WORCESTER POLYTECHNIC INSTITUTE

Evaluation of the National Park Service's Progress Towards the Climate Change Action Plan

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An Interactive Qualifying Project Report:

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Date Submitted:
August 8th, 2021

Report submitted to:
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Abstract

This project, facilitated by Dr. Bianchi of Worcester Polytechnic Institute, evaluated the progress the National Parks Service (NPS) has made towards reducing the impacts of climate change based on the objectives of the Climate Change Action Plan (CCAP). In addition, it identified areas of improvement and made suggestions for additional actions. This was achieved by examining the eight action areas of the CCAP and identifying examples that support each goal. This report identified areas where the NPS has been successful, and it made recommendations for improvement where insufficient actions were found.

Acknowledgments

We would like to thank Professor Frederick Bianchi for his support and guidance. We greatly appreciate all that he has done throughout this project.

We would also like to thank Amanda Babson, the Coastal Landscape Adaptation Coordinator for the Northeast Region of the National Park Service, and Lee Fink, the retired Chief Ranger of Denali National Park, for taking the time to talk to us and share their knowledge regarding the National Park Service. We enjoyed hearing their perspectives, and it helped guide our project.

Executive Summary

Introduction

As science has expanded its examination of climate change, the world has developed a greater understanding of the danger it poses. The impacts of climate change have been felt around the globe through rising sea levels, increased frequency of natural disasters, and a loss of habitat for countless animals. These environmental impacts are shaping how countries protect their most vulnerable and unique lands. The United States of America is no exception as it has worked to create protections for its precious ecosystems. The National Park Service (NPS) is charged with maintaining the parks and ensuring they can survive not only the gradual changes in climate, but also extreme weather or natural disasters.

Climate change is expected to increase these dangers and make the preservation of the National Parks more difficult. Past actions of the NPS have mostly been focused on weather events, generally not considering the full impact of climate change. In 2010, the NPS released its Climate Change Action Plan (CCAP) which listed several "high-priority no-regrets actions" that the NPS can take to help mitigate climate change and minimize its effects.

The National Park Service has already implemented several of the aspects of the CCAP. They have focused on the introduction of eco-friendly transportation, monitoring landscape changes while working with the US Geological Survey, and utilizing alternative, green energy sources.

Despite these efforts, there is still much that must be done to help the National Parks mitigate and adapt to climate change. The NPS is a large government organization that lacks resources, funding, and the structure necessary to implement widespread change. Additionally, technology is improving quickly, but the NPS struggles to keep pace with that and stay up-to-date.

The goal of this project was to evaluate the progress the NPS has made toward the objectives of the Climate Change Action Plan, identify areas of improvement, and make suggestions for additional actions where applicable. This was achieved by examining each of the eight action areas of the CCAP and identifying actions and activities that support each goal. This approach allowed us to determine how much progress the NPS has made towards each goal and determine the action areas that need the most support. Through this examination, we have

identified areas where the NPS has been successful, where there are specific examples supporting their progress and other areas that lack information.

This project can be used to highlight the areas of the CCAP that need further improvement and focus by the NPS and the Climate Change Response Program (CCRP). It can serve as a jumping-off point for future improvements and implementations of climate change adaptation and mitigation strategies.

Methodology

This project aimed to evaluate the progress the NPS has made toward the objectives of the Climate Change Action Plan, identify areas of improvement, and make suggestions for additional actions where applicable. This was achieved by examining each of the eight action areas of the CCAP and identifying examples of actions that support each goal. The eight action areas are listed below:

1. Enhance Workforce Climate Literacy
2. Engage Youth & Their Families
3. Develop Effective Planning Frameworks
4. Provide Climate Change Science to Parks
5. Implement the Green Parks Plan
6. Foster Robust Partnerships
7. Apply Appropriate Adaptation Technologies
8. Strengthen Communication

The CCAP was evaluated based upon the results of each of the eight action areas. Following the evaluation, we aimed to note any areas of the CCAP that could be improved and suggested how the NPS can make further progress against the impacts of climate change. This approach allows us to determine how much progress the NPS has made toward each goal and therefore the action areas that need the most additional work. Through this examination, we have identified areas where the NPS have been successful, where there are specific examples supporting their progress, and other areas that lack information.

Findings

Overall, our methodology revealed that the National Park Service (NPS) has successfully implemented most of the actions described in the *Climate Change Action Plan* (2010). The NPS offices and partner organizations have clearly embraced the plan and worked to execute the actions dictated by the plan. Many of the NPS climate change-related activities were found supporting each of the eight emphasis areas. There were, however, some areas that still need additional actions, and in others, the activities we found were from early in the implementation of the plan and have not been updated recently. Most information on the NPS activities was relatively easy to find. The NPS and partner organizations have extensive libraries of NPS publications describing climate change-related activities, and there are also several web pages highlighting the work done and its expected impacts. In some areas, particularly those related to internal processes and actions, information was more difficult to find or unavailable.

It is important to note that the *Climate Change Action Plan* (2010) was intended to be completed in one to two years with an annual review, and then a revision of this plan would be conducted in 2014. There have not been any published revisions of this plan, and several of these goals were not completed until several years after the established timeline. We acknowledge that the implementation of change can face roadblocks and delays, especially for the National Park Service due to its large size and lack of funding as a government program. With this in mind, we have decided to focus our evaluation on the quality and quantity of action that has occurred in accomplishing the goals of the CCAP, rather than if the goals were accomplished in the set timeline of one to two years.

Conclusions

As described above, the NPS has made significant progress in implementing the recommendations of the Climate Change Action Plan. Many activities and examples were found for most of the emphasis areas. In particular, the NPS has done very well implementing actions that support the areas of:

1. Engage Youth & Their Families
2. Provide Climate Change Science to Parks
3. Implement the Green Parks Plan
4. Foster Robust Partnerships
5. Apply Appropriate Adaptation Tools & Options

6. Strengthen Communication

It was more difficult to find examples in the areas of:

1. Enhance Workforce Climate Literacy - As an external observer, it is challenging to identify all the training and literacy actions the NPS has undertaken because these are largely internal actions that are not released to the public. Much of what has been released is 4-5 years old, so it is unclear if there have been any recent activities or updates.
2. Develop Effective Planning Frameworks & Guidance - Although there exist several examples of effective planning frameworks, due to the lack of organization on the NPS website, they are difficult to find. These vital resources are not being utilized to the best potential because the park management is not aware of these available resources or not able to locate them.

In all of the eight areas, the NPS must continue to expand and update its climate change-related activities. Public engagement, communication, partnerships and adaptation actions need to be ongoing to ensure our National Parks can maintain their resilience to climate change and other natural threats.

Recommendations

The National Park Service (NPS) has been mostly successful in accomplishing the goals set by the Climate Change Action Plan (CCAP), but there are still some areas that can be improved and expanded upon. As a government program, the NPS generally lacks resources and organization, which became clear in our findings. The areas that lacked the most information were the Enhance Climate Workforce Literacy and Develop Effective Planning Frameworks & Guidance areas which focus on the internal structure of the National Parks. For these two areas, planning and framework examples were found, but it was difficult to find specific information on how these plans were implemented in the parks. Without the proper resources and implementation, these strategies do not accomplish their intended impacts; they are reduced to simple plans rather than actions and changes.

Additionally, the CCAP was written in 2010 and has not been updated recently. Although it proved to be effective in taking the initial steps needed for the NPS to address climate change, there are technological and societal advancements that have occurred since the CCAP's publication. There are areas regarding improving communication and public engagement that can be further improved and expanded upon beyond the initial scope of the CCAP. Since 2010, the internet and social media have become far more accessible and popular to individual Americans through the use of mobile phones. This is an aspect that can be utilized to strengthen communication and public engagement, which was not as strongly emphasized in the CCAP. This is an area of opportunity that can be expanded upon for the future of the NPS climate change actions.

Recommendation 1: Improve Public Engagement with Social Media

Public engagement and communication are crucial to update and maintain during the National Park Service's efforts against climate change impacts. To continue to improve this area, our first recommendation is to improve the NPS's social media outreach. Social media is the technology of the future. It is a vital platform that allows organizations to develop relationships with their target audience, and it is a faster and cheaper way to spread awareness than traditional advertising. (Henderson, 2020). The Climate Change Response Program (CCRP) currently runs several climate change awareness social media platforms for the NPS. However, these platforms have a small audience, with their largest platform, Twitter, having 34.3K followers, compared to the National Park Service twitter page (@NatlParkService) which has 654.6K followers. These platforms are an opportunity to educate a larger audience and inspire people to take action with the National Parks.

Recommendation 2: Improve Communication with Citizen Science Technology

As a government organization, the NPS understands, imperatively, the necessity of communication with the public. Through the citizen science programs, the NPS can make a stronger impact by collecting data from the citizens in the parks in real time. While technologies evolve, so must the format in which matters are addressed. We recommend incorporating a citizen science link via the main page of the NPS website,

along with real time QR codes on signage at the parks. Research conducted by Dr. Filip Meysman at the University of Antwerp, Belgium, provides an insight into the evolution of the way data is collected by citizen scientists. More than 20,000 citizen scientists were involved in Dr. Meysmans air quality research, of which 99% of the participants returned their sensors and every participant willingly paid the €10 signup fee (Aisling, 2018). Programs like this are excellent examples of how the implementation of citizen science into the NPS main page, parks signage, and mailers can make an exponential difference in the NPS's climate change mitigation response time frame. Utilizing citizen science technology would also allow the NPS to receive additional support from volunteers when they face understaffing and limited financial support from the government.

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Conclusions & Recommendations

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1. Introduction

As science has expanded its examination of climate change, the world has developed a greater understanding of the danger it poses. The impacts of climate change have been felt around the globe through rising sea levels, increased frequency of natural disasters, and a loss of habitat for countless animals. These environmental impacts are shaping how countries protect their most vulnerable and unique lands. The United States of America is no exception as it has worked to create protections for its precious ecosystems. The National Park Service (NPS) is charged with maintaining the parks and ensuring they can survive not only the gradual changes in climate, but also extreme weather or natural disasters. As a result, in 2010, the NPS released the Climate Change Response Strategy (CCRS), which provided guidance to the National Parks on how to respond to the impacts of climate change. It focused on the areas of science, adaptation, mitigation, and communication.

For over 100 years, the NPS has been challenged by weather events and natural disasters. Climate change is expected to increase these challenges and make the preservation of the National Parks more difficult. Past actions of the NPS have mostly been focused on weather events, generally not considering the impacts of climate change. In 2010, building on the CCRS, the NPS released its Climate Change Action Plan (CCAP) which listed several "high-priority no-regrets actions" that the NPS can take to help mitigate climate change and minimize its effects. The CCAP has brought the effects of climate change to the forefront, helping the NPS prepare for likely future conditions.

The National Park Service has already implemented several of the aspects of the CCAP. They have focused on the introduction of eco-friendly transportation, monitoring landscape changes while working with the US Geological Survey, and utilizing alternative, green energy sources.

Despite these efforts, there is still much that must be done to help the National Parks mitigate and adapt to climate change. The NPS is a large government organization that lacks resources, funding, and the structure necessary to implement widespread change. There is a surplus of suggestions and information that is collected by the parks, but the NPS is unable to act on a lot of it due to these restrictions. In addition, several of these suggestions are only applicable to individual National Parks and cannot be incorporated on a larger, national scale. Additionally,

technology is improving quickly, but the NPS struggles to keep pace with that and stay up-to-date.

The goal of this project was to evaluate the progress the NPS has made toward the objectives of the Climate Change Action Plan, identify areas of improvement, and make suggestions for additional actions where applicable. This was achieved by examining each of the eight action areas of the CCAP and identifying actions and activities that support each goal. This approach allowed us to determine how much progress the NPS has made towards each goal and determine the action areas that need the most support. Through this examination, we have identified areas where the NPS has been successful, where there are specific examples supporting their progress and other areas that lack information.

This project can be used to highlight the areas of the CCAP that need further improvement and focus by the NPS and the Climate Change Response Program (CCRP). It can serve as a jumping-off point for future improvements and implementations of climate change adaptation and mitigation strategies.

2. Background

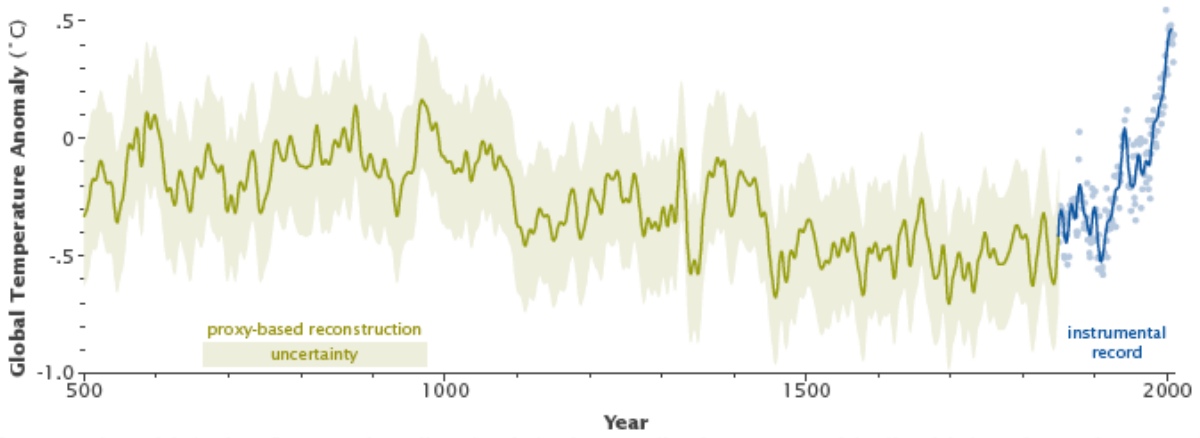
In this chapter, we discuss the background information for this report which includes the history of climate change, the history of climate change and National Parks, technologies addressing climate change (including citizen science and social media), the Climate Change Response Program, and the Climate Change Action Plan.

2.1 History of Climate Change

Climate change describes the long-term changes in the average weather patterns that define the Earth's regional and global climates. The earth's climate is a complicated system that can be changed by many things, both natural and manufactured. Some examples include El Nino and La Nina, changes in the amount of volcanic activity or energy from the sun, and most importantly, the emission of greenhouse gases from burning fossil fuels (NASA, 2021b). A changing climate can affect many different aspects of the environment.

In recent years the overall trend for climates across the globe has been an increase in temperature. According to the Intergovernmental Panel on Climate Change (IPCC), the "observed global mean surface temperature (GMST) for the decade 2006–2015 was 0.87°C (likely between 0.75°C and 0.99°C) higher than the average over the 1850–1900 period" (2018, p.4) They also point out that many land regions are warming faster than the global average, with areas of the Arctic warming three times as fast (IPCC, 2018).

The earth's temperature in the common era reached a low point in the mid 1800's, coinciding with the start of the industrial revolution. Since that time, the earth has warmed by about 1 degree C (Riebeek, 2010). The IPCC predicts that this warming trend will continue, with mid-range estimates for the end of the century at approximately 2 degrees above pre-industrial temperatures (IPCC, 2014). Figure 1 shows the earth's temperature history (Riebeek, 2010). Figure 2 shows the globally averaged combined land and ocean surface temperature anomaly (IPCC, 2014, p3). Figure 3 shows the global average surface temperature change from 1986 to 2005 (IPCC, 2014, p.11) .



Temperature histories from paleoclimate data (green line) compared to the history based on modern instruments (blue line) suggest that global temperature is warmer now than it has been in the past 1,000 years, and possibly longer. (Graph adapted from Mann et al., 2008.)

Figure 1: The Earth's Temperature History

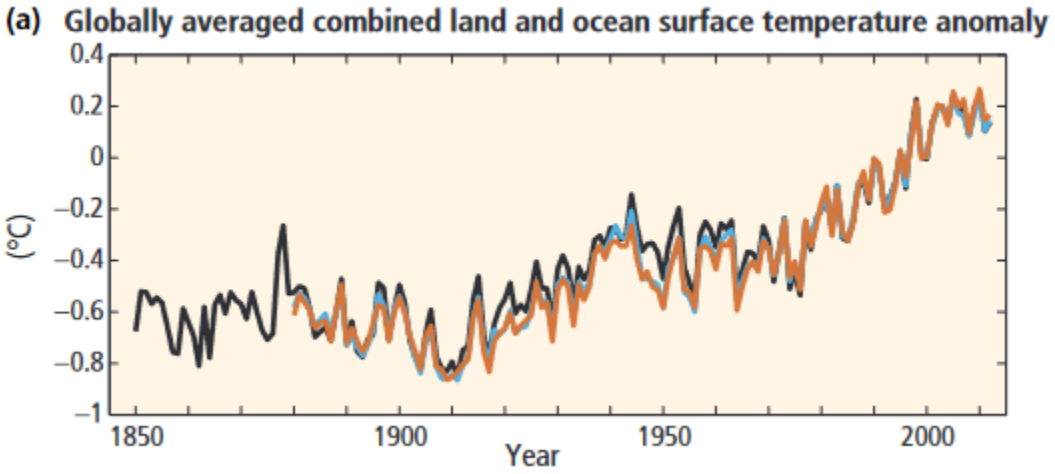


Figure 2: Globally Averaged Combined Land and Ocean Surface Temperature Anomaly

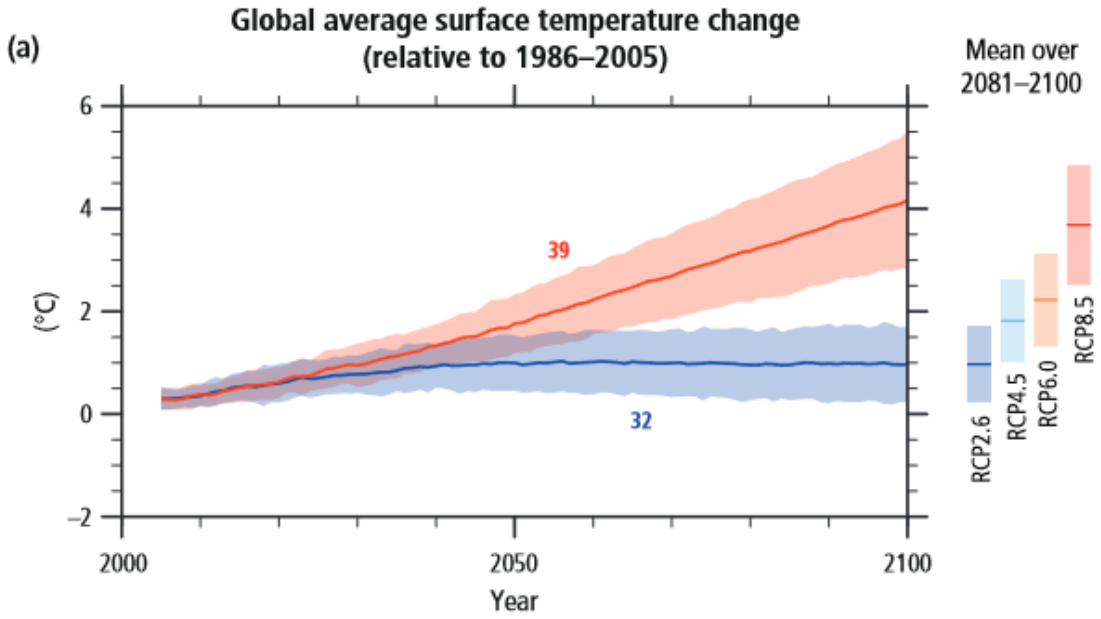


Figure 3: Global Average Surface Temperature Change

Another indicator of climate change is sea-level rise. According to NASA, the global mean sea-level has increased by 3.7 inches since 1992, and the annual rate of increase has risen from 2.5mm/year to 3.4mm/year (Carlowics, 2020). This change can cause increased coastal flooding and erosion. Local rates of change can be higher or lower than this due to land-use changes, ocean currents, and wind and elevation changes due to movements of the earth's crust. Figure 4 shows the global mean sea-level rise from 1996 to 2016 (Carlowics, 2020).

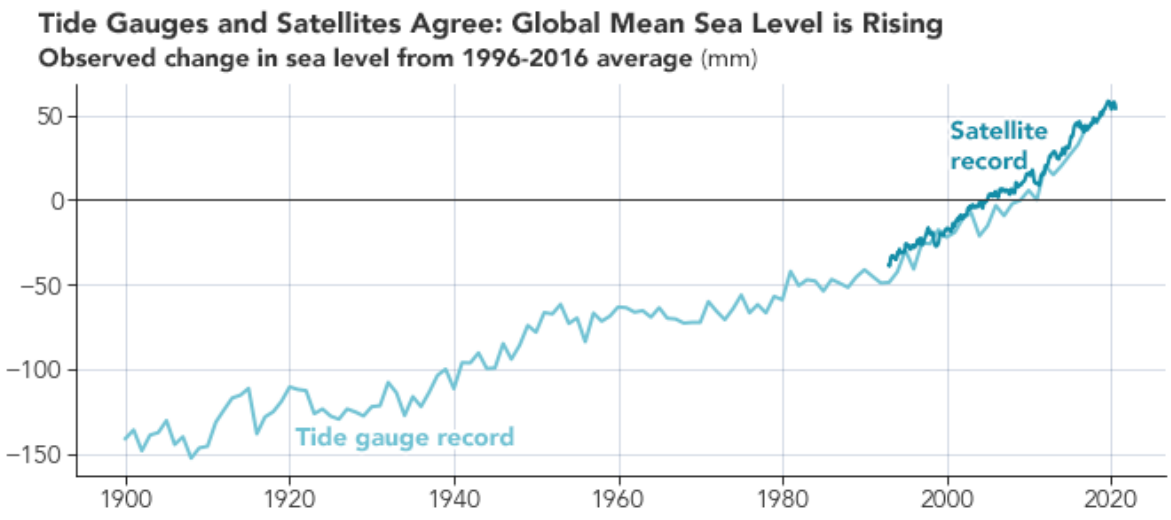


Figure 4: Global Mean Sea-Level Rise

The primary cause of anthropogenic(caused by humans) climate change is the addition of carbon dioxide to the earth's atmosphere from the burning of fossil fuels. In the early 1800's, scientists proposed that the earth's atmosphere traps heat near the surface, keeping the planet warmer than it would be otherwise. They termed this the greenhouse effect, since greenhouses also trap heat, keeping their contents warmer than their surroundings. Water vapor is the most abundant greenhouse gas (*The Causes of Climate Change*, 2021), accounting for about 60% of the warming effect (Carlowics, 2020). Carbon dioxide was first recognized as a greenhouse gas by John Tyndal in the 1860s, and in 1885, Swedish chemist Svante Arrhenius determined that doubling the amount of CO_2 in a dry atmosphere would increase the global temperature by about 5 degrees (History.com Editors, 2017).

2.2 History of Climate Change and National Parks

The effect of climate change on National Parks has created alarming consequences across the country. National Parks make up 4% of our country's land and inhabit an abundance of our wildlife (Horton, 2021). Much of the effect of climate change on parks is due to "human-caused climate change" (Horton, 2021). The mass groups of people coming to observe the beauties of national parks might seem harmless. However, between the years of foot traffic and human

influence, most parks have undergone significant changes. These changes inch parks closer and closer to becoming unrecognizable as they age.

Rising temperatures are the primary threat to National Parks. A large percentage of National Parks are located at a high elevation, where the atmosphere is thinner, allowing them to become warmer quicker. Because of this, the most commonly known effect of climate change is the disappearance of glaciers and ice sheets. Melting glaciers add to rising sea-levels, creating an increase in coastal erosion, and elevating storm surges. Parks with lower elevations are more likely to experience flooding, harsher storms, soil contamination with salt, and even a loss of habitat for fish, birds, and plants (Hancock, 2021). In 2012, Hurricane Sandy impacted a massive patch of the United States along the Atlantic coast, bringing a record storm surge and flooding to areas of New York and New Jersey. Storm events, like Hurricane Sandy, are proof that rising sea-levels can exacerbate damage from storm surges in both coastal parks and nearby communities. Additionally, for the areas of melting ice caps, there has been a wildlife crisis. A place that was once very cold is now warmer than ever, forcing wildlife to either adapt or perish as the glaciers disappear. The more the ice melts the harder it is for the remaining ice to maintain itself. Once the snow melts it exposes dark surfaces that absorb heat. Glacier National Park, located in Montana, is well known for its glacier-carved peaks, mirror-like lakes, and unfortunately, being a victim of climate change. One of the most attractive parks in the country could eventually become obsolete by losing the main reason for its existence - glaciers.

Yellowstone National Park suffers from droughts and wildfires. The high temperatures result in a lack of water and moisture throughout the park. Due to this, regulated controlled burns are banned, increasing the build-up of brush. Yellowstone park is known for its thick, towering forests. However, with the intense wildfires fueled by the newly collected brush, the forest has immensely thinned out. According to Jack Williams, a climate researcher at the University of Wisconsin, if climate change continues to ravage through Yellowstone like this, it'll one day be a 'rolling grassland' (Horton, 2021).

The National Park Service Climate Change Response Program (CCRP), established in 2010, began with the intention to maximize support, information sharing, learning, and project effectiveness of National Parks. This program is a part of the National Park Service Climate Change Response Strategy (CCRS)that features four integrated components: science, adaptation,

mitigation, and communication (*National Park Service Climate Change Response Strategy,* 2010). The CCRS seeks to:

1. Participate in partnerships that increase scientific understanding of climate change and its effects
2. Analyze potential climate change impacts and adaptively apply the information
3. Set high standards for energy efficiency and greenhouse gas emissions reduction
4. Communicate broadly about climate change science and its impacts and the actions that can be taken to mitigate and adapt

For this approach to be successfully integrated, this program will work with local communities, traditional cultures, and historic preservation partners to identify appropriate actions and strategies to adapt cultural resources to a changing climate.

To reduce the warming climate, Glacier National Park has chosen more eco-friendly options. They have replaced their electricity with solar panels; their energy is supplied by photovoltaic arrays, and they utilize a micro-hydroelectric power plant from Cleveland Creek (*National Park Service Climate Change Response Strategy,* 2010). Aside from energy efficiency, improvements to the recycling program have been made, and employees are encouraged to walk, bike, or use the employee shuttle to get to work to reduce their carbon emissions. Additionally, scientists from the United States Geological Survey (USGS) and National Park Service (NPS) are working together to monitor and measure glacier loss in hopes of reducing the rate at which the glaciers are melting.

2.3 Technologies Addressing Climate Change

2.3.1 Social Media

Social media is an internet-based technology that connects billions of people all across the world, and it facilitates the sharing of ideas and multi-media content through virtual networks and communities (Dollarhide, 2021). The most famous social media platforms include Facebook, Youtube, and Instagram. Social media originated with individuals sharing information between friends and family members, but it has now evolved to play a key role with businesses, organizations, and politicians. Social media is valuable to businesses and organizations because

it allows fast communication worldwide to connect with billions of consumers. Social media allows organizations to target consumers, build a following, and increase their exposure worldwide (Dollarhide, 2021). Due to this, social media currently plays a key role in influencing consumers and spreading awareness or popularity of different organizations, events, and causes.

Furthermore, social media plays a critical role in communicating climate change. It provides a space for discussion and education, spreads knowledgeable information regarding climate change, and mobilizes climate change activists (Idowu, 2018). Depending on how it is used, social media can influence a wide range of attitudes and behaviors around climate change, from encouraging change to spreading fear to inciting disagreements. Social media can be used to positively influence opinions, behavior, and knowledge regarding climate change, and it can reach newer, different audiences to build a larger following (Idowu, 2018). Social media is a crucial tool that should be utilized to play a positive role in understanding and managing the impacts of climate change.

2.3.2 Citizen Science

Citizen science is a technology where the public voluntarily participates in science programs where data is collected and organized (*About CitizenScience.gov*, *n.d.)*. This participation supports larger federal and nonfederal organizations in developing technologies and applications that address societal needs. CitizenScience.gov is an official government website that aids the use of citizen science and crowdsourcing across the United States. This website consists of three key resources:

1. A catalog that contains federally supported citizen science projects
2. A toolkit which provides guidance and assistance to federal practitioners with creating and maintaining their projects
3. A gateway that connects hundreds of citizen science coordinators and practitioners in a countrywide community

The National Park Service has most recently used citizen science in 2020 at Cowles Bog Trail of the Indiana Dunes National Park (Brennan, 2020). This project encourages park visitors to take several photos from specific points that overlook Cowles Bog and email them to Chonolog. These photos are then added to a long-term time lapse that is used to monitor the bog.

The data collected allows the Indiana Dune National Park Service to better manage the health of the ecosystem and encourage public awareness of the environmental changes that are occurring.

2.4 Climate Change Response Program

The National Park Service has also used several technologies to handle the impacts of climate change. Established in 2010, the National Park Service Climate Change Response Program (CCRP) aims to address the impact due to climate change across the breadth of the National Park System. The program works with other agencies and organizations, such as universities, laboratories, and institutes, both nationally and internationally, to perform the research, guidance, training, and planning. (*Climate Change Response Program,* 2021).

The CCRP is a cross-disciplinary program that provides guidance, training, technical expertise, project funding, and educational products that support actions of the NPS to preserve the natural and cultural resources and values of the National Park Service.

There are four roles expected for the CCRP to perform: (*National Park Service Climate Change Response Program Strategic Plan,* 2019).

1. Catalyst for Response and Adaptation
2. Representative of the NPS
3. Information Source
4. Guide, Supporter, and Capacity Builder

The CCRP identified six goals for the program. The program aims to enable National Parks to achieve these outcomes: (*National Park Service Climate Change Response Program Strategic Plan,* 2019).

1. " Parks are knowledgeable about the challenges of climate change, understand how to prepare for future possibilities, and draw from the best available climate science and assessment tools to inform and assist relevant management decisions."
2. "Climate change adaptation is a routine component of park planning, decision-making, and management."

3. “Parks inform their audiences about climate change effects in parks and how the NPS is responding to these challenges. ”
4. “ NPS promotes sustainability by seeking ways to reduce its carbon emissions. ”
5. “Parks and programs across the NPS and in other agencies and organizations find value in collaborating with the Program, and the Program similarly benefits from these partnerships. ”
6. “ CCRP staff are satisfied, valued, and work well together within the Program, and with other NPS employees, agencies, organizations, and the public.”

The NPS’s response to climate change is coordinated around four areas of emphasis:

1. Using Science
2. Adapt
3. Mitigate
4. Communicate

2.4.1 Using Science

The National Park System (NPS) uses science to help the park understand ecosystem and regional scale information, which better guides the park facilities on how to manage and understand their cultural and natural resources. The key elements are synthesizing existing information, research, inventory and monitoring, and providing relevant information to support decision making. This is by the scientists and professional partners of the NPS, including universities, United States Geological Survey, laboratories, and contracted and uncontracted commercial organizations.

Scientists from the NPS and its partners conduct applied research to answer key resource management questions related to (*Climate Change Response Program Science Brief,* 2020):

1. Climate trends,
2. Historical impacts of climate change,
3. Identifying vulnerable species and resources,
4. Monitoring climate and ecological indicators,
5. And quantifying greenhouse gas emissions.

2.4.2 Adapt

The National Park Service defines adaptation as an adjustment in natural or human systems that moderates harm or exploits beneficial opportunities in response to climate change (*National Park Service Climate Change Response Strategy,* 2010). The NPS is working to incorporate adaptation strategies into its routine planning and operations processes. These strategies include (*Climate Change Response Program Adaptation Brief,* 2020):

1. Provide analysis of science to support park planning.
2. Develop guidance for including climate change in planning and decision documents.
3. Analysis of park resource and facility issues associated with climate change.
4. Develop guidance and policies to support the NPS response to climate change.
5. Conduct vulnerability assessments for parks.

Portions of the NPS have adopted the RAD (Resist-Accept-Direct) framework, which acknowledges three possible responses to a changing environment. "Managers can actively resist change by intervening to reduce vulnerability to change and/or restore conditions where change has occurred. Alternatively, they can accept change, allowing ecosystems to drift into new, unprecedented conditions, often with uncertain consequences. The third option is to guide, direct, or facilitate change by intervening to transform ecosystems into new states more concordant with emerging climates and better able to sustain desired ecosystem services" (*Resist-Accept-Direct (RAD)—A Framework for the 21st-century Natural Resource Manager,* 2020). These three options have varying levels of human intervention and will have different outcomes for the park environment.

The adaptation actions that park managers take will differ greatly between parks, and even within a single park, areas will have varying response strategies. For example, adaptation strategies for coastal areas, to improve resiliency to hurricanes, would be very different from those taken in a forested area further inland, to adapt to higher heat and drought. In addition, care must be taken when planning adaptation actions to minimize unintended consequences and to balance positive and negative outcomes.

2.4.3 Mitigate

The National Park Service (NPS) identifies mitigation as a crucial aspect of adapting to climate change. Mitigation efforts of the NPS include (*Mitigate the Cause,* n.d):

1. Reduce carbon footprints, by using less energy, shifting to renewable energy options, and altering land management practices.
2. Encourage low-cost efficiency and conservation measures throughout park boundaries and NPS offices.
3. Carbon sequestration, a process that reduces carbon dioxide in the atmosphere through biological and physical processes. Two areas that are responsible for pulling large amounts of carbon dioxide from the atmosphere, which are partly managed by the NPS, include:
    a. Giant sequoia trees in California
    b. Mangroves along the Gulf Coast

The NPS mitigation efforts are quickly becoming models for thoughtful and environmentally sensitive climate stewardship.

2.4.4 Communicate

The National Parks Service (NPS) is focused on reducing climate change by reaching out to communities, stakeholders, and partners via their website and promotional materials. In 2010, the NPS deployed the Climate Change Response Strategy (CCRS), which emphasized the understanding of communication with the public. The Climate Change Response Program (CCRP) helped to produce multiple goals within the NPSs' communications objectives, including:

- Use innovative techniques and engagement practices to connect with our audiences, encourage public involvement, and inspire personal action.
- Showcase NPS efforts and investments in adapting to and mitigating climate change.
- Develop and implement training that will ensure our workforce has the most up-to-date knowledge, skills, and tools to address climate change.

CCRP deployment of a new series of materials called the *National Climate Change Interpretation and Education Strategy* (2016), setting the infrastructure for positive changes in climate. The CCRP approached participants climate change interpretation in the field via:

- Development and delivery of interpretive training opportunities
- Development of place-based interpretive media
- Development and delivery of place-based opportunities for the K-12 education community

A vast form of communication methods are maintained by the CCRP, including (*Climate Change Response Program Communication Brief,* 2020):

- The National Park Service climate change subject site
- A webinar series featuring climate change experts speaking on topics relevant to parks
- A monthly newsletter to share climate-related activities from NPS central offices, regions, programs, and parks.
- Online videos, briefing statements, and a self-study training module for interpreting climate change.
- An online community of practice for park interpreters
- High-level, quality trainings available for staff and volunteers in a variety of positions
- Media and public information services in support of science communications
- Funded internship opportunities in park interpretation and education operations

2.5 Climate Change Action Plan

The National Park Service released the *Climate Change Action Plan* (2010), which summarized the future actions that the NPS will focus on to address climate change in the National Parks. This plan prioritized the actions required by the NPS to help focus their efforts, and it provides a systematic process across all the parks to take these actions. This action plan

also acknowledges that changes in social and environmental conditions, such as the advancement in technology, will require the NPS to adapt and change their mindsets as changes occur.

The *Climate Change Action Plan* (2010) is organized in three sections to best prepare the National Park Service workforce. These three sections include:

1. Context for Action -

   This section provides background on the Climate Change Response Program and identifies guidelines that currently exist for the NPS to manage climate change impacts.

2. Identifying Near-Term Priorities -

   This section prioritizes and outlines immediate action items, and it provides cost-effective actions that will provide results. This section identifies eight areas of emphasis and recognizes which NPS programs are responsible for each action area.

3. Preparing for New Challenges and Opportunities -

   This section anticipates future conditions and describes how parks and program managers may consider additional actions as things change over time.

These eight emphasis areas identified for near-term priorities, which will play a key role in our evaluation of the plan, are:

1. Enhance Workforce Climate Literacy
2. Engage Youth & Their Families
3. Develop Effective Planning Frameworks and Guidance
4. Provide Climate Change Science to Parks
5. Implement the Green Parks Plan
6. Foster Robust Partnerships
7. Apply Appropriate Adaptation Tools & Options
8. Strengthen Communication

The *Climate Change Action Plan* (2010) aims to provide guidance and motivation to act for the betterment of the NPS. This plan was originally meant to be a short-term plan, to be completed in one to two years, which would be reviewed annually and result in a revision

conducted in 2014. However, there have been no additional revisions of this plan published, and some of the goals set in this plan were not completed until several years after the initial timeline that was set, which is shown in our Findings Section.

3. Methods

The goal of this project was to evaluate the National Park Service (NPS) and its *Climate Change Action Plan* (CCAP) (2010). This evaluation was made based upon how well the NPS followed the CCAP and what specific actions were taken by the NPS. This evaluation was done by first individually examining the eight action areas of the CCAP, which included:

1. Enhance Workforce Climate Literacy
2. Engage Youth & Their Families
3. Develop Effective Planning Frameworks
4. Provide Climate Change Science to Parks
5. Implement the Green Parks Plan
6. Foster Robust Partnerships
7. Apply Appropriate Adaptation Technologies
8. Strengthen Communication

Then, the CCAP was evaluated based upon the results of each of the eight action areas. Following the evaluation, we aimed to note any areas of the CCAP that could be improved and suggested how the NPS can make further progress against the impacts of climate change.

3.1 Enhance Workforce Climate Literacy

According to the *Climate Change Action Plan* (2010), this action area is intended to build a knowledgeable workforce regarding the effects of climate change and the response options. This is to ensure that climate change can be addressed as part of the parks' routine operations. Aiming to provide cost-effective training and learning opportunities, this action area focuses on designing climate change topics and modules that can fit into existing training programs. This training also incorporates communication technologies such as video and online training access.

Table 1: Enhance Workforce Literacy Goals

ACTIONS	WHO HAS A ROLE
EMPHASIS AREA #1 – ENHANCE WORKFORCE CLIMATE LITERACY *CCRS GOAL 13; C2A #23, #30, #31; NFWPCAS STRATEGY 3.1*	
Conduct vulnerability and risk assessment training [1]	I&M lead with CCRP support; Parks may request onsite training or take course at National Conservation Training Center
Develop framework for Interpreting Climate Change competency; make broadly available online [2]	Collaboration between CCRP, I&E, L&D incorporating natural and cultural content; Parks may submit technical assistance requests; online training available in 2013
Identify existing NPS training curricula; develop and insert appropriate climate change and sustainability content (e.g., superintendents, resource professionals, interpreters) [2]	Collaboration between CCRP and L&D; Park staff may contact their training manager or career field academy for opportunities; Regions, parks, program offices can incorporate climate change into local training programs
Create innovative videos and online training modules for use in numerous training forums [2, 3]	Collaboration among Mather Training Center, Eppley Institute, Colorado State University, CCRP and participating park staffs; Prototypes will be available online in 2013; Parks and regions can create their own case studies
Conduct Green Procurement Training for parks [4]	SOCC leads as part of the GPP; Regions and parks may request training

Table 1 describes the activities planned to accomplish this area of action, Enhance Workforce Climate Literacy. To evaluate this action plan, we:

1. Investigated the current vulnerability and risk assessment training, examining if it was changed or improved since 2010.
2. Investigated the framework for Interpreting Climate Change competency. This framework should be available online, and we examined how effectively it has been made available and incorporated into training.
3. Investigated the videos and online training modules that have been created, examining the availability and if new content has been created.
4. Investigated the Green Procurement Training for parks, examining the number of parks that have participated in this training and the program's effectiveness.

3.2 Engage Youth & Their Families

This action plan focused on Engaging Youths & Their Families in learning how to prevent climate change and build stewardship ethics in the parks. To understand how the National Parks Service connects with youths & their families on climate change and parks preservation, we looked at actions specified for the "Engage Youth & Their Families" section of the *Climate Change Action Plan* (CCAP) (2010). These actions benefit younger members by gaining education, mentorship, and hands-on work experiences.

Table 2: Engage Youth & Their Families Goals

EMPHASIS AREA #2 – ENGAGE YOUTH & THEIR FAMILIES *CCRS GOAL 13; C2A #2, #7, #18, #20, #36; NFWPCAS STRATEGY 6.2*	
Continue George Melendez Wright climate change fellowship and internship opportunities to support park high priority needs [3]	CCRP leads; Parks are encouraged to submit internship proposals and encourage young researchers to seek funding for park research through the fellowship program
Leverage climate change through other youth and diversity programs (i.e., the Student Conservation Association (SCA), webrangers, diversity program) [3]	Collaboration across multiple program areas
Provide mentorship opportunities for youth interested in climate change management and policy issues [3]	Parks, regions, and national program offices

Areas of focus for this evaluation, as provided from the *Climate Change Action Plan* (2010) in table 2, we:

1. Examined how the George Melendez Wright Climate Change Fellowship and Internship programs have helped the high priorities of the parks.
2. Investigated the contribution of youth and diversity programs such as the Student Conservation Association (SCA), web rangers, and diversity program.
3. Examined what mentorship opportunities were provided and their contribution to climate change management and policy issues.

3.3 Develop Effective Planning Frameworks & Guidance

The *Climate Change Action Plan* (2010) identified the third area of action as developing effective planning frameworks and guidance. This action area targets the internal structure and management of the National Park Service to effectively provide guidance across all parks on a national, regional, and individual level. Effective guidance is crucial for the National Parks to properly understand and manage the impacts of climate change.

Based upon the goals set in table 3, from the *Climate Change Action Plan* (2010), we evaluated this action area as follows; we:

1. Examined how climate change guidance was implemented in Long-Range Transportation Plans (LRTP's).

2. Examined how climate change planning was incorporated through prototyping into the park planning process and stewardships.
3. Reviewed changes made to General Management Plans (GMPs) to determine whether climate change was considered and if it is being addressed appropriately.
4. Reviewed the developed scenario planning guidance and training.
5. Investigated how climate change guidance was incorporated into Foundation Documents (FDs).
6. Examined Regional Strategies the NPS created to prevent climate change.
7. Examined the strategic development and implementation of cultural resource climate change core program.
8. Investigated how guidance was provided from the National Environmental Policy Act (NEPA) for considering climate change.

Table 3: Develop Effective Planning Frameworks & Guidance Goals

ACTIONS	WHO HAS A ROLE
EMPHASIS AREA #3 – DEVELOP EFFECTIVE PLANNING FRAMEWORKS & GUIDANCE *CCRS GOALS 2, 3, 5, 8; C2A #23, #30; NFWPCAS STRATEGIES 2.1, 4.2*	
Require all projects submitted to Development Advisory Board (DAB) address climate change impacts; provide reviews [5]	CPMD sets requirement, CCRP reviews; Parks identify how they have considered climate change in proposed projects
Implement climate change guidance for Long-Range Transportation Plans (LRTPs); conduct prototypes [6]	Collaboration among PFMD, CCRP, and participating regions and parks Prototypes in SER, NER, AKR and Cape Cod NS and a national LRTP underway
Conduct prototypes for incorporating climate change into a range of park planning processes and stewardship activities (e.g. GMPs [7], RSSs [8], FMPs [9], LRIPs [2])	Collaboration among PPSS, DSC, CCRP, WRD, and participating parks (e.g. Assateague Island NS, Pinnacles NM, Sequoia & Kings Canyon NPs, Catoctin Mountain Park, Joshua Tree NP); All park planning processes should consider climate change effects and responses
Review all GMPs to ensure climate change is being considered and appropriately addressed [7]	Collaboration between PPSS, DSC and CCRP; Parks conducting GMPs should consider climate change and may submit technical assistance requests to CCRP for support
Provide scenario planning guidance and training; maintain "community of practice" [10, 14]	CCRP, WRD collaborate with other directorates, divisions and regions; Parks and regions may submit technical assistance requests
Develop guidance and incorporate climate change into Foundation Documents (FDs) [7]	PPSS collaborates with CCRP and parks; All parks should consider historical and projected climate change in their FDs
Create regional climate change strategies [11]	Regional coordinators and teams work together to share approaches (e.g. PWR, AKR, NER, MWR); Parks become familiar with regional climate change strategy to identify their role
Develop and implement strategy for cultural resource climate change core program [12]	CR adaptation coordinator collaborates with Desert Southwest CESU, CR, regions, and parks
Provide guidance for considering climate change under the National Environmental Policy Act (NEPA) [19]	NRSS leads in releasing interim guidance that parks can implement while the Council on Environmental Quality develops and establishes final policy guidance

3.4 Provide Climate Change Science to Parks

According to the *Climate Change Action Plan* (2010), this action area focuses primarily on supplying climate change science to parks by pushing toward better stewardship and treating NPS units and surrounding areas as coupled human-ecological systems. By doing so, the NPS's

contribution to science results in understanding how people have been affected by and responded to changes in their environments. In the future, there are four primary goals to maintain the health of National Parks:

1. Use the best available scientific data and knowledge to inform decision-making regarding climate change.
2. Collaborate with partners to develop, test, and distribute the best results from climate change models to inform NPS activities.
3. Inventory and monitor key attributes of natural and cultural resources, and the visitor experiences likely to be impacted by climate change.
4. Acquire, provide, and apply scientific information to reduce the National Park Service's carbon footprint.

Park managers hold a large responsibility when ensuring science and communication remain throughout parks. If the NPS accomplishes these goals, there's sure to be an improvement in climate change. Table 4 provides the initial goals for this action area set by the *Climate Change Action Plan* (2010). Based upon those specific goals, we evaluated this action area as follows:

1. Investigated how the NPS monitored change and resource conditions throughout National Parks.
2. Examined how the NPS participated in international and national climate change science, adaptation synthesis, and assessment studies.
3. Investigated how the NPS analyzed the historical and projected climate trends for the NPS units; linked to park planning and provided guidance for how to use the report.
4. Examined how climate change was incorporated into the State of the Parks reporting, an additional tracking document.
5. Examined how the NPS assessed the vulnerability of park resources and ecosystems.
6. Examined how the NPS established a vulnerability assessment framework for consistency and comprehensive coverage for NPS units.

7. Examined how the NPS has researched and communicated how past cultures adapted to changing climates.

Table 4: Provide Climate Change Science to Parks Goals

ACTIONS	WHO HAS A ROLE
EMPHASIS AREA #4 – PROVIDE CLIMATE CHANGE SCIENCE TO PARKS *CCRS GOALS 1-3, 6-8; C2A #28; NFWPCAS STRATEGIES 4.2, 5.2, 5.3*	
Monitor change and resource condition at parks [1]	Vital Signs monitoring conducted through I&M networks includes climate change drivers and effects; CR collaborate with I&M to improve linkage to cultural resource condition assessment
Participate in international and national climate change science and adaptation synthesis and assessment studies (i.e., Intergovernmental Panel on Climate Change [IPCC], the National Climate Assessment [NCA]) [13]	NPS scientists (e.g., CCRP, GRD, CR, I&M, AKR) collaborate with partners
Analyze historical and projected climate trends for NPS units; link to park planning and provide guidance for how to use the reports [13, 14]	CCRP collaborates with PPSS, the University of Wisconsin, and park planners; Online access will be provided to park-specific downscaled information and synthesis reports
Incorporate climate change into State of the Parks reporting [10]	NRSS leads; Park-specific climate information included in State of the Parks database
Assess vulnerability of park resources and ecosystems [13]	Servicewide Comprehensive Call (SCC)–funded climate change projects reported as part of the DOI High Priority Performance Goals; list available on climate change intranet site
Establish vulnerability assessment framework for consistency and comprehensive coverage for NPS units [13]	CCRP (I&M, CR, GRD, and others) collaborate with park and regional scientists; Interested parks may request technical assistance
Research and communicate how past cultures adapted to changing climates [12]	CR will collaborate with parks, regions, and program offices (e.g., BRMD, I&E, I&M)

3.5 Implement the Green Parks Plan

The *Green Parks Plan* or GPP was first introduced in April 2012 to affirm the NPS's commitment to reduce their carbon footprint and increase sustainability. By integrating sustainability practices and sharing information, many parks have made large improvements through recycling, conserving energy/water/fuel, and using reusable resources. This is done to mitigate greenhouse gases which in return will decrease carbon footprint throughout each park. Table 5 lists the goals set for this action area from the *Climate Change Action Plan* (2010), which is what we used to evaluate this area and better understand the effects of the GPP; we:

1. Investigated how the number of Climate Friendly Parks has increased since 2010.
2. Examined how the Climate Leadership In Parks tool was used to assess greenhouse gas operational emissions.
3. Investigated how the NPS conducts energy audits at parks and implemented Energy Conservation Measures.
4. Investigated how the NPS conducts water audits at parks and implemented Water Conservation Measures.

5. Examined how the NPS has pursued Fleet Optimization opportunities to "right-size" the NPS fleet.
6. Examined the NPS Sustainable Buildings Implementation Plan and how assessments have begun at selected parks.
7. Examined how the NPS has issued a "no idling" policy for non-law enforcement or emergency vehicles.
8. Investigated how the NPS has used Energy Star Portfolio Managers to understand and improve energy efficiency for high-consumption parks and facilities.
9. Investigated how the NPS deployed the "My Green Parks" web tool to facilitate sustainable practices at each employee's worksite.

Table 5: Implement the Green Parks Plan Goals

ACTIONS	WHO HAS A ROLE
EMPHASIS AREA #5 – IMPLEMENT THE *GREEN PARKS PLAN* (SELECTED ACTIONS) *CCRS GOALS 9-11; C2A #23, #25; NFWPCAS STRATEGY 7.2*	
Increase the number of Climate Friendly Parks (CFP)	These actions are being implemented largely through park and regional initiatives; Coordination is conducted through the Sustainable Operations and Climate Change Branch of PPMD as part of implementing the *Green Parks Plan* [4]
Use the Climate Leadership In Parks (CLIP) tool to assess greenhouse gas operational emissions	
Conduct energy audits at parks and implement Energy Conservation Measures (EMCs)	
Conduct water audits at parks and implement Water Conservation Measures (WCMs)	
Pursue Fleet Optimization opportunities to "right-size" NPS fleet	
Finalize NPS *Sustainable Buildings Implementation Plan*; begin assessment at selected parks	
Issue "no idling" policy for non-law enforcement or emergency vehicles	
Use Energy Star Portfolio Managers to understand and improve energy efficiency for high-consumption parks and facilities	
Deploy "My Green Parks" web tool to facilitate sustainable practices at each employee's worksite	

3.6 Foster Robust Partnerships

Climate change mitigation and adaptation are much larger than a single organization. Groups from all areas must work together to minimize the impacts of changing climates. The National Park Service has a long history of working with diverse groups, both nationally and locally, at each park. Several of these partnerships can be expanded to work on the climate change problem in a unified way. New partnerships can also be created to work on specific climate change related initiatives to preserve our parks.

To evaluate how well the NPS has fostered robust partnerships, we looked for examples of NPS partnerships related to climate change. In particular, we looked for partnerships related to the actions listed in the *Climate Change Action Plan* (2010). Table 6, taken from the *Climate Change Action Plan* (2010) lists examples of groups we expected to find partnerships with, including other government agencies, universities, and non-profit organizations.

Table 6: Foster Robust Partnerships Goals

ACTIONS	WHO HAS A ROLE
EMPHASIS AREA #6 – FOSTER ROBUST PARTNERSHIPS *CCRS GOALS 6, 12; C2A #1, #11, #22, #26; NFWPCAS STRATEGIES 3.2, 5.1, 6.3*	
Strengthen regional partnerships with DOI Landscape Conservation Cooperatives (LCCs) & Climate Science Centers (CSCs) to ensure NPS climate change science and adaptation needs are addressed [10]	Regional staffs provide adaptation coordinators to four LCCs (Great Northern, Pacific Islands, South Atlantic and North Atlantic); Regional staff, I&M staff, and park superintendents engage with LCC technical or steering committees
Engage NOAA Regional Integrated Science and Assessment (RISA) teams in science and adaptation planning for parks [10]	CCRP leads; Parks and regions may apply for new RISA project funding opportunity targeting NPS scenario planning
Coordinate Clean Cities NPS Partnership with the Department of Energy to fund transportation efficiencies[4]	Actions from GPP
Maintain and strengthen relationships within the air quality community (state, federal and tribal regulators; industry; interest groups; air quality science community) to influence GHG emission reductions [20]	ARD leads
Build communities of practice with gateway communities in cooperation with non-profit organizations [3]	Pilot projects conducted through CCRP in collaboration with the National Parks Conservation Association and participating Research Learning Center staff in parks (i.e., Kenai Fjords and Glacier National Parks and Indiana Dunes National Lakeshore)
Expand new relationship with Department of Education to include climate change literacy [15]	I&E in collaboration with the Department of Education
Identify landscape conservation goals and adaptation strategies with adjacent jurisdictions [10, 12]	Collaboration among BRMD, CR, CCRP, university, and other partners; CR provides assistance to LCCs in developing landscape-scale approaches to cultural resources

3.7 Apply Appropriate Adaptation Tools & Options

This action area is intended to maintain healthy parks and protected areas, which helps ecosystems and human communities adapt to climate change, according to the *Climate Change Action Plan* (2010). Short-term adaptation tools focus on promoting resilience, while long-term adaptation tools aim to focus on conservation efforts and enhancing decision making regarding what the NPS aims to protect. This action area establishes a consistent framework that links adaptation tools, including vulnerability and risk assessments, and climate change scenarios to better guide management decisions. Table 7 describes the goals set in the *Climate Change Action Plan* (2010) for applying appropriate adaptation technology.

Table 7: Apply Appropriate Adaptation Tools & Options Goals

ACTIONS	WHO HAS A ROLE
EMPHASIS AREA #7 – APPLY APPROPRIATE ADAPTATION TOOLS & OPTIONS *CCRS GOALS 3, 5-8, 12; C2A #21; NFWPCAS STRATEGIES 3.3, 4.2*	
Create director's memo to provide management guidance on policies related to the effects of climate change on cultural resources [12]	Cultural Resources & Science Directorate
Create director's memo to provide management guidance on policies related to the effects of climate change on facilities [5]	Park, Planning, Facilities & Lands Directorate
Conduct "listening sessions" with NPS employees on *Revisiting Leopold* recommendations and next steps [10]	CCCG collaborates with the Science Committee of the NPS Advisory Board
Pilot adaptation planning processes and actions that connect vulnerability assessments and scenarios to park planning; report to DOI and communicate widely [10]	CCRP leads; adaptation actions reported to DOI High Priority Performance Goals (posted on the CCRP SharePoint site); Parks may submit examples
Complete *Renewable Energy Installation Siting Guidance* [17]	Collaborative with PFMD, ARD and GRD
Initiate decision framework for navigating various resource adaptation options and practices [10]	Collaboration across natural and cultural resources and facilities; Parks can get involved through the adaptation review team
Create risk screening tool for assessing risk to facilities; extend to cultural resources [4, 10, 12]	Collaboration across natural and cultural resources and facilities; Selected park prototypes

We evaluated this action area based upon table 7; we:

1. Examined director's memos that provide management guidance on policies related to the effects of climate change on cultural resources.
2. Examined director's memos that provide management guidance on policies related to the effects of climate change on facilities.
3. Investigated the NPS employee "listening sessions" on *Revisiting Leopold* recommendations.
4. Examined the *Renewable Energy Installation Siting Guidance.*
5. Investigated the decision framework regarding resource adaptation options and practices.
6. Investigated the risk screening tool for assessing risk to facilities and cultural resources.

3.8 Strengthen Communication

This action area is intended to strengthen communication between the NPS and citizens of all ages. This can be done through direct experiences such as natural classrooms or interpretive and educational media. There are also opportunities through the internet to connect the broader public with park employees in new ways. The goal of this communication is to engage the public in understanding how climate change affects the planet's resources and to empower people to adapt their behavior to mitigate the causes of climate change and promote resource stewardship.

Table 8: Strengthen Communication Goals

ACTIONS	WHO HAS A ROLE
EMPHASIS AREA #8 – STRENGTHEN COMMUNICATION *CCRS GOALS 5, 6, 8, 12-14; C2A #3, #14, #17, #19; NFWPCAS STRATEGIES 6.1, 6.2*	
Link new interpretive exhibits using social networking tools to present climate change issues common to many parks (e.g., sea level rise; phenology) [2]	Collaboration among Harpers Ferry Center, CCRP, and participating park staffs; Prototype waysides can be used as templates by interested parks
Include climate change in national social media strategy [18]	I&E leads; Parks serve as innovative examples and implement approaches in their local communications
Create a "network of champions" throughout parks to share compelling stories and messages of hope to empower other parks and visitors to take action [2]	Cross-cutting effort involving L&D, CCRP, CR, ARD, and park leaders; Parks are encouraged to find and share their examples
Disseminate successful internal communication products to public audiences [2]	Parks and regions identify and share best practices with the public
Continue regular climate change webinars for employees [16]	CCRP collaborates with other divisions, directorates and regions (e.g., AKR, WRD, CR, SOCC) Parks and regions are encouraged to submit topics of interest
Develop internal website to share planning, adaptation, and communication guidance and products; include park stories and an online forum to support communities of practice [2]	CCRP collaborates with other divisions and directorates (e.g., WRD, CR, BRMD, GRD, ARD)
Develop and release a national interpretive plan for climate change [2, 15]	I&E collaborates with CCRP, regional, and park staff
Coordinate climate change and cultural resource community of practice [12]	CR adaptation coordinator leads conference calls and online community, with participation and support from CR, other directorates, regions, and parks

Table 8, from the *Climate Change Action Plan* (2010), describes the actions the NPS planned to accomplish for this area, Strengthen Communication. To evaluate this action plan, we:

1. Investigated the number of interpretive exhibits presenting climate change issues that have been added to National Parks since the Climate Change Action Plan began in 2010.
2. Investigated the social media activity regarding climate change of the National Park Service and how it has been enhanced to improve its connection to local communities.
3. Investigated the number and quality of climate change webinars for employees since 2010.

4. Investigated the NPS website for online forums that share planning and support communities of practice.
5. Investigated the development of the interpretive plan for climate change and if it has been released yet.

3.9 Summary of Methods

Following the individual examinations of the eight action areas, we evaluated the National Park Service and its *Climate Change Action Plan* (CCAP) (2010) as a whole. This evaluation was determined based upon:

1. How well the CCAP was followed
2. Whether most, if not all, of the goals of the CCAP were accomplished
3. How well the CCAP goals were completed, and whether some areas are lacking fulfillment
4. And finally, If there are areas that can be improved

The NPS and its CCAP could receive an excellent evaluation if all of the goals were accomplished and the NPS took further action after accomplishing the original goals set. They could receive a poor evaluation if few of the goals were accomplished, the NPS showed a lack of action, or if information is not accessible. A fair or good evaluation would mean that the NPS accomplished some or most of the goals set in the CCAP, but there is still strong room for improvement or goals left to fulfill completely.

4. Findings

Overall, our methodology revealed that the National Park Service (NPS) has successfully implemented most of the actions described in the *Climate Change Action Plan* (2010). The National Parks, NPS offices, and partner organizations have clearly embraced the plan and worked to execute the actions dictated by it. Many NPS climate change-related activities were found supporting each of the eight emphasis areas. There were, however, some areas that still need additional actions, and in others the activities we found were from early in the implementation of the plan and have not been updated recently. Most information on NPS activities was relatively easy to find. The NPS and partner organizations have extensive libraries of NPS publications describing climate change-related activities, and there are also web pages highlighting the work done and the impacts it is expected to have. In some areas, particularly those related to internal processes and actions, information was more difficult to find or unavailable.

It is important to note that the *Climate Change Action Plan* (2010) was intended to be completed in one to two years with an annual review, and then a revision of this plan would be conducted in 2014. There have not been any published revisions of this plan, and several of these goals were not completed until several years after the established timeline. We acknowledge that the implementation of change can face roadblocks and delays, especially for the National Park Service due to its large size and lack of funding as a government program. With this in mind, we have decided to focus our evaluation on the quality and quantity of action that has occurred in accomplishing the goals of the CCAP, rather than if the goals were accomplished in the set timeline of one to two years.

4.1 Enhance Workforce Climate Literacy

Since the introduction of the *Climate Change Action Plan* in 2010, the National Park Service (NPS) has demonstrated specific actions to Enhance Workforce Climate Literacy. The NPS has several up-to-date resources for risk assessment training and online training resources, such as videos and modules. There exists a framework for Interpreting Competency of Climate change, but the most recent resource available is from 2017, 4 years old, so it could be beneficial

to look into ways to update this framework more frequently as information and technology regarding climate change progress. This would be a lower priority task, but it could still be helpful. Additionally, there is not easily accessible information regarding the Green Procurement Training for parks, so it could be valuable to research if this plan is still relevant, and if there is a more efficient and up-to-date alternative. This action area was evaluated in the same order that is proposed in the Methodology Section; we:

1. Investigated the current vulnerability and risk assessment training, examining if it has changed or improved since 2010:
    a. In 2016, partnering with the Program for the Study of Developed Shorelines at Western Carolina University, the NPS created the *Coastal Hazards and Sea-Level Rise Asset Vulnerability Assessment Protoco*l. This protocol established a standard methodology for conducting vulnerability assessments for coastal facilities. With a set standard for assessment practices, this allows the data collected to be comparable to other parks from a local to a national level. Since the start of the program, there exists 19 current Coastal Facilities Vulnerability Assessments ranging across the nation from parks in Maine, Florida, and Alaska. This information also allows park management to make better decisions on what parts of the park should be protected, moved further inland, or abandoned. New assessments have been done every year since the start of the program in 2015, with the most recent report coming out from 2019 (*Coastal Facilities Vulnerability Assessments,* 2020), which demonstrates that this is still an active program that is growing and enhancing the workforce climate literacy.
    b. In 2019, the NPS partnered with the Coastal Resources Center of the University of Rhode Island (URI) to develop a standard methodology for conducting integrated coastal climate change vulnerability assessments (*Amanda Babson,* 2021). Integrated vulnerability assessments aid park managers in identifying and choosing adaptation actions with a better understanding of the connection of different resource types throughout the parks. Since the start of this protocol, there have been two assessments completed at Fire Island National Seashore and Colonial National Historic Park, and there are currently other assessments in progress at additional coastal parks (*Integrated Vulnerability Assessments,* 2020).

Amanda Babson, who we interviewed, is the Coastal Landscape Adaptation Coordinator for the Northeast Region of the NPS, and she is currently working with URI to conduct vulnerability assessments following this newly established protocol. She discussed her current studies focusing on the Boston Harbor Islands and Acadia National Park, which are additional coastal parks that are partaking in the vulnerability assessments. In our interview, Babson emphasized the key role these vulnerability assessments play in educating people. Not only are these reports vital to the decision-making of park management, but they are also important to educate the general public on the current dangers of climate change in hopes to inspire individuals to change their actions. Based upon the NPS's data, corroborated by our interview with Amanda Babson, this current vulnerability assessment program is playing a positive role in enhancing the workforce climate literacy.

2. Investigated the framework for Interpreting Climate Change competency. This framework should be available online, and we examined how effectively it has been made available and incorporated into training.
    a. The *National Climate Change Interpretation and Education Strategy* was released in 2016, which provided a plan to NPS leaders and employees to communicate the impacts of climate change. Relevant goals of this publication include providing opportunities for employees and the public to better understand climate change, developing a climate literate workforce, and cultivating a climate change communication community with their partners. This strategy established a unified approach to communicate climate change impacts across all of the National Parks.
    b. The *Climate Change Communication Toolkit*, which was most recently updated in 2017, provides a list of resources to support climate change communicators. These resources include general information about climate change, example exhibits and presentations for educators, communication tips, and specific information on what the NPS is currently doing to combat the impacts of climate change.

3. Investigated the videos and online training modules that have been created, examining the availability and if new content has been created:
    a. The National Park Service provides online self-study modules for climate training which was introduced in 2016. The Interpreting Climate Change Self-Study Modules includes four modules with a study guide and learning companion for each module (*Toolkit: Training,* 2018). This provides consistent climate training to all of the employees of the NPS and it is available to the public as well.
    b. NPS also offers an Interpreting Climate Change Virtual Course. This course is intended for interpretation and education practitioners and supervisors to provide practical knowledge and skills to develop effective, engaging climate change programming (*Toolkit: Training,* 2018). This course is intended for NPS employees, but interested employees from other career fields and agencies are allowed to apply for the training.
    c. According to the *Toolkit Training* (2018), the NPS is partnered with several other organizations and agencies to provide more online educational opportunities, which includes:
        i. "Earth to Sky" offers some courses and webinars for climate change communicators, and it is a place to learn and share science and communication techniques.
        ii. "Climate Change: Fitting the Pieces Together" is a free collection of learning resources for the geoscience community which also offers training modules.
        iii. "Climate Basics - Climate Change Resource Center" contains a wide range of climate information, including an overview of current climate science and frequently asked questions.
        iv. "The Climate Interpreter" is a collaboration of national aquariums and the National Network for Ocean and Climate Change Interpretation which offers several training references and video units.
    d. The NPS offers additional training called "Foundation of Interpretation", which is a free online self-study course that provides a basic understanding of the theory and practice of interpretation (*Toolkit: Training,* 2018).

4. Investigated the Green Procurement Training for parks, examining the number of parks who have participated in this training and the program's effectiveness:
    a. There is no information published regarding Green Procurement Training for parks, so this goal was not completed. However, there exists a Green Purchasing Policy for parks which provides guidance for purchasing products and services that reduce negative impacts on the environment and human health (*Green Purchasing*, 2015).

4.2 Engage Youth & Their Families

After researching the second plan of action, to Engage Youth & Their Families, and their actions on the NPS's CCAP, we found multiple programs and mentorships established to engage the park's youths and their family members. Based upon the methodology, we:

1. Examined how the George Melendez Wright Climate Change Fellowship and Internship programs have helped the high priorities of the parks:
    a. As of July 1st, 2010, The George Melendez Wright Climate Change Fellowship and Internship programs helped establish 12-week internship and fellowship opportunities at NPS park locations to highly accomplished undergraduate students, graduate students, and recent alumni (*National Park Service Press Release*). According to *RLC Internships and Fellowships* (2021), these roles within the parks engaged diversified planning to fight the advancement of climate change; the interns engaged in topics such as:
        i. Resource conservation and adaptation
        ii. Climate effects monitoring
        iii. Park facilities adaptation
        iv. Policy development
        v. Sustainable operations & mitigation
        vi. Communication, interpretation, or education.

However, the hyperlinks for the program's websites led to an error message, which limits the information found regarding the specifics of these programs.

2. Investigated the contribution of youth and diversity programs such as the Student Conservation Association (SCA), web rangers, and diversity program:
    a. Student Conservation Association (SCA) - According to *SCA's Impact on Youth* (2021), the SCA led to a majority of the students, roughly 70% of the alumni, returning to a career that positively impacted the climate's health. When partnered with the Search Institute in 2015 to determine the impact of SCA programs on their participants, the Search Institute found conservation awareness, action, leadership, and social responsibility increased by the students' participation. SCA projects were diverse with 33% Black, 34% White, 22% Multi-Racial, 10% Asian, and 1% American Indian or Alaskan Native.
    b. WebRangers – According to *WebRangers (U.S. National Park Service)* (2020), The WebRangers site retired in 2019, while the service was in use, there were a reported 115,000 members in 2010. Junior Ranger Online is the new form of WebRangers and follows the same structure as WebRangers by engaging participants in historical exploration via the web and interactive printouts with follow along instructions. These provided members with ways to interact with and preserve nature.

3. Examined what mentorship opportunities were provided and their contribution to climate change management and policy issues:
    a. Mentorships were provided through programs, such as examples 1 and 2. With the experience of park rangers to guide the fellows and interns on proper stewardship ethics and parks conservation, these mentorships contributed to climate change management and policy change. NPS fellows and interns gain hands-on/field experience provided by the park rangers, which includes informing the participants of how to move the habitat for animals to manage climate change species morbidity and later contributes to policy formation through mentees input and collected data (Jarvis, 2014).

4.3 Develop Effective Planning Frameworks and Guidance

The National Park Service has appeared to effectively incorporate climate change into the planning frameworks and guidance. There are examples of this on a national, regional, and individual parks level, and this is shown for several different types of planning frameworks, including both long-term and short-term plans. The largest challenge with evaluating this action area was that the information of published National Park Service documents is not organized well and can be difficult to find. There are numerous climate change planning frameworks that exist for the NPS, but they are difficult to locate, which makes them less likely to be utilized because parks are not well informed of their available resources.

We evaluated these areas of action:

1. Examined how climate change guidance was implemented in Long-Range Transportation Plans (LRTP's)), which are 20-year plans for transportation infrastructure management and investment:
    a. In the *National Long Range Transportation Plan* (2017), the National Park Service identified their two biggest challenges as climate change and fiscal constraint. This plan identified one of its objectives as "adapt transportation systems to climate change impacts." NPS transportation systems were built to withstand long-term weather conditions, but as temperatures change and severe weather conditions occur, transportation systems and infrastructure need to be updated to adapt to these effects of climate change. This shows that climate change is an issue that is being considered seriously in recent LRTPs on a nationwide standard of practice.
    b. The *Pacific West Region Long Range Transportation Plan* (2015) noted the threats posed by climate change within its own unique section. This regional plan considered the increased risk of road flooding and susceptible wildfire regions due to climate change which threatens the transportation system. Adjustments are being made due to the threat of climate change, such as life-cycle cost analysis

and then reinvesting in major transportation facilities, especially those vulnerable to rising sea-levels.

c. The *Denali National Park and Preserve Long Range Transportation Plan* (2018) identified a climate change-related goal with two related objectives as shown in figure 5:

CLIMATE CHANGE GOAL:
Plan for climate change impacts to the park's transportation system.

Adaptation and Mitigation Objective:
Recognize the impacts of global climate change on the park's resources and minimize Denali's transportation systems emissions.

Performance Measure	2022 Performance Target	Existing/Baseline Condition
Complete Asset Vulnerability Assessment	Complete Asset Vulnerability Assessment	Denali Park Road Risk Assessment Utilizing the Unstable Slope Management Program Completed

Communication Objective:
Support climate change research to inform transportation system management and park users.

Performance Measure	2022 Performance Target	Existing/Baseline Condition
Complete Climate Friendly Parks Plan (per Green Parks Plan initiatives)	Complete Climate Friendly Parks Plan	Complete Climate Friendly Parks Plan not yet completed

Figure 5: Denali National Park LRTP Climate Change Goal

This demonstrates how the impacts of climate change are being considered in LRTPs at an individual park level. This plan also shows that it will utilize the Asset Vulnerability Assessment and Climate Friendly Parks Plan, which are other initiatives encouraged in the *Climate Change Action Plan* (CCAP) which shows that the CCAP was referenced in the creation of this LRTP. Additionally, we interviewed Lee Fink, the retired Chief Ranger of Denali National Park, and he discussed the impact of climate change on this park and how it is becoming more of a focus in the park's planning. Fink stated that change is "slow going" across the National Parks, but climate change awareness is increasing, and training has been shifting accordingly.

2. Examined how climate change planning was incorporated through prototyping into the park planning process and stewardships. This includes examining General Management

Plans, Resource Stewardship Strategies, and Fire Management Plans. Note that Long Range Interpretive Plans are not examined in this section as they were previously examined in section one of this area:

a. A General Management Plan establishes direction for resource preservation and visitor use (*Management Plans (National Park Service)*, 2021). In the *Everglades National Park Final General Management Plan* (2015), the effects of climate change are considered a threat to the park. This plan noted that climate change is anticipated to affect the park's weather resources which will have a direct impact on the park's resource management, park operations, and maintenance of facilities.
b. A Resource Stewardship Strategy (RSS) is a long-range plan regarding natural and cultural resource management (*Resource Stewardship Facts Sheet,* 2006). It is difficult to find published RSSs; the only published RSS found is the 2008-2027 Denali National Park RSS which predates the publication of the *Climate Change Action Plan*. The *Denali National Park and Preserve Resource Stewardship Strategy* (2009) lightly considers the effects of climate change in its resource management with several considerations made for specific resources, but there is not a dedicated section for the topic. No RSSs published after 2010 were found, so it can not be gauged how the CCAP has caused RSSs to incorporate climate change in their plans. However, the *Resource Stewardship Strategy Supplemental Guidance* was published in 2020, which provides a methodology to better address climate change in RSSs. This supplemental guide is a good start to better incorporate the impacts of climate change in future updates to individual park RSSs.
c. A Fire Management Plan (FMP) provides guidance on what actions can be taken regarding wildfire and prescribes fire on the ground, which requires careful landscape and resource management (*Fire Management Plans (U.S. National Park Service)*, 2017). FMPs predating 2010 were found for parks including Point Reyes, Tonto, and Saint Croix National Parks, which each lightly consider the impacts of climate change in their plans. The *Big Cypress National Preserve and Florida Panther National Wildlife Refuge Fire Management Plans Environmental*

Assessment (2016) noted the risks posed by climate change, especially with rises in sea-level threatening native species. However, there are not sufficiently precise models in sea-level and water temperature increase due to climate change, so the potential impacts of climate change were not analyzed in detail in this plan.

3. Reviewed changes made to General Management Plans (GMPs) to determine whether climate change was considered and if it is being addressed appropriately:
    a. General Management Plans (GMP) were examined in the previous section of this action area, and it was determined that climate change is appropriately addressed and considered in updated GMPs, such as the Everglades National Park GMP.

4. Reviewed the developed scenario planning guidance and training:
    a. In 2019, the *Climate Change Scenario Planning for Resource Stewardship: Applying a Novel Approach in Devils Tower National Monument* was developed. This document demonstrated scenario planning as a new adaptation tool in response to climate change.
    b. In 2021, the *Climate Change Scenario Planning for Research and Resource Management at White Sands National Park* was published. This document developed several climate-resource scenarios to help identify key vulnerabilities and improve management and research teams at the White Sands National Park.
    c. In 2021, the *Implications of Climate Scenarios for Badlands National Park Resource Management* was published. This project briefly identified potential climate impacts and management responses to preserve the natural and cultural resources of the Badlands National Park.

5. Investigated how climate change guidance was incorporated into Foundation Documents (FDs):
    a. Foundation Documents provide a basic understanding of the park's resources, values, and history; it provides fundamental information for park planning (*Foundation Documents for National Park Units,* 2021). The *Manhattan Project National Historical Park Foundation Document* (2017) incorporated climate change by stating threats posed to the park exacerbated by climate change. These

threats included extreme weather conditions, such as high winds, precipitation, and flooding which also pose a risk to wildlife.

   b. The *Dry Tortugas National Park Foundation Document* (2017) addressed climate change by stating threats associated with the effects of climate change, including water temperature, diminished biodiversity, and ocean acidification. This FD also proposed an opportunity to expand water quality monitoring to improve understanding of the effects of climate change and its relation to ecosystem health.
   c. The *Craters of the Moon National Monument and Preserve Foundation Document* (2014) incorporated climate change by identifying threats posed to the park by climate change, including changes to the vegetation and wildlife habitats, less snow coverage, increased pests, and threats to ice deposits in caves. This FD proposed the opportunity to continue and complete vulnerability assessment projects that are related to climate change.

6. Examined Regional Strategies the NPS created to prevent climate change:
   a. No new information was found regarding regional climate change strategies. There does not seem to be regional strategies dedicated to climate change guidance, but current regional strategies such as Long Range Transportation Plan (LRTPs) address climate change in their plans which is previously examined in section one of this action area.

7. Examined the strategic development and implementation of cultural resource climate change core program:
   a. The *Cultural Resources Climate Change Strategy* was published in 2016, which identified major directions of action for all National Parks to address climate change threats and preserve cultural resources.

8. Investigated what guidance was provided for considering climate change under the National Environmental Policy Act (NEPA):
   a. NEPA issued guidance on the consideration of greenhouse gases and the effects of climate change in 2016, and it is currently under review for revisions and updates as of February 19, 2021. This document provides all Federal agencies a common

approach for evaluating proposed Federal actions and assists Federal agencies in their consideration of the effects of greenhouse gas emissions and climate change (Goldfuss, 2016).

4.4 Provide Climate Change Science to Parks

The integration of climate change science has benefited National Parks immensely. Science has given researchers the ability to analyze past research to understand the present and future climate conditions of National Parks. The NPS continues to make improvements to the health and well-being of National Parks. Through awareness and education on the past, present, and future conditions of the parks, the NPS has been able to reduce or maintain the impacts of climate change. These results provide specific examples that the NPS has taken to improve this action item. The NPS has focused on improving vehicle emissions, such as no idling rules, and encouraging the use of bikes or public transportation provided at some parks. This response lessens the chances of landscape destruction, human-caused climate change, and carbon footprints produced in National Parks. By incorporating climate change science, the NPS has provided themselves and climate change personnel with the tools to mitigate climate change in National Parks. This action area was evaluated through applied research; we:

1. Investigated how the NPS monitored change and resource conditions throughout National Parks:
    a. On the *Monitoring* (2020) National Park Service webpage, monitoring is defined as "the repeated observation and measurement of specific park natural resources to better understand their condition." Monitoring is vital to the NPS to protect its resources because it allows early identification of problems and measures their protection success. Monitoring data and analysis provides park management with more information so that they can make well-informed decisions. The *Monitoring* (2020) webpage also provides resources to the monitoring frameworks that the NPS follows and some of the tools they utilize.
    b. Extensive weather and climate monitoring occurs in the Mojave Desert Network Parks. This includes monitoring the precipitation, temperatures, sensitive habitats, and endangered species within the National Parks of this region ((*Weather and*

Climate Monitoring (U.S. National Park Service), 2021). This monitoring allows the parks to predict higher temperatures and less precipitation in future seasons, so park management is better informed with how to react and better protect these habitats.

2. Examined how the NPS participated in international and national climate change science, adaptation synthesis, and assessment studies:
    a. The Intergovernmental Panel on Climate Change (IPCC), established by the United Nations Environmental Programme and the World Meteorological Organization, is the leading body for the assessment of climate change (*National Park Service Climate Change Response Strategy*, 2010). Collaboration with the IPCC is highly encouraged by the National Park Service, and scientists employed by the NPS have contributed to the work of the IPCC on a voluntary basis (IPCC, 2021).
    b. Employees of the NPS Climate Change Response Program (CCRP) have contributed to several national climate change studies that have been published (*Climate Change Response Program Publications,* 2021). Some of the recent publications of CCRP employees include:
        i. The 2021 *Managing for RADical ecosystem change: applying the Resist-Accept-Direct (RAD) framework,* which was published by the Frontiers in Ecology and the Environment
        ii. The 2021 *Supporting the adaptive capacity of species through more effective knowledge exchange with conservation practitioners,* which was published by Evolutionary Applications
        iii. The 2021 *Expanding Climate Action Through Nature-Based Solutions,* which was published by the California Natural Resources Agency

3. Investigated how the NPS analyzed the historical and projected climate trends for the NPS units; linked to park planning and provided guidance for how to use the report:
    a. According to the *Climate Change Response Program Science Brief* (2020), the NPS utilizes “computational analyses of large datasets” to improve their

understanding of climate change in the National Parks. These analyses provided insight regarding recent past climates and plausible future climates.

   b. The NPS also conducts field research to monitor the changes in ecosystem processes and conditions, including "melting glaciers, increased wildfire, tree death, coastal erosion caused by sea level rise, bleaching coral, and upslope shifts in vegetation and wildlife" (*Climate Change Response Program Science Brief,* 2020). By better understanding these changes in ecosystems, park management can better prepare for future changes and impacts of climate change.

4. Examined how climate change was incorporated into the State of the Parks reporting, an additional tracking document:
   a. The National Park Service (NPS) published *Planning for Climate Change* (2021), which serves as a guide for park management. This document provided guidance regarding plans and decisions that best preserve park resources and landscapes due to the impacts of climate change.
   b. The *Climate Change Adaptation: Department of the Interior* (2021) report addressed the impacts of climate change, including wildfires, rising sea-levels, and invasive species, to National Park Resources. It also reported how the NPS has addressed these impacts through "research, education, and adaptive management" (Comay et al., 2021).

5. Examined how the NPS assesses the vulnerability of park resources and ecosystems:
   a. According to the *Vulnerability Assessment Brief* (2016), the NPS assesses climate change impacts on plants, wildlife, cultural resources, and infrastructure using vulnerability analyses. The NPS also identifies the vulnerable areas and potential refugia of the parks, and they provide analyses that are used to prioritize areas for adaptation.
   b. The NPS values vulnerability assessments as a tool that guides park management decisions regarding risks, priorities, and options for adaptation. The *Vulnerability Assessments* (2020) NPS web page provides a list of available vulnerability assessments divided regionally between Coastal, Inland, and Integrated assessments.

6. Examined how the NPS established a vulnerability assessment framework for consistency and comprehensive coverage for NPS units:
    a. According to the Association of Climate Change Officers (ACCO), the National Park Service (NPS) offers live online vulnerability assessment training classes. For example, two online classes were offered in 2020 titled “Fundamentals of Climate Science & Implications on NPS Facilities” and “Conducting Vulnerability Assessments & Prioritizing Preparedness Actions” (ACCO, 2021).
    b. The National Park Service, in collaboration with Western Carolina University's Program for the Study of Created Shorelines, has developed a coastal hazards and climate change asset vulnerability assessment program (*NPS Vulnerability Protocol,* 2018). This protocol defines a standard methodology for conducting vulnerability assessments in the built environment, as well as a set of best practices. These assessments may be compared on a local, regional, and national level by standardizing the procedures and data employed.

7. Examined how the NPS has researched and communicated how past cultures adapted to changing climates:
    a. No specific information was found regarding this topic. It is unclear what progress the NPS has made in researching and communicating how past cultures adapted to changing climates.

4.5 Implement the Green Parks Plan

By implementing the Green Parks Plan, the National Park Service (NPS) has encouraged, not only themselves, but many others to be aware of the effect people and organizations have on the environment. By doing so, the NPS has improved in terms of recycling, energy saving, reduction of greenhouse gas emissions, and increasing the number of climate-friendly parks. So far, the NPS has been successful in implementing this plan and continuously bringing popularity to “going green” in order to help prepare for and mitigate climate change impacts. This is an action plan that can continue to be used and will continue to benefit the planet and mankind. This area of action was evaluated using the following specific examples; we:

1. Investigated how the number of Climate Friendly Parks has increased since 2010:
    a. As part of the National Park Service's Green Park Program, Climate Friendly Parks (CFP) is one of many initiatives supporting the program. These tools and resources are designed to address climate change and ensure that parks are operating as sustainably as possible (*Climate Friendly Parks Program*, 2021). In 2015, there existed over 100 National Parks participating in the CFP program (*Climate Friendly Park Program,* 2015*)*. There are currently more than 140 participating parks which shows how the CFP program has continued to grow.
    b. There are currently 100 parks participating in the CFP program with completed Climate Action Plans which are available on the National Park Service website (*Climate Friendly Parks Program*, 2021).

2. Examined how the Climate Leadership In Parks tool was used to assess greenhouse gas operational emissions:
    a. The Climate Leadership in Parks (CLIP) tool is a software application that provides two modules to aid National Parks in the process of becoming a Climate Friendly Park (U.S. Department of Energy, 2011). These two modules include an Emission Inventory Module and an Action Planning Module. The Emission Inventory Module helps National Parks estimate and assess the resulting emissions from individual parks. This tool helps parks identify the impacts to climate and air pollution on their different operational activities, including the impact of employees, concessionaires, and visitors (U.S. Department of Energy, 2011).

3. Investigated how the NPS conducts energy audits at parks and implemented Energy Conservation Measures:
    a. The NPS website provides guidance on when energy audits should occur and what the audit evaluates, located under the Sustainability tab of the NPS Technical Preservation Services website (*Conduct an Energy Audit,* n.d.). These audits are meant to evaluate the current thermal performance of the system and identify any deficiencies in the system. The NPS also recommends that an energy

audit must occur before any energy-improvement measures are implemented into the system under consideration (*Conduct an Energy Audit,* n.d.).

b. For implementing energy conservation measures, the NPS follows their "Be Energy Smart" objectives from the Green Parks Plan. These objectives include (*Be Energy Smart,* 2021):
    i. Reducing building energy use by 25 percent by 2050 (with the 2015 baseline).
    ii. Prioritizing energy conservation measures according to the energy audits conducted, focusing on the buildings with the highest energy consumptions.
    iii. Increasing energy efficiency and reducing fossil fuel consumption with the goal to move towards net-zero energy consumption.
    iv. Prioritizing renewable energy sources and efficient fuel alternatives for park equipment and facilities.
c. The NPS follows guidance from the Environmental Protection Agency (EPA), including the Local Government Climate and Energy Strategy Series (U.S. Environmental Protection Agency, 2011). This series provides an overview of greenhouse gas emission reduction strategies that can be applied by local governments. The topics of this series include "energy efficiency, transportation, community planning and design, solid waste and materials management, and renewable energy" (U.S. Environmental Protection Agency, 2011).
d. The NPS is required to conduct energy evaluations "at facilities that consume at least 75% of agency-wide energy use" according to the Energy Independence and Security Act of 2007 (*Energy & Water Conservation,* 2015). This results in the NPS conducting energy audits often at many parks across the country.

4. Investigated how the NPS conducts water audits at parks and implemented Water Conservation Measures:
    a. The NPS Commercial Services environmental audit program supports the U.S. Department of the Interior (DOI) to conduct environmental audits, including water audits, of all National Park facilities and operations (*Environmental Audit*

Information, 2020). This program complies with the U.S. Environmental Protection Agency regulations and DOI policies.

b. The NPS is also required to conduct water evaluations (alongside their energy audits) "at facilities that consume at least 75% of agency-wide energy use" according to the Energy Independence and Security Act of 2007 (*Energy & Water Conservation,* 2015). This results in the NPS conducting water audits often at many parks across the country.

5. Examined how the NPS has pursued Fleet Optimization opportunities to "right-size" the NPS fleet:
    a. The San Antonio Missions Park has made continued efforts to reduce their park's carbon footprint through fleet management. Nine of their twenty-two vehicles use alternative fuel, and their park has gone from 4% alternative fuel usage in 2003 to 41% in 2013 (*Fleet Management*, 2016).
    b. The NPS partnered with the Yellowstone Environmental Coordinating Committee (YECC) to provide plug-in hybrid vehicles and electric charging stations throughout Yellowstone Park (*Electric Vehicles in Yellowstone,* 2019). By doing so, the NPS and YECC have improved on reducing Yellowstones' greenhouse gas emissions and petroleum consumption.
    c. According to the *National Park Service Personal Property Management Handbook #44* (2009), the NPS has a designated full-service senior fleet manager position to implement and establish fleet management policies and procedures throughout the park. In doing so, the goal is to reduce the overall vehicle expenditures, which in turn, will decrease the amount of deterioration on the park(s) created by traffic.

6. Examined the NPS Sustainable Buildings Implementation Plan and how assessments have begun at selected parks:
    a. In response to federal executive orders, the Department of the Interior issued the *Sustainable Buildings Implementation Plan* (2015). This led the National Park Service (NPS) to develop a sustainable implementation plan.

b. The NPS Sustainable Building Implementation Plan (SBIP) provides guidance on new construction and major renovations of bureau buildings (*Sustainable Buildings Implementation Plan,* 2015). The SBIP encourages more sustainable buildings and tracks the sustainability of current buildings. The goal of the SBIP is to improve energy efficiency, reduce natural resource consumption, reduce greenhouse gas emissions, and provide healthier buildings and workplaces (*Sustainable Buildings Implementation Plan,* 2015).
c. We were unable to find information on specific sustainable building assessments for selected National Parks.

7. Examined how NPS has issued a "no idling" policy for non-law enforcement or emergency vehicles:
    a. The NPS partnered with the Clean Cities program through Clean Cities National Parks Initiative to reduce vehicle emissions in national parks (*The Benefits of Vehicle Idle Reduction,* 2018). This partnership has resulted in multiple National Parks participating in idle reduction efforts, including Yellowstone and Zion National Park.
    b. Clean Cities also offers an online educational idle reduction toolbox, which includes educational presentations, savings calculators, technology solutions, fact sheet templates, and policy templates all related to idle reduction (*The Benefits of Vehicle Idle Reduction,* 2018).
    c. The NPS posted an article on their website titled *The Benefits of Vehicle Idle Reduction* (2018) which highlights the environmental benefits of idle reduction, such as conserving energy, reducing pollution, and saving money.
    d. Yellowstone National Park created an Idle-Free Campaign with the Yellowstone-Teton Clean Energy Coalition. This program seeks to educate park visitors and encourage "alternative fuels, advanced vehicles, and fuel-saving technologies" (*Idle-Free Campaign with Yellowstone-Teton Clean Energy Coalition,* 2019). This program helps the park decrease idling by both employees and visitors with efforts that include "vehicle stickers, reminder cards, and an Idle-Free pledge for businesses."

8. Investigated how the NPS has used Energy Star Portfolio Managers to understand and improve energy efficiency for high-consumption parks and facilities:
    a. The Energy Star Portfolio Manager is used to compare the energy consumption of specific buildings to similar buildings across the country (Energy Star, n.d.). This management tool is used to better understand building performance and energy consumption on a broader scale. This management tool is also used to track and assess the energy and water consumption across several buildings (Energy Star, n.d.).
    b. This management tool can be utilized by the NPS to better understand and improve their energy consumption on an individual park, regional, and national level. However, there is no clear information published by the NPS on how they utilize this tool.

9. Investigated how the NPS deployed the "My Green Parks" web tool to facilitate sustainable practices at each employee's worksite:
    a. As stated in point two of this section, the Climate Leadership in Parks (CLIP) tool is a software application that provides two modules to aid National Parks in the process of becoming a Climate Friendly Park (U.S. Department of Energy, 2011). These two modules include an Emission Inventory Module and an Action Planning Module.
    b. Aside from the CLIP tool, there is no other new web tool that has been developed by the Green Parks Program.

4.6 Foster Robust Partnerships

The NPS's sixth climate change emphasis area is to foster robust partnerships. Although the NPS has always used partnerships to advance its priorities, there has been significant success in expanding existing partnerships and adding new partnerships to help the parks prepare for and combat climate change impacts. There are specific examples for most of the action areas within this section. The only area which had minimal evidence of progress was strengthening relationships with the air quality community. Although the NPS is concerned about the air

quality in the National Parks, we were unable to find any partnerships related to this area. Among the examples of climate change focused partnerships are:

1. Under the goal of strengthening partnerships with Department of the Interior (DOI) Landscape Conservation Centers, numerous projects were found with NPS participation including:
    a. Evaluating management alternatives to mitigate the adverse effects of climate change on whitebark pine ecosystems in the Greater Yellowstone Ecosystem (Great Northern Landscape Conservation Cooperative, 2015).
    b. NPS Vessel Traffic Simulation (Landscape Conservation Cooperative Network, n.d.a).
    c. Strategic conservation planning for management applications in Cascadia (Landscape Conservation Cooperative Network, n.d.b).

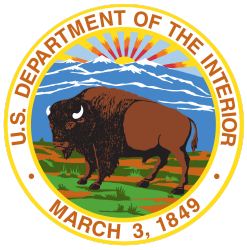


Figure 6: U.S. Department of the Interior Logo

2. Partnerships with NOAA's Regional Integrated Sciences and Assessments (RISA) program. There have been several examples of NPS/RISA partnership efforts (NOAA, n.d.) including:
    a. Organic Soil Moisture Monitoring in Coastal North Carolina
    b. Sectoral Impacts of Drought and Climate Change
    c. Identifying Emergent Research Priorities and Expanding the Regional Network
    d. Apostle Islands National Lakeshore Climate Change Vulnerability Assessments

Figure 7: NOAA Regional Integrated Sciences and Assessments Program Logo

3. The NPS partners with the Department of Energy's Vehicle Technologies Office through the Clean Cities National Parks Initiative to supply the parks with electric or propane vehicles to replace their petroleum vehicles (Clean Cities Coalition Network, n.d.).

Figure 8: National Park Service Electric Car

Figure 9: National Park Service Electric Car Charging Station

4. The NPS has established an internship program with George Mason University Center for Climate Change Communication (2020). This program helps students understand climate change and its effects on parks and gain experience communicating these effects to the public.

Figure 10: George Mason University Center for Climate Change Communication Internship Program Logo

5. BMW has entered into a partnership with the NPS and the Department of Energy to donate and install 100 electric car chargers in and around national parks. This will enable users of electric vehicles to recharge their vehicles while visiting these parks (*Partnerships add a Charge to your Travel Plans*, 2019).

6. The North Cascadia Adaptation Partnership: The goals of the NCAP were to build an inclusive partnership, increase climate change awareness, assess vulnerability, and develop science-based adaptation strategies to reduce these vulnerabilities (Raymond et al., 2013).

7. The Olympic Adaptation Partnership was a science-management collaboration between Olympic National Forest and Olympic National Park to determine how to adapt the management of federal lands on the Olympic Peninsula, Washington to climate change. This project, which was led by the Pacific Northwest Research Station and University of Washington, began in 2008 and continued for two years (Adaptation Partners, n.d.).

8. The National Park Conservation Association (NPCA) works to protect national parks and communities from the causes and detrimental effects of climate change. They advocate for policies and regulations to mitigate and adapt to climate change (NPCA, 2021).

Figure 11: National Parks Conservation Association Logo

9. Snap Inc. entered into a partnership with Re: wild and the National Park Service to support restoration efforts in areas devastated by California's recent wildfires. They will use their Snapchat platform to educate users and are funding the planting of over 10,000 trees and 100,000 other native plants in California parks (BusinessWire, 2021).

4.7 Apply Appropriate Adaptation Tools & Options

The National Park Service (NPS) has demonstrated several specific actions to complete most of the goals for this action area, Apply Appropriate Adaptation Tools & Options. Director memos and framework guidance have been published in a timely manner since the *Climate Change Action Plan* (2010) was published, and there are several tools that the NPS are currently utilizing in their adaptation strategies. However, there is no NPS publication titled *Renewable Energy Installation Siting Guidance* which the CCAP aimed to complete, so this could mean that it has not yet been completed or that the title was revised after the *Climate Change Action Plan* was published. Overall, excellent progress has been made towards this action area.

This action area was evaluated in the same order that is proposed in the Methodology Section; we:

1. Examined director's memos that provide management guidance on policies related to the effects of climate change on cultural resources:
    a. In 2012, the National Park Service (NPS) Director, Jonathan Jarvis, released a memorandum titled *Applying National Park Service Management Policies in the Context of Climate Change*. This memo addressed initial guidance for park resource management regarding climate change. It stated the current responsibilities and resources of the park management, and it stated that there would be more policy memos to follow regarding climate change management.
    b. In 2014, an additional director's memo was released titled *Climate Change and Stewardship of Cultural Resources* (Jarvis, 2014). This memo provided guidance on the management of cultural resources. It addressed the emerging threats of climate change, the vulnerability of cultural resources, the park management responsibilities, and the sustainability actions available for the parks.

2. Examined director's memos that provide management guidance on policies related to the effects of climate change on facilities:
    a. In 2015, a director's memo was released title *Addressing Climate Change and Natural Hazards for Facilities* (Jarvis, 2015). This memo provided guidance "on the design of facilities to incorporate impacts of climate change adaptation and natural hazards." It addressed the natural hazards to the parks, assets of the parks, and provided sources regarding the authority of this memo from the U.S. President, U.S. Department of the Interior, and the National Park Service.

3. Investigated the NPS employee "listening sessions" on *Revisiting Leopold* recommendations:
    a. *Revisiting Leopold* is a report that developed goals, policies, and management guidance regarding all natural and cultural resources of the NPS (Avery et al., 2014). The *Revisiting Leopold* "listening sessions" allow discussions between the public and NPS employees to address resource management related to the impacts of climate change. Since 2006, over 40 listening sessions have occurred, collecting over 6000 public comments which provides a strong collaboration between the NPS and the public (Moritsch, 2013).
    b. Since the publication of the *Climate Change Action Plan* (2010), two "listening sessions" have occurred in the Intermountain Region of the National Parks. Conducted by Dr. Gary Machilis, Science Advisor to the Director, these two sessions occurred with one in-person session at the Lakewood Regional Office and a video session for the Yellowstone staff (Whittington et al., 2013).
    c. The Mid-Atlantic Network established a network natural resources technical advisory group that holds annual "listening sessions". These meetings provide an overview of the management issues that need to be addressed, and it improves collaboration among the National Park and Mid-Atlantic Network staff (Bennetts et al, 2016).

4. Examined the *Renewable Energy Installation Siting Guidance*:
    a. No specific publication titled *Renewable Energy Installation Siting Guidance* was found, so this could mean that it has not yet been completed or that the title was

revised after the *Climate Change Action Plan* was published. Other NPS renewable energy guidance is provided below:

b. In 2014, a *Guide To Evaluating Visual Impact Assessments for Renewable Energy Projects* was published by the National Parks Service. This guide addresses the increased number of renewable energy project proposals and the challenge of evaluating them efficiently (Sullivan & Meyer, 2016). This guide provides information to aid park and resource managers in evaluating the quality of visual impact assessments, and it assists them to identify and understand the potential impacts of proposed renewable energy projects. The types of renewable energy projects addressed in this guide include wind energy (onshore and offshore), solar energy, and electric transmission projects.
c. The *Sustainability Standards* page on the National Park Website provides an up-to-date list of regulations, resources, and programs which includes renewable energy guidance (*Sustainability Standards,* 2021).

5. Investigated the decision framework regarding resource adaptation options and practices:
    a. *Revisiting Leopold* (2014) is a report that developed goals, policies and management guidance regarding all natural and cultural resources of the NPS. It is an update from the original *Leopold Report* (1963) that addressed the modern challenges in natural and cultural resource management. *Revisiting Leopold* provides a decision framework regarding resource management in response to climate change that is applicable across all National Parks, and it is used to encourage further collaboration and exploration of climate change adaptation tools and options (Avery et al, 2014).
    b. The NPS document, *Integrating Science and Park Management* (2016), provides further guidance regarding resource adaptation options and practices. This document is a framework to integrate scientific information into park decision-making. This framework is intended to be a set of principles that can be flexibly applied to park management, and it includes several recommendations to strengthen the partnership between scientists and decision-makers, which would result in more science-informed decisions (Bennett et al, 2016).

6. Investigated the risk screening tool for assessing risk to facilities and cultural resources:
    a. The Climate Analyzer is a tool that creates custom graphs and tables from historical weather station data. This tool can conduct statistical calculations to generate specific results, including data from specific timeframes and regions. This is a well-maintained tool that the NPS utilizes to analyze current climate conditions, and it also provides current climate data of specific park locations and bodies of water, such as Old Faithful Geyser of Yellowstone National Park(Walking Shadow Ecology, 2021).
    b. The Greater Yellowstone Area Climate Explorer is a tool that compares the average of historical (1916-2006) climate values to a future projection for the mid-century (Ensemble Mean 2030-2059 values) for variables including temperature, precipitation, snowpack, snow water equivalent, and streamflow (*Yellowstone Climate Explorer,* n.d.). This tool can be used by park management to conduct resource and climate assessments, which is helpful for assessing climate change risks to facilities and cultural resources.
    c. The Great Northern Landscape Conservation Cooperative partnered with Headwater Economics to create an online interactive tool that can be used to access economic and climatic trend data (Whittington et al, 2013). This tool is available for federal and public use. It can be used by NPS management to gather and share consistent information. This would improve the communication across the National Parks to utilize consistent data when planning.

4.8 Strengthen Communication

The National Park Service (NPS) has progressed consistently with its goals set to strengthen communication, including developing more interactive exhibits, webinars, and social media. Now that change is underway, and progress is being made, it is important to widen the scope of their audience. Spreading awareness and information is a vital part of combating the impacts of climate change within the National Parks. The NPS could increase awareness of the impacts of climate change through increasing social media presence, such as increasing views

and followers on their current accounts. This action area was evaluated in the same order that is proposed in the Methodology Section; we:

1. Investigated the number of interpretive exhibits presenting climate change issues that have been added to national parks since the *Climate Change Action Plan* was published in 2010:
    a. In 2013, Pannier graphics partnered with the NPS to create wayside exhibits to share information on the impacts of climate change (Pannier, 2016). Phase one of this project focused on providing awareness of rising sea-levels, including future water level predictions and the impact they will have on specific areas. Phase two of this project allowed visitors to become a Citizen Scientist, where they are encouraged to take pictures of the parks and upload them to a shared website that allows people to see how the landscape has changed over time. An example of one of the Pannier exhibits is shown in figure 12 (Pannier, 2016):

Figure 12: Pannier Graphics Citizen Science Exhibit

    b. In 2014, the Many Glacier Wayside Project began which added several wayside exhibits throughout Glacier National Park (*Toolkits: Exhibits,* 2020). These exhibits explain the natural and cultural significance of specific park resources, including the impact of climate change (*Your Dollars at Work,* 2016). This is an

important tactic in spreading awareness of the impacts of climate change to visitors. One of these exhibits is pictured in figure 13 (*The Answer*, 2020), and it is explaining the future of the park considering the melting and gradual disappearance of glaciers:

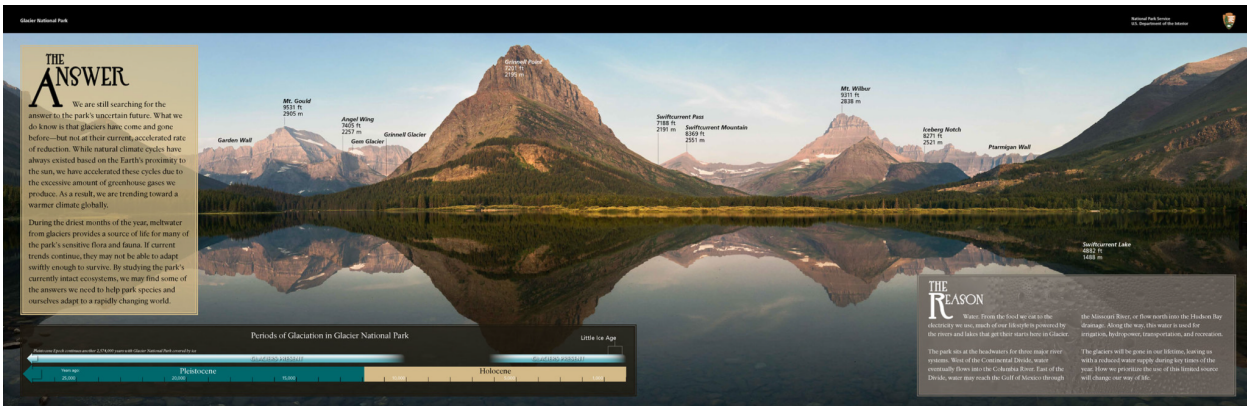


Figure 13: Many Glacier Wayside Project Exhibit

c. In 2020, a series of three outdoor signs were installed in the Everglades National Park (*Toolkit: Exhibits,* 2020). This series, titled "Bright Ideas in Alternative Energy," highlights climate change issues and mitigation efforts. The first panel of the series is pictured in figure 14 (*Bright ideas in alternative energy*, 2020):

Figure 14: Everglades National Park Alternative Energy Exhibit

d. In 2014, an art exhibit, titled “Piecing Together a Changing Planet”, was installed in Biscayne National Park (*Toolkit: Exhibits,* 2020). This exhibit includes twenty-six quilts used to highlight the impacts of climate change on the National Parks. After this exhibit's debut, it has traveled to many other parks, including Glacier National Park, Statue of Liberty National Monument, and Point Reyes National Seashore. A picture of part of the exhibit is shown in figure 15 (Biscayne National Park, 2014):

Figure 15: Biscayne National Park Climate Change Exhibit

2. Investigated the social media activity regarding climate change of the National Park Service and how it has been enhanced to improve its connection to local communities:

a. The National Park Service utilizes social media to engage and educate the public. The Climate Change Response Program (CCRP) runs several climate change related accounts including Facebook, Twitter, Flickr, and Youtube (*Toolkit: Social Media,* 2016). The Facebook account, @NPSClimateChange, was created in 2014, and it is still posting regularly with the most recent post occurring in July of 2021. The Twitter account, @ClimateNPS, was created in 2015 and also remains as active as the Facebook account, with 34.3K followers. The Flickr account, NPS Climate Change Response, was created in 2014, and it remains active sharing photos of the national parks and spreading awareness of the effects of climate change. The Youtube page, NPS Climate Change Response, was created in 2014 and remains semi-active, with the most recent post occurring in January of 2021. The Youtube account shares educational videos of the effects of climate change at specific parks, engaging viewers to draw the parks in "Drawing Connections" videos and sharing the stories of the park employees and passions.

3. Investigated the number and quality of climate change webinars for employees since 2010:
    a. The Climate Change in America's National Parks webinar series is presented by the Climate Change Response Program to connect NPS employees, volunteers, and NPS partners (*Toolkit: Learn and Engage,* 2016). This webinar series allows researchers to share credible, recent information regarding climate change in the national parks through a service-wide forum. As a forum, this series also allows participants to engage with each other in discussion and be part of a group mailing list.

4. Investigated the NPS website for online forums which share planning and support communities of practice:
    a. The Climate Change Response Program quarterly newsletter is an archive dating back to 2009 (*Program Newsletters - Climate Change Response Program,* 2021). The newsletter highlights recent climate change research and occurrences in national parks, and it shares positive news regarding climate adaptation,

mitigation, and interpretation. The newsletter is open for anyone to sign up for on the NPS website.

b. On the National Park Service website, the NPS shares other credible forums and informational websites, including the RealClimate blog, Skeptical Science, and Climate Interpreter (*Toolkit: Learn and Engage,* 2016). The RealClimate blog shares current stories related to climate change and commentary from climate scientists. Skeptical Science shares information which debunks common climate change myths and explains the real story of climate change. The Climate Interpreter is a forum of science education practitioners which shares resources and training about climate change.

5. Investigated the development of the interpretive plan for climate change and if it has been released:
    a. The *National Climate Change Interpretation and Education Strategy* was published by the NPS in 2016. This document shares a systematic approach for communicating the science and impact of climate change throughout the National Park System. This strategy encourages park staff and visitors to personally connect with the relevance of climate change and share those connections with others.

4.9 Summary of Findings

As described above, the NPS has made significant progress in implementing the recommendations of the Climate Change Action Plan. Several specific examples were found for each of the eight emphasis areas. In particular, NPS has done very well implementing actions that support the areas of:

1. Engage Youth & Their Families
2. Provide Climate Change Science to Parks
3. Implement the Green Parks Plan
4. Foster Robust Partnerships
5. Apply Appropriate Adaptation Tools & Options
6. Strengthen Communication

It was more difficult to find examples in the areas of:

1. Enhance Workforce Climate Literacy - as an external observer, it is challenging to identify all the training and literacy actions that the NPS has undertaken because these are largely internal actions that are not released to the public. Much of what has been released is 4-5 years old, so it is unclear if there have been any recent activities.
2. Develop Effective Planning Frameworks & Guidance - Although there exists several examples of effective planning frameworks, due to the lack of organization on the NPS website, they are difficult to find. These vital resources are not being utilized to the best potential because the park management is not aware of these available resources or not able to locate them.

In all areas, the NPS must continue to expand and update its climate change-related activities. Public engagement, communication, partnerships, and adaptation actions need to be ongoing to ensure our National Parks can maintain their resilience to climate change and other natural threats.

5. Conclusions & Recommendations

5.1 Conclusions

The National Park Service (NPS) has been mostly successful in accomplishing the goals set by the Climate Change Action Plan (CCAP), but there are still some areas that can be improved and expanded upon. As a government program, the NPS generally lacks resources and organization, which became clear in our findings. The areas that lacked the most information were the Enhance Climate Workforce Literacy and Develop Effective Planning Frameworks & Guidance areas which focus on the internal structure of the National Park Service. For these two areas, planning and framework examples were found, but it was difficult to find specific information on how these plans were implemented in the parks. Without the proper resources and implementation, these strategies do not accomplish their intended impacts; they are reduced to simple plans rather than actions and changes.

Additionally, the CCAP was written in 2010 and has not been updated recently. Although it proved to be effective in taking the initial steps needed for the NPS to address climate change, there are technological and societal advancements that have occurred since the CCAP's publication. There are areas regarding improving communication and public engagement that can be further improved and expanded upon beyond the initial scope of the CCAP. Since 2010, the internet and social media have become far more accessible and popular to individual Americans through the use of mobile phones. This is an aspect that can be utilized to strengthen communication and public engagement, which was not as strongly emphasized in the CCAP. This is an area of opportunity that can be expanded upon for the future of the NPS climate change actions.

These findings can be utilized by the National Park Service to identify areas of opportunity and to better understand where to focus their actions regarding climate change. This information can also be used by the NPS to update the *Climate Change Action Plan* and incorporate newer technological ideas in their plans. This evaluation can also be a starting point for future IQP reports to delve further into specific areas of the CCAP to improve recommendations and provide additional aid. This report is a starting point that identifies areas of improvement, so that future IQP reports and NPS plans can expand upon our work to create

tools and recommendations to improve the areas that we identified. For example, future IQP reports could expand upon our work with the following focuses:

1. Develop technology and strategies that can be used to Enhance Workforce Climate Literacy.
2. Create a framework and implement Citizen Science displays into more National Parks.
3. Improve the NPS climate change social media platforms to increase public engagement.
4. Create a database that improves the organization and accessibility of National Park Service documents and data.

5.2 Recommendation 1 - Improve Public Engagement with Social Media

As previously stated in the conclusions of our Results Section, public engagement and communication are crucial to update and maintain during the National Park Service's efforts against climate change. To continue to improve this area, our first recommendation is to improve the NPS's social media outreach.

Social media is the technology of the future. It is a vital platform that allows organizations to develop relationships with their target audience, and it is a faster and cheaper way to spread awareness than traditional advertising (Henderson, 2020). The Climate Change Response Program (CCRP) currently runs several climate change awareness social media platforms for the NPS, including Facebook, Twitter, and Youtube. However, these platforms have a small audience, with their largest platform, Twitter, having 34.3K followers, compared to the National Park Service twitter page (@NatlParkService) which has 654.6K followers. These platforms are an opportunity to educate a larger audience and inspire people to take action with the national parks. As a government organization, the National Park Service often lacks the resources and financing to implement large changes and technology, so utilizing social media is a more feasible solution for the NPS.

Some strategies that the NPS could use to improve their social media presence include:

1. Post more frequently. So that the accounts remain relevant and up-to-date.

2. Post at more desirable times. Generally, posting in the morning has been shown to receive the most views and interactions because most people check social media when they first wake up (Cooper, 2021).
3. Partner with influencers who can promote the NPS platforms. Partnering with celebrities or other influencers on social media can broaden the audience of the NPS and increase awareness, bringing new viewers to their pages. For example, in July of 2021, Olivia Rodigro partnered with the Biden Administration to encourage COVID-19 vaccinations (Rogers, 2021). This allows the Biden Administration to widen their audience and efforts towards a different demographic that is the millennial and gen-z followers of Rodrigo.
4. Allocate more resources to the social media department of the NPS. There are professionals who understand the algorithms and trends of social media that could provide greater insight and improvements to the current NPS climate change pages.

Overall, social media is a valuable aspect that can be utilized to improve communication and public engagement with the National Park Service. From small changes in how the accounts are run to larger partnerships and professional aid, this is a newer area with room for growth that the NPS can feasibly begin exploring. Improvements in the NPS climate change social media can widen their audience, inspire more visitors, and encourage change on a larger scale than before.

5.3 Recommendation 2 - Improve Communication with Citizen Science Technology

The state of the National Parks relies heavily on communication. Through exchanges, the park has received the urgent attention needed to deal with climate change. The National Park Service (NPS) has done a good job in encouraging communication, however, in order to improve, they must integrate citizen science technology.

Citizen science is when data is collected or analyzed on a large scale by the general public, generally in collaboration with professional scientists. The public participates in citizen science in a variety of ways that may include formulating research questions, conducting experiments in the laboratory, collecting data, and interpreting results. For online, distributed problem solving through crowdsourcing techniques, organizations post an open call asking a

large group of individuals to volunteer their time and expertise. Crowdsourcing is a powerful tool for involving the American public in addressing society's needs and increasing science, technology, and innovation. It asks people to take photos of the park, upload them to a shared website, and analyze the evolution of the landscape by comparing their photos to those of other park visitors. This has already begun with the 2013 Pannier graphics citizen science exhibits shown in section 4.8.

A few ways the NPS can improve through citizen science technology:

1. If parks lack the funding and organization to take on larger projects, citizen science could be beneficial to the collection of climate change data, reducing the NPS's overall response time and mitigation of current climate change. Visitor interaction, understanding, and participation will be improved as a result. Large expenses to the NPS's budget can be reduced by integrating citizen science into the park's signage as well as nps.gov.
2. While the presence of citizen science is integrated into nps.gov, it would be most advantageous to create a citizen science button via the NPS's main page on nps.gov. Displaying the button to this section via the main page will not only generate more traffic to the interactive tasks available on the NPS's citizen science webpage, but will also increase awareness for citizen science.
3. Increasing the signage around the parks, to include citizen science QR codes, bringing park member's attention to the interactivities in real time.
4. Partnering with the U.S. General Services Administration's (GSA) "citizenscience.gov" initiative, to integrate features mentioned in numbers 1-3, would provide stronger understanding of current citizen science programs at community, national, and global levels to reduce the effects of climate change synchronously. Provisions from the U.S. GSA will reduce the time necessary for program development and deployment, due to the collection of data provided through citizenscience.gov.

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