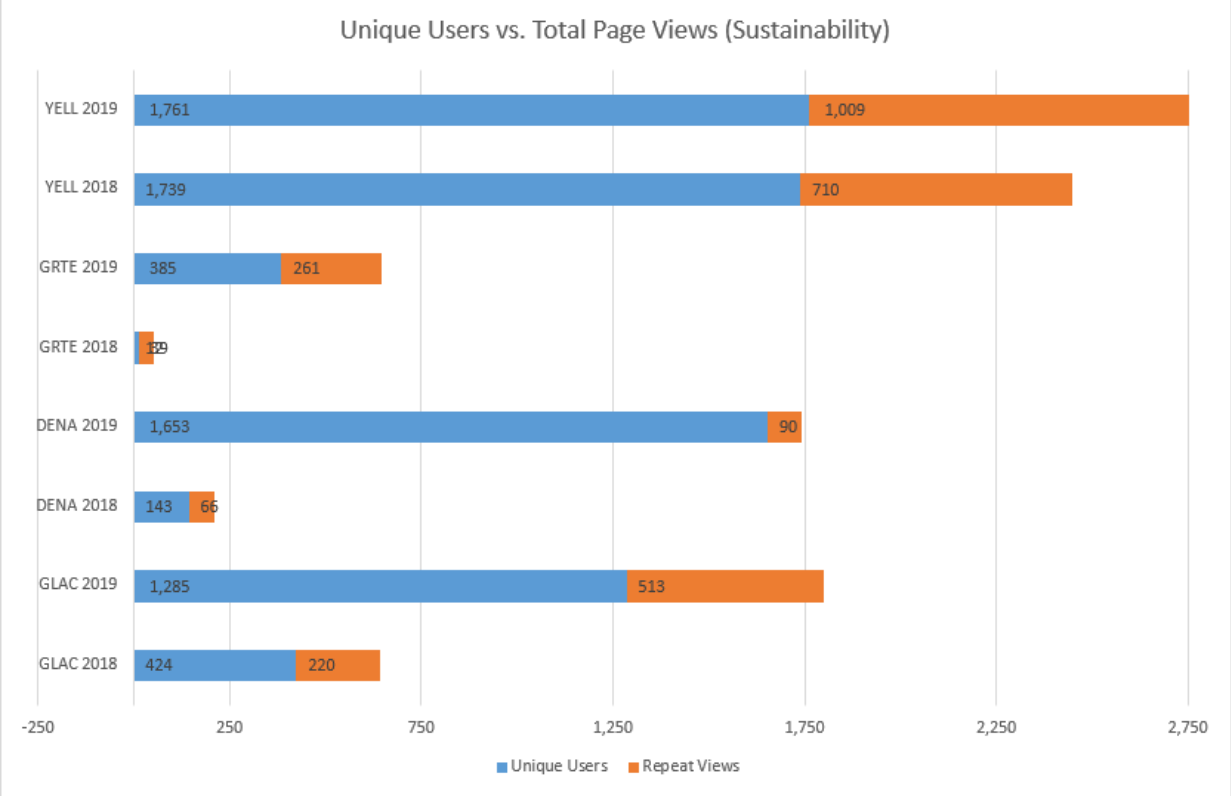

Unique Users (Plan Your Visit)
YELL
538,477
526,609
YOSE
458,588
476,422
GRTE
111,225
120,766
DENA
67,457
71,923
GLAC
21,884
16,041
-
500,000
1,000,000
1,500,000
2,000,000
2,500,000
Users
2019
2018

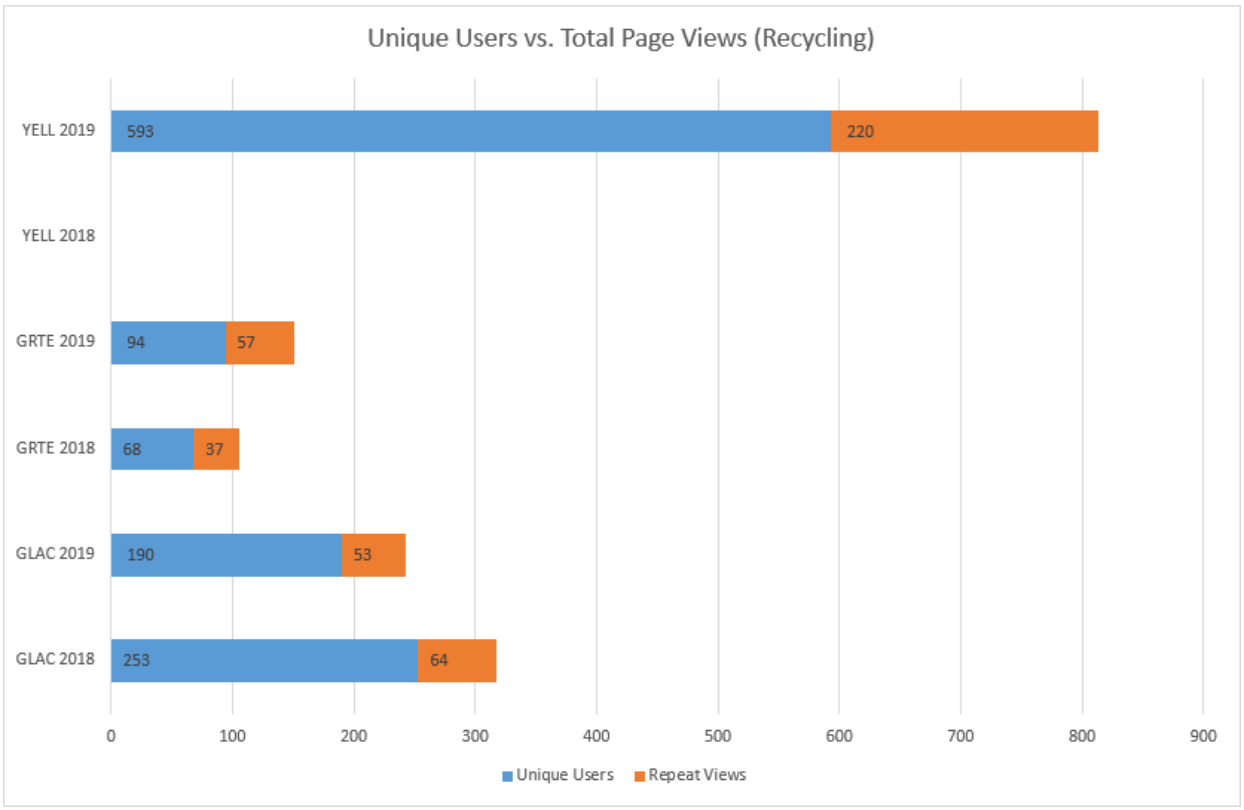

Unique Users (Sustainability)
YELL
1,761
1,739
GRTE
385
12
DENA
197
143
GLAC
1,285
424
-
500
1,000
1,500
2,000
Users
2019
2018

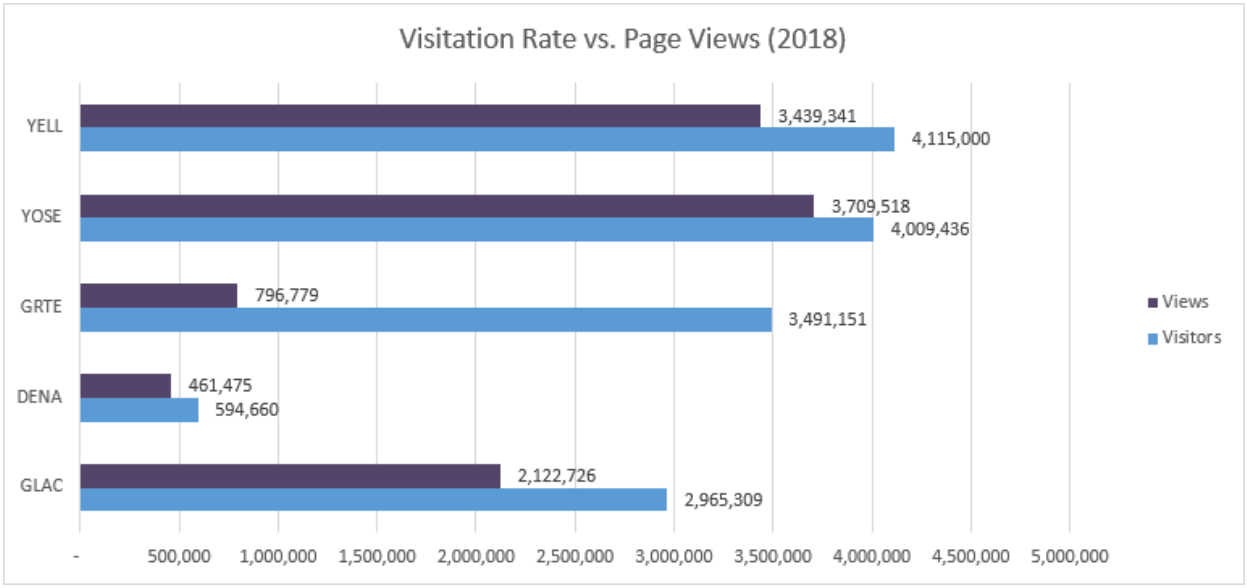

Unique Users (Recycling)
YELL
593
GRTE
94
68
GLAC
190
253
2019
2018
-
500
1,000
1,500
2,000
Users

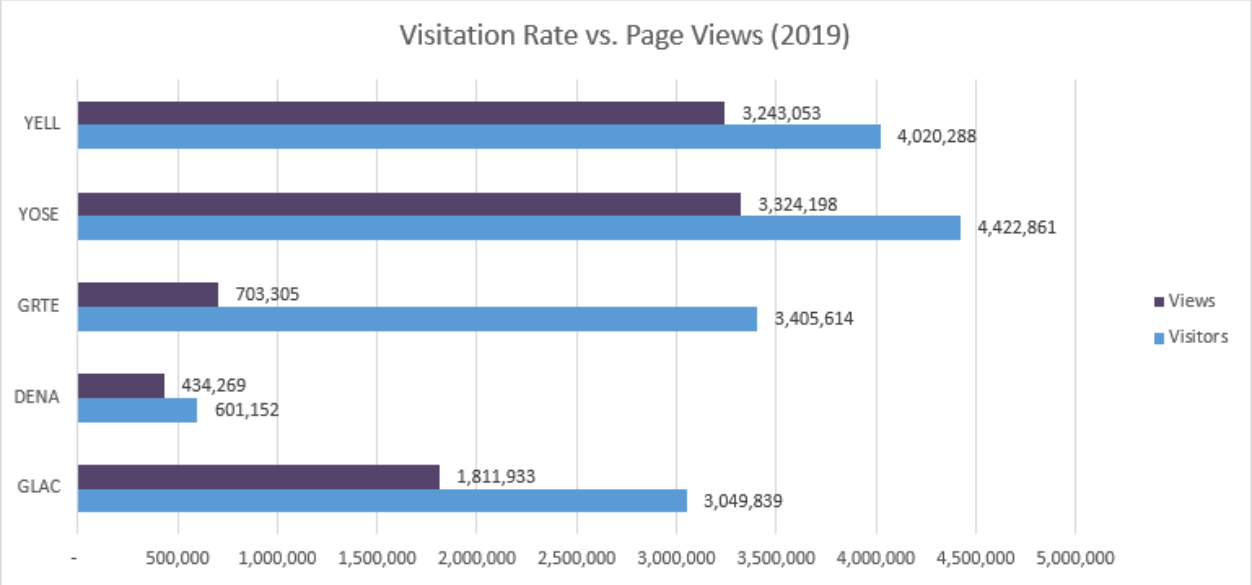

Unique Users vs. Total Page Views (Main Page)
YELL 2019
1,979,925
1,263,128
YELL 2018
2,074,885
1,364,456
YOSE 2019
2,223,346
1,100,852
YOSE 2018
2,403,407
1,306,111
GRTE 2019
470,094
233,211
GRTE 2018
530,934
265,845
DENA 2019
273,932
160,337
DENA 2018
282,739
178,736
GLAC 2019
993,406
818,527
GLAC 2018
1,116,148
1,006,578
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
3,500,000
4,000,000
Unique Users
Repeat Views


Unique Users vs. Total Page Views (Plan Your Visit)
YELL 2019
538,477
251,354
YELL 2018
526,609
263,564
YOSE 2019
458,588
195,744
YOSE 2018
476,422
230,346
GRTE 2019
111,225
54,050
GRTE 2018
120,766
56,847
DENA 2019
67,457
29,731
DENA 2018
71,923
33,123
GLAC 2019
GLAC 2018
0
100,000
200,000
300,000
400,000
500,000
600,000
700,000
800,000
Unique Users
Repeat Views


Unique Users vs. Total Page Views (Sustainability)
YELL 2019
1,761
1,009
YELL 2018
1,739
710
GRTE 2019
385
261
GRTE 2018
DENA 2019
1,653
90
DENA 2018
143
66
GLAC 2019
1,285
513
GLAC 2018
424
220
-250
250
750
1,250
1,750
2,250
2,750
Unique Users
Repeat Views


Unique Users vs. Total Page Views (Recycling)
YELL 2019
YELL 2018
GRTE 2019
GRTE 2018
GLAC 2019
GLAC 2018
593
220
94
57
68
37
190
53
253
64
0
100
200
300
400
500
600
700
800
900
Unique Users
Repeat Views


Visitation Rate vs. Page Views (2018)
YELL
YOSE
GRTE
DENA
GLAC
3,439,341
4,115,000
3,709,518
4,009,436
796,779
3,491,151
461,475
594,660
2,122,726
2,965,309
-
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
3,500,000
4,000,000
4,500,000
5,000,000
Views
Visitors



Sustainability Pages:	Glacier	Denali	Grand Teton
Type of Data	**Best Park**	**Data**	**Compare to Glacier's**
Users	Yellowstone	1761	1285
Sessions	Yellowstone	1089	626
Pageviews	Yellowstone	2770	1798
Bounce Rate	Grand Teton	52.76%	55.91%
Exit Rate	Denali	36.93%	42.49%
Average Time Spent	Denali	205.43s	193.89s
	Clicks to Get to Page:		
	Glacier	2	
	Denali	2	
	Grand Teton	2	
	Yellowstone	2	

Recycling Pages:	Glacier	Yellowstone	Grand Teton
Type of Data	**Best Park**	**Data**	**Compare to Glacier's**
Users	Yellowstone	593	190
Sessions	Yellowstone	407	171
Pageviews	Yellowstone	813	243
Bounce Rate	Grand Teton	63.64%	74.85%
Exit Rate	Grand Teton	51.66%	61.32%
Average Time Spent	Glacier	217.49s	-
	Clicks to Get to Page:		
	Glacier	?	
	Yellowstone	3	
	Grand Teton	3	

Leave No Trace:	Glacier
Type of Data	**Glacier's Data**
Users	5402
Sessions	2042
Pageviews	6181
Bounce Rate	84.97%
Exit Rate	45.87%
Average Time Spent	179.30s

Zero Landfill Initiative:	Denali	Grand Teton
Type of Data	**Best Park**	**Data**
Users	Yosemite	2396
Sessions	Yosemite	1676
Pageviews	Yosemite	3047
Bounce Rate	Grand Teton	62.01%
Exit Rate	Denali	47.48%
Average Time Spent	Grand Teton	248.79s
	Clicks to Get to Page:	
	Denali	3
	Grand Teton	3
	Yosemite	2

Appendix C – Visitor Survey

Link to the survey: http://wpi.qualtrics.com/jfe/form/SV_eA97POuYFNbwDPL

Faculty Investigators: Professors Frederick Bianchi and Frederick Looft

Student Investigators: Victoria Carreiro, Will Kelly, Nathan Sarachick, Erin Venard

Contact Information: gr-TeamRecycling@wpi.edu

Title of Research Study: Glacier National Park Recycling and Sustainability

Sponsor: Glacier National Park

Intro: You are being asked to participate in a survey. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose: The overall purpose of this study is to determine the current status of recycling in Glacier National Park, and identify the areas in which recycling outreach can be developed to help improve the park's ability to reduce, reuse, and recycle waste.

Participation in this study should take **approximately 10 minutes** for the **anonymous survey** to be completed. Further, you are free to terminate your participation in this research at any time, or to refuse to answer any questions to which you don't want to respond. Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you and you may decide to stop participating in the research at any time without penalty. The project investigators retain the right to cancel or postpone the research procedures at any time they see fit.

This study poses minimal risk to you. Therefore, you are not likely to experience significant physical or emotional discomfort. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study. Should the data be published, no individual information will be disclosed.

Data from this survey will be collected to help improve Glacier National Park's current recycling system.

Some aspects of the survey may contain some demographic questions. You are free to decline to answer any questions that you do not wish to answer for any reason. Your participation in this study is voluntary. By completing this survey, you are voluntarily agreeing to participate. If you do not agree to participate, please close this page.

Please understand that you do not give up any of your legal rights by participating in this research. For more information about this research or about the rights of research participants contact the investigators mentioned at the top of the page. In addition, you may contact the IRB Manager (Ruth McKeogh, Tel. 508 831-6699, Email: irb@wpi.edu) and the Human Protection Administrator (Gabriel Johnson, Tel. 508-831-4989, Email: gjohnson@wpi.edu).

What is your age?

- ○ Under 18
- ○ 18 - 24
- ○ 25 - 34
- ○ 35 - 44
- ○ 45 - 54
- ○ 55 - 64
- ○ 65+
- ○ Prefer Not to Answer

What is the city/country you reside in? (optional)

Do you have children?

- ○ Yes
- ○ No
- ○ Prefer Not to Answer

"I recycle everything I can"

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Have you visited Glacier National Park before?

- ○ Yes
- ○ No

How many times have you visited Glacier National Park?

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5+

How long in advance did you begin planning your trip(s)? (Select all that apply)

- [ ] 1 Week
- [ ] 2-4 Weeks
- [ ] 1-3 Months
- [ ] 3-6 Months
- [ ] 6-12 Months
- [ ] 1 Year +

Where did you stay overnight? (Select all that apply)

- [ ] RV
- [ ] Hotel/Motel
- [ ] Chalet
- [ ] Campground
- [ ] Backcountry
- [ ] Other

Did you buy your tickets the day of or reserve them in advance?

- [ ] Day of
- [ ] In advance

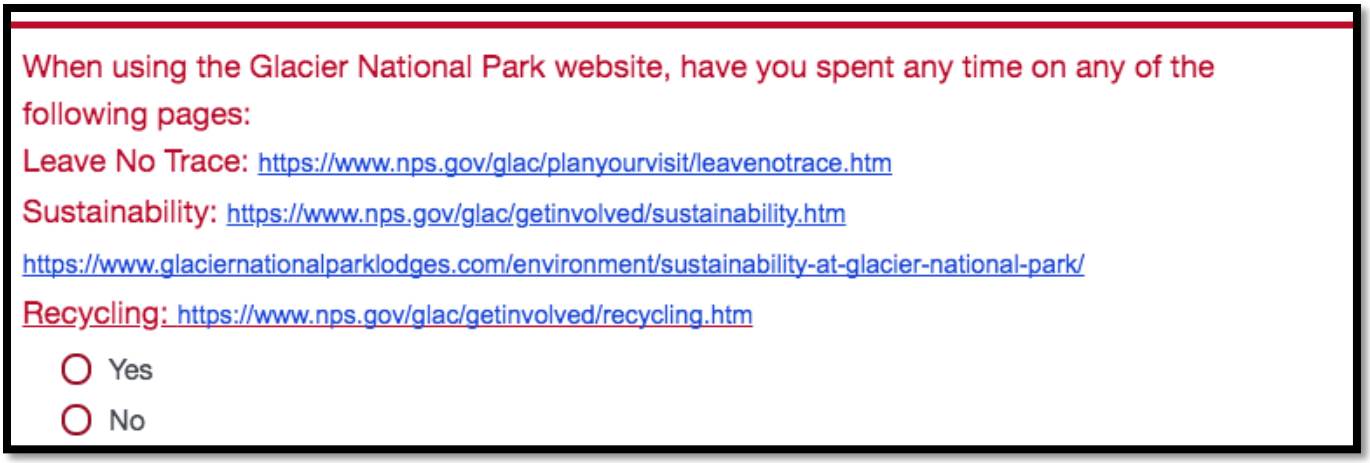
Did you receive any pre-trip information before arriving at the park? Ex. Verification/Reminder Email or Text

- ○ Yes
- ○ No

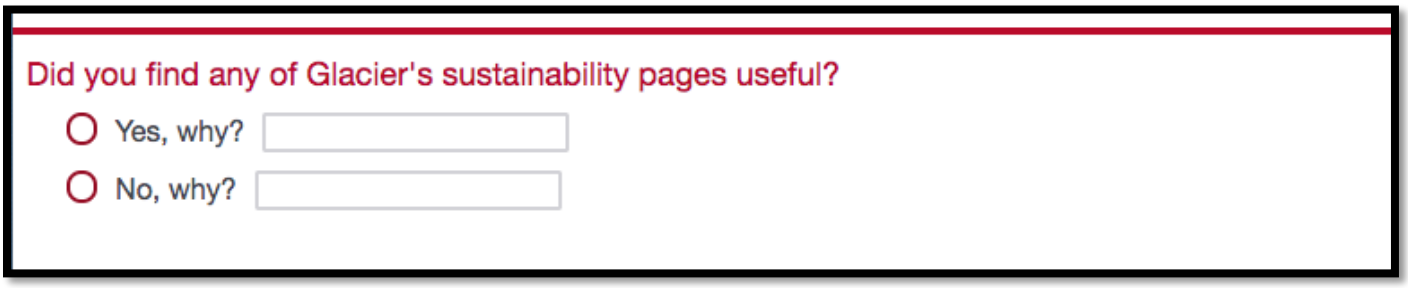
When you began planning your trip, did you utilize the Glacier National Park website?

- ○ Yes
- ○ No

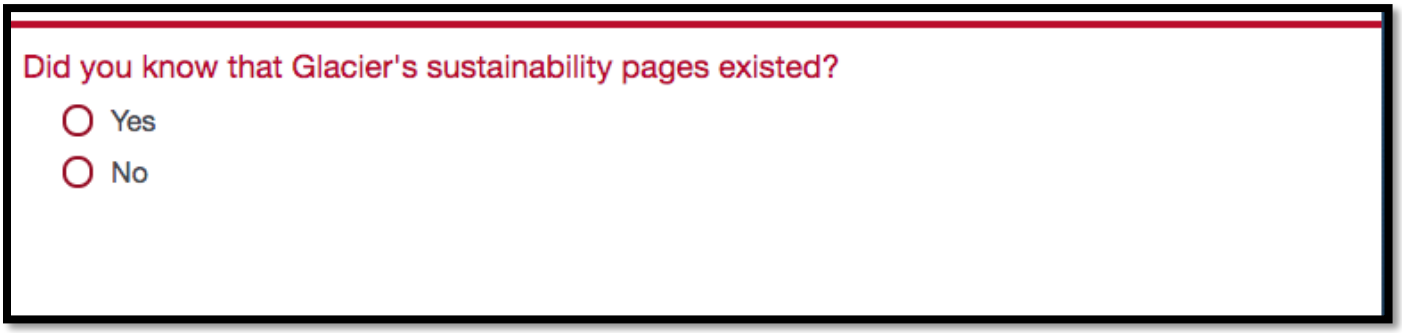
If the participant answers yes, the following question is shown:



If the participant answers yes, the following question is shown:



If the participant answers no, the following question is shown:



What kinds of recyclables did you bring into the park? (Select all that apply)

- [ ] Plastic
- [ ] Aluminum
- [ ] Steel
- [ ] Cardboard
- [ ] Paper
- [ ] Glass
- [ ] Other

Did you have any trouble finding trash receptacles or recycling bins in the park?

- ○ Yes
- ○ No

Did you have to ask questions about the locations of waste receptacles (trash or recycling)?

- ○ Yes
- ○ No

Were you able to properly dispose of waste?

- ○ Yes
- ○ No
- ○ Sometimes
- ○ I am not always sure what recycling is accepted

Was there information about recycling and sustainability available in the park?

- ○ Yes
- ○ No
- ○ I'm not sure

Do you have any suggestions to make the recycling process easier for visitors at Glacier National Park? (optional)

We thank you for your time spent taking this survey.
Your response has been recorded.

Appendix D – Staff Survey

Faculty Investigators: Professors Frederick Bianchi and Frederick Looft

Student Investigators: Victoria Carreiro, Will Kelly, Nathan Sarachick, Erin Venard

Contact Information: gr-TeamRecycling@wpi.edu

Title of Research Study: Glacier National Park Recycling and Sustainability

Sponsor: Glacier National Park

Intro: You are being asked to participate in a survey. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose: The overall purpose of this study is to determine the current status of recycling in Glacier National Park, and identify the areas in which recycling outreach can be developed to help improve the park's ability to reduce, reuse, and recycle waste.

Participation in this study should take **approximately 10 minutes** for the **anonymous survey** to be completed. Further, you are free to terminate your participation in this research at any time, or to refuse to answer any questions to which you don't want to respond. Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you and you may decide to stop participating in the research at any time without penalty. The project investigators retain the right to cancel or postpone the research procedures at any time they see fit.

This study poses minimal risk to you. Therefore, you are not likely to experience significant physical or emotional discomfort. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study. Should the data be published, no individual information will be disclosed.

Data from this survey will be collected to help improve Glacier National Park's current recycling system.

Some aspects of the survey may contain some demographic questions. You are free to decline to answer any questions that you do not wish to answer for any reason. Your participation in this study is voluntary. By completing this survey, you are voluntarily agreeing to participate. If you do not agree to participate, please close this page.

Please understand that you do not give up any of your legal rights by participating in this research. For more information about this research or about the rights of research participants contact the investigators mentioned at the top of the page. In addition, you may contact the IRB Manager (Ruth McKeogh, Tel. 508 831-6699, Email: irb@wpi.edu) and the Human Protection Administrator (Gabriel Johnson, Tel. 508-831-4989, Email: gjohnson@wpi.edu).

Do you get asked questions by visitors regarding trash, recycling, and sustainability?

- ○ Yes
- ○ No

How often are you asked questions by visitors regarding trash, recycling, and sustainability?

- ○ Rarely (1-2 per month)
- ○ 1-2 times per week
- ○ Several times per week
- ○ Once a day
- ○ Several times each day

If you do get asked questions regarding these topics, is the information readily available in the park? (Is the information they need posted somewhere within the park?)

- ○ Yes
- ○ Maybe
- ○ No

What do you think the most important recycling information is for visitors to know when visiting the park?

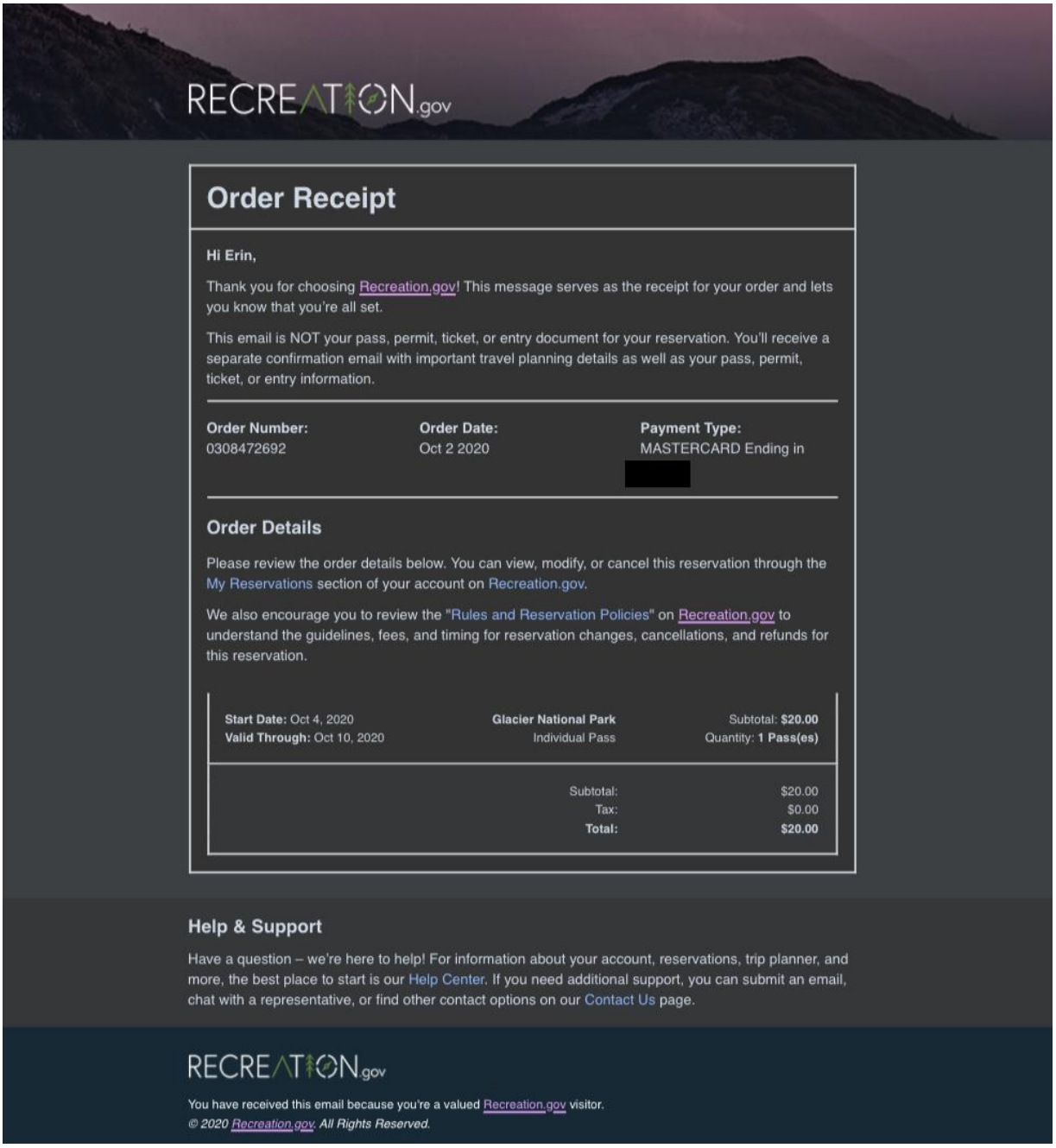
Do you think there needs to be better outreach to visitors regarding trash, recycling, and sustainability?

- ○ Yes
- ○ No

Do you have any suggestions/ideas to make information on trash, recycling and sustainability easily available to visitors? (Optional)

We thank you for your time spent taking this survey.
Your response has been recorded.

Appendix E – Reservation Confirmation Email



RECREATION.gov

Order Receipt

Hi Erin,

Thank you for choosing Recreation.gov! This message serves as the receipt for your order and lets you know that you're all set.

This email is NOT your pass, permit, ticket, or entry document for your reservation. You'll receive a separate confirmation email with important travel planning details as well as your pass, permit, ticket, or entry information.

Order Number:	**Order Date:**	**Payment Type:**
0308472692	Oct 2 2020	MASTERCARD Ending in [redacted]

Order Details

Please review the order details below. You can view, modify, or cancel this reservation through the My Reservations section of your account on Recreation.gov.

We also encourage you to review the "Rules and Reservation Policies" on Recreation.gov to understand the guidelines, fees, and timing for reservation changes, cancellations, and refunds for this reservation.

Start Date: Oct 4, 2020 **Valid Through:** Oct 10, 2020	**Glacier National Park** Individual Pass	Subtotal: **$20.00** Quantity: **1 Pass(es)**

Subtotal:	$20.00
Tax:	$0.00
Total:	**$20.00**

Help & Support

Have a question – we're here to help! For information about your account, reservations, trip planner, and more, the best place to start is our Help Center. If you need additional support, you can submit an email, chat with a representative, or find other contact options on our Contact Us page.

RECREATION.gov

You have received this email because you're a valued Recreation.gov visitor.

© 2020 Recreation.gov. All Rights Reserved.

Appendix F – Updated Waste Receptacle Signage


corrugated
cardboard
dry and flattened
no food, no paperboard


recycle across america
.org
www.recycle across america.org


mixed paper
clean and dry
no cardboard


recycle across america
.org
www.recycle across america.org

Let's recycle right!®

To prevent mistakes and contamination of the recycling:
if you're not sure if something is recyclable or not,
please put it in the trash bin.

To reorder: www.recycle across america.org