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SIAM
Society for Industrial and Applied Mathematics
3600 Market Street, 6th Floor
Philadelphia, PA 19104 USA
M3Challenge@siam.org
M3Challenge.siam.org

M3 CHALLENGE®

PREVIEW PAPER: ABOVE AVERAGE

The judges noted that the executive summary in this submission was mediocre. It did not include much information about their model nor their conclusions. Their general approach was to perform regression on the data, but they did not create models based on their interpretation of the problem. Finally, the team seemed to assign certain values in an ad hoc way which appeared arbitrary in places.

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From Sea to Shining Sea: Looking Ahead with the National Park Service

February 24-25, 2017

Dear National Park Service,

We, along with countless individuals and groups all over the world, share in your concern for the negative effects of climate change. This is something that is extremely important to discuss and address in all contexts, and yet it is often neglected or even blindly dismissed by the public. We are grieved to hear that national parks all across America are feeling the effects of such a massive issue.

Climate change impacts not only the resources of these parks, forcing them to make weighty decisions regarding their operation and maintenance, but also the experience of all who visit them. We recognize that your mission is to "preserve unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations."

And so we have developed a mathematical model that could potentially address and solve some of the largest problems created by climate change for national parks in the United States. We gathered data from the National Park Service spanning from 1997 to 2016 on mean sea level, air quality, temperature, visitor statistics, and many other key factors that relate to the issue at hand.

Using this data, we generated graphs, lines of best fit, and subsequent equations to represent the trend of climate change in five different parks in all parts of the United States. We then developed a climate change vulnerability score for each park based on factors such the likelihood and severity of natural disasters, fluctuating temperatures, and more.

Finally, we considered this vulnerability score along with visitor statistics to decide how monetary resources should be allocated, and how projects should be prioritized in light of the looming matter of climate change. We generated equations that could predict visitor attendance in the years 2030 and 2050, which may aid in the decision-making process. Through all of this, we offer the following recommendations:

Cape Hatteras National Park should receive the greatest amount of funding, followed by Acadia National Park, Olympic National Park, Padre Island National Seashore, and Kenai Fjords National Park, respectively. These recommendations are all based on how susceptible each park is to climate change, as well as the predicted visitor attendance for the future.

We sincerely hope that you will take these recommendations into consideration and that they will aid you immensely as you seek to tackle the great issue of climate change within these individual parks and communities.

Contents

1 Introduction

1.1 Background

The United States Environmental Protection Agency says, "Climate change refers to any significant change in the measures of climate lasting for an extended period of time" [1]. This is certainly something that we can observe in our world today. Over the past several decades, climate change has become a growing concern not only in the United States, but all across the globe. Extensive research and observation has shown that environmental conditions in all parts of the earth are shifting in a way that is harmful to all of its inhabitants.

Climate change is not merely an issue in regards to global health, however. It affects individual countries, organizations, and people on a very real and tangible level. National parks in the United States are especially experiencing the negative consequences of this deeply important concern. The National Park Service (NPS) has the challenge of preserving the purpose of these parks – to educate, entertain, and enlighten the public through nature. As the NPS seeks to do this, it will have to learn to adapt to this time of change that we are now undergoing.

1.2 Restatement of the Problem

The problem at hand consists of three separate components, which all connect in regards to the effect of climate change on various national parks. The five parks that are to be used as sample 'test' groups are as follows: Acadia National Park in Maine, Cape Hatteras National Seashore in North Carolina, Kenai Fjords National Park in Alaska, Olympic National Park in Washington, and Padre Island National Seashore in Texas. Here are the aforementioned problems that we will seek to solve via our model:

1. **Tides of Change** – What is the risk for change in sea level for each of the five parks? Could there be potential for a mathematical model that realistically predicts these risks for 10, 20, 50, or even 100 years to come?
2. **The Coast is Clear?** – What is the relative vulnerability of each park to climate-related events? Taking into account the likelihood and severity of various climate issues, can an all-encompassing vulnerability score be assigned to each park?
3. **Let Nature Take its Course?** – In light of climate-related risks, how should the National Park Service allocate funds to maximize efficiency? How should it prioritize this allocation in an environment that is susceptible to change? What impact do visitor statistics and vulnerability have on this decision?

2 Tides of Change

2.1 Background & Definition of Variables

One major contributing factor to climate change is the fluctuation of sea levels in coastal areas. The rise of sea levels in itself is a sufficiently complicated matter. The NPS feature "Planning for the impact of sea-level rise on U.S. national parks" says, "Changes in sea level can occur as a result of numerous drivers. Steric sea-level change is driven by a change in water density, thermosteric changes are the result of changes in temperature, and halosteric change is caused by changes in salinity" [2].

In order to build a mathematical model that would determine a sea level change risk rating for each of the following five national parks, we developed relative interpretations of the categories 'high', 'medium', and 'low' for each park, based solely on the mean monthly sea levels for the five specified parks over a 20-year time frame. We obtained this data from the NPS Spreadsheet of Mean Sea Level.

2.1.1 High*

Based on data from the National Park Service, the maximum sea level from 1997 to 2016 for Acadia National Park was 0.182 millimeter. The maximum sea level for Cape Hatteras National Park was 0.334 millimeter. The maximum sea level for Kenai Fjords National Park was 0.258 millimeter. The maximum sea level for Olympic National Park was 0.3 millimeter. The maximum sea level for Padre Island National Seashore was 0.235 millimeter.

This data led us to formulate our interpretation and definition of the medium category as 0.2 millimeters and above.

2.1.2 Medium*

Based on data from the National Park Service, the average sea level from 1997 to 2016 for Acadia National Park was 0.04453414 millimeter. The average sea level for Cape Hatteras National Park was 0.065079498 millimeter. The average sea level for Kenai Fjords National Park was -0.060659664 millimeter. The average sea level for Olympic National Park was -0.000543933 millimeter. The average sea level for Padre Island National Seashore was 0.032402516 millimeter.

This data led us to formulate our interpretation and definition of the medium category as 0.0 to 0.2 millimeters.

2.1.1 Low*

Based on data from the National Park Service, the minimum sea level from 1997 to 2016 for Acadia National Park, from 1997 to 2016 was -0.078 millimeter. The minimum sea level for Cape Hatteras National Park was -0.076 millimeter. The minimum sea level for Kenai Fjords National Park was -0.346 millimeter. The minimum sea level for Olympic National Park was -0.237 millimeter. The minimum sea level for Padre Island National Seashore was -0.121 millimeter.

This data led us to formulate our interpretation and definition of the low category as 0.0 millimeters and below.

*Our definitions of 'high,' 'medium,' and 'low' for the MSL are based solely off of the data obtained for these five National Parks. We are aware that MSL data can range significantly higher or lower; however, the simplicity of our model was necessary.

2.2 Acadia National Park

We used the mean sea level values from 1997 to 2016 for Acadia National Park to form a trend line that gave us the following equation, as a prediction for the sea level for the next 10, 20, and 50 years:

Y=0.0003x-0.0014

Given that x is in months since 1997, and Y_0 is 240:

X	Y
360	0.1066
480	0.1426
840	0.2506

For X=360, or in the next 10 years, the sea level of Acadia National Park is projected to be 0.1066, which lies in the medium range. The risk rating is medium.

For X=480, or in the next 20 years, the sea level of Acadia National Park is projected to be 0.1426, which lies in the medium range. The risk rating is medium.

For X=840, or in the next 50 years, the sea level of Acadia National Park is projected to be 0.2506, which lies in the high range. The risk rating is high.

2.3 Cape Hatteras National Park

We used the mean sea level values from 1997 to 2016 for Cape Hatteras National Park to form a trend line that gave us the following equation, as a prediction for the sea level for the next 10, 20, and 50 years:

$Y=0.0005x + 0.0095$

Given that x is in months since 1997, and Y_0 is 240:

X	Y
360	0.1895
480	0.2495
840	0.4295

For X=360, or in the next 10 years, the sea level of Cape Hatteras National Park is projected to be 0.1895, which lies in the medium range. The risk rating is medium.

For X=480, or in the next 20 years, the sea level of Cape Hatteras National Park is projected to be 0.2495, which lies in the high range. The risk rating is high.

For X=840, or in the next 50 years, the sea level of Cape Hatteras National Park is projected to be 0.4295, which lies in the high range. The risk rating is high.

2.4 Kenai Fjords National Park

We used the mean sea level values from 1997 to 2016 for Kenai Fjords National Park to form a trend line that gave us the following equation, as a prediction for the sea level for the next 10, 20, and 50 years:

$Y=-0.0003x-0.0207$

Given that x is in months since 1997, and Y_0 is 240:

X	Y
360	-0.1287
480	-0.1647
840	-0.2727

For X=360, or in the next 10 years, the sea level of Kenai Fjords National Park is projected to be -0.1287, which lies in the low range. The risk rating is low.

For X=480, or in the next 20 years, the sea level of Kenai Fjords National Park is projected to be -0.1647, which lies in the low range. The risk rating is low.

For X=840, or in the next 50 years, the sea level of Kenai Fjords National Park is projected to be -0.2727, which lies in the low range. The risk rating is low.

2.5 Olympic National Park

We used the mean sea level values from 1997 to 2016 for Olympic National Park to form a trend line that gave us the following equation, as a prediction for the sea level for the next 10, 20, and 50 years:

Y=0.00005x – 0.0069

Given that x is in months since 1997, and Y_0 is 240:

X	Y
360	0.0111
480	0.0171
840	0.0351

For X=360, or in the next 10 years, the sea level of Olympic National Park is projected to be 0.1066, which lies in the medium range. The risk rating is medium.

For X=480, or in the next 20 years, the sea level of Olympic National Park is projected to be 0.1426, which lies in the medium range. The risk rating is medium.

For X=840, or in the next 50 years, the sea level of Olympic National Park is projected to be 0.2506, which lies in the high range. The risk rating is high.

2.6 Padre Island National Seashore

We used the mean sea level values from 1997 to 2016 for Padre Island National Seashore to form a trend line that gave us the following equation, as a prediction for the sea level for the next 10, 20, and 50 years:

Y=-0.000006x + 0.036

Given that x is in months since 1997, and Y_0 is 240:

X	Y
360	0.03384
480	0.03312
840	0.03096

For X=360, or in the next 10 years, the sea level of Padre Island National Seashore is projected to be 0.03384, which lies in the medium range. The risk rating is medium.

For X=480, or in the next 20 years, the sea level of Padre Island National Seashore is projected to be 0.03312, which lies in the medium range. The risk rating is medium.

For X=840, or in the next 50 years, the sea level of Padre Island National Seashore is projected to be 0.03096, which lies in the medium range. The risk rating is medium.

2.7 Model Viability

Although this model is founded upon reliable statistical data and analysis, it would not formulate a realistic prediction for the sea levels of these five parks in the next 10, 20, or 50 years. Therefore, it would certainly not be able to realistically predict sea levels for the next 100 years. There is a multitude of factors that influence sea level change in these various places. Future sea levels cannot be determined solely by data from past years, because climates and other environmental factors are always fluctuating in frequency and intensity.

If the conditions over the past 20 years were to remain relatively constant, our model could be viable solution to determine sea level change. However, given that this is not the case, a realistic prediction about the risk of sea level change cannot be formulated in this manner.

3 The Coast is Clear?

3.1 Background & Defining Variables

This task involved developing a 'vulnerability score' for each of the five parks, intended to measure their susceptibility to climate change. According to the Department of Energy and Environmental Protection, "Systems that are sensitive to climate and less able to adapt to changes are generally considered vulnerable to climate change impacts" [3]. Our vulnerability scores were primarily based on the likelihood and severity of the following factors: heat index, hurricanes, wildfires, temperature, and air quality. The data that we obtained on these particular topics was drawn from the NPS spreadsheets of heat indexes, hurricane categories, wildfire classes, average temperatures, and air quality indexes in the five parks.

3.1.1 Individual Score Rating

For the process of generating vulnerability scores, we generated scores for each of the aforementioned categories for each park. These categorical scores were based on a scale from 1 to 10, 1 being the least alarming and 10 being the most. They take into account likelihood and severity. Unique, relevant factors were taken into consideration for each category as well. The categorical scores were eventually added together for a total out of 50. That total became the final vulnerability score for the park in question.

3.1.2 Heat Index

Aside from likelihood and severity, the most significant determinant of the categorical scores for heat index was constancy. To determine constancy, we graphed the average heat indexes from 1997 to 2016 for each park, using data from the NPS Heat Index Spreadsheet. A horizontal line represented little to no fluctuation in heat. Fluctuating graphs represented great inconsistency in heat. We compared these levels of fluctuation to each other in order to assign the categorical score for each park.

3.1.3 Hurricanes

Hurricanes were rated primarily on their frequency over the 20-year time frame in each location, as well as their categories. The categories themselves are based on sustained winds. We obtained this data from the NPS Hurricane Spreadsheet. The main hurricane categories and their corresponding sustained winds are as follows:

Category	Sustained winds
H5	157 mph or higher
H4	130-156 mph
H3	111-129 mph
H2	96-110 mph
H1	74-95 mph
TS	39-73 mph
TD	less than 39 mph
ET	N/A (result from temperature contrast)

3.1.4 Wildfires

Wildfires were ranked primarily on their frequency over the 20-year time frame in each location, as well as their classes. The classes judge the wildfires on their size, or to what extent they spread. We obtained this data from the NPS Wildfire Spreadsheet. The main wildfire classes and their sizes are as follows:

Category	Size (Spread)
A	¼ acre or less
B	More than ¼ acre, less than 10 acres
C	10 or more acres, less than 100 acres
D	100 or more acres, less than 300 acres
E	300 or more acres, less than 1000 acres
F	1000 acres or more, less than 5000 acres
G	5000 acres or more

3.1.5 Temperature

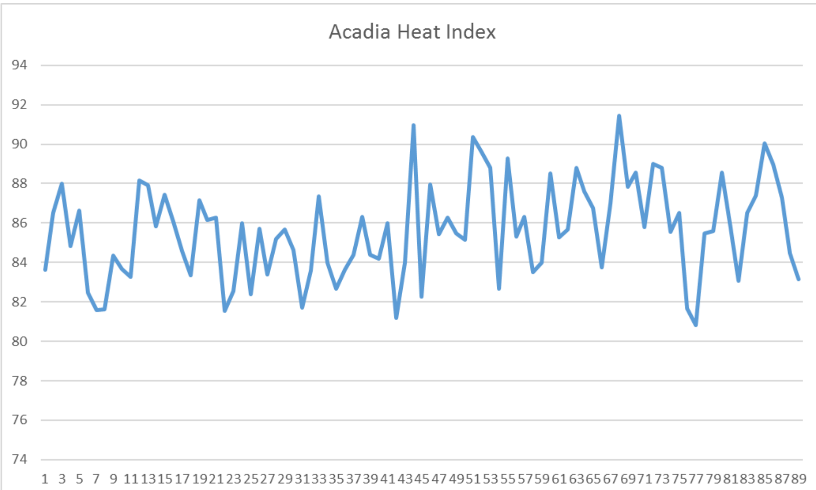
Average temperature, like heat index, was graphed and observed for fluctuations. We obtained this data – average temperature from 1997 to 2016 for each park – from the NPS Temperature Spreadsheet. A constant graph represented a fairly constant temperature, whereas a fluctuating graph represented inconsistencies in temperature, which are indicative of climate change in the given areas.

3.1.6 Air Quality

Air quality was ranked based on average AQI (air quality index) and their frequencies over the 20-year time frame for each park. We obtained this data from the NPS Air Quality Index Spreadsheet. A lower average AQI would result in a higher categorical score, whereas a higher average AQI would result in a lower categorical score.

3.2 Acadia National Park

The graph of Acadia National Park's average heat indexes from 1997 to 2016 is as follows:

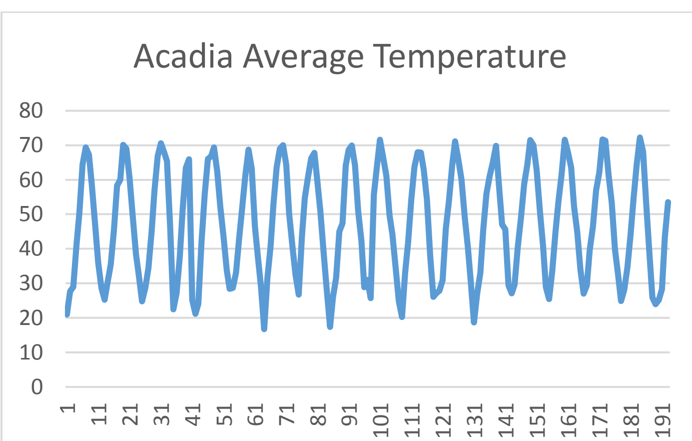


This graph was the 2nd most fluctuating graph out of all heat index graphs for all parks. We assigned Acadia National Park a heat score of 7/10 based on its wide range of temperatures and inconsistency.

Using the NPS spreadsheet, we determined that the area surrounding Acadia National Park underwent 6 hurricanes in 20 years. 5 of these hurricanes were categorized as ET, and one of them was categorized as an H3. Therefore, only ET hurricanes are frequent in this area, which are low damage. We assigned a hurricane score of 3/10.

Using the NPS spreadsheet, we determined that the area surrounding Acadia National Park underwent 73 wildfires in 20 years. Of these, 11 were Class B, 3 were Class C, 1 was Class NR, 1 was Class D, and 57 were Class A. 724.25 acres were burned in total. This park earned a wildfire score of 2/10 because of the low total acreage destroyed.

The graph of average temperature is as follows:



This graph covered a fairly wide range, and it also exemplified some fluctuation. Given the discrepant graph trends, the temperature score for Acadia would be 7/10.

Finally, we defined an air quality index of 0-50 as 'good' and one from 50-100 as 'bad.' Out of the air quality indexes over the time frame, 198 of them were good, and 52 of them were bad. 79.8% of them were good, leading us to assign an AQI score of 3/10.

In total, Acadia National Park accumulated a climate vulnerability score of 22/50, or 44% vulnerable.

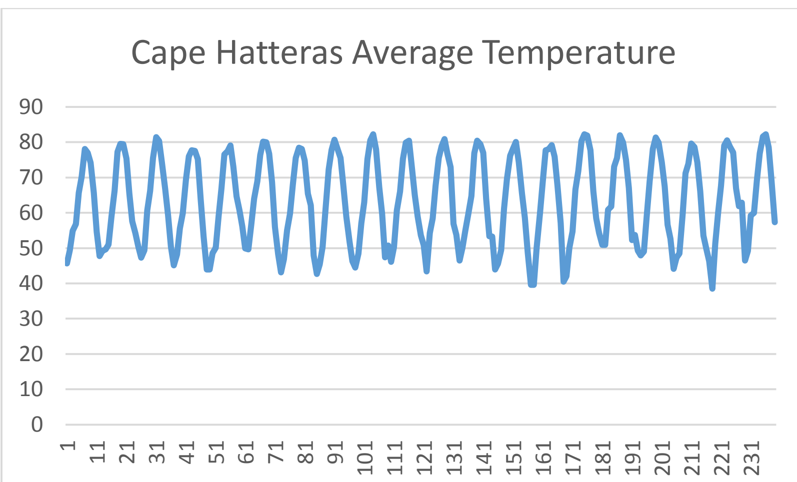
3.3 Cape Hatteras National Park

The graph of Cape Hatteras National Park's average heat indexes from 1997 to 2016 was the most fluctuating graph out of all heat index graphs for all parks. There was no consistency or pattern. Therefore, we assigned a heat score of 8/10.

Using the NPS spreadsheet, we determined that the area surrounding Cape Hatteras National Park underwent 32 hurricanes in 20 years. 8 of these hurricanes were categorized as ET, 5 were TD, 9 were TS, 4 were H1, and 6 were H2. The hurricanes in this area are both frequent and high damage. We assigned a hurricane score of 7/10.

Using the NPS spreadsheet, we determined that the area surrounding Cape Hatteras National Park underwent 86 wildfires in 20 years. Of these, 2 were Class D, 3 were Class C, 22 were Class B, and 59 were Class A. 1134.75 acres were burned in total. Due to the low acreage destroyed, this park earned a wildfire score of only 3/10.

The graph of average temperature is as follows:



This graph covered a moderate range, and it was inconsistent. Overall, the temperature score for Cape Hatteras would be 5/10.

For Cape Hatteras, out of the air quality indexes over the time frame, 148 of them were good, and 66 of them were bad. 59.7% of them were good, leading us to assign an AQI score of 4/10.

In total, Cape Hatteras National Park accumulated a climate vulnerability score of 27/50, or 54% vulnerable.

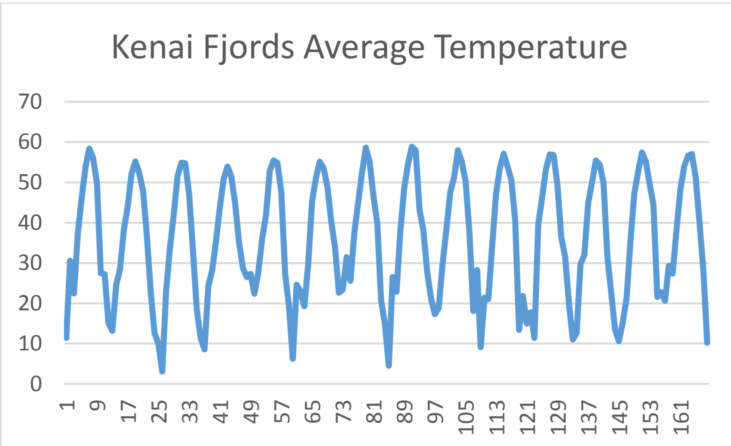
3.4 Kenai Fjords National Park

The graph of Kenai Fjords National Park's average heat indexes from 1997 to 2016 had minimal fluctuation and also the least amount of fluctuation. It was generally very consistent. Therefore, we assigned a heat score of 1/10.

Using the NPS spreadsheet, we determined that the area surrounding Kenai Fjords National Park underwent 0 hurricanes in 20 years. Therefore, we assigned a hurricane score of 1/10.

Using the NPS spreadsheet, we determined that Kenai Fjords underwent – 0 wildfires in 20 years. Therefore, this park earned a wildfire score of 1/10.

The graph of average temperature is as follows:



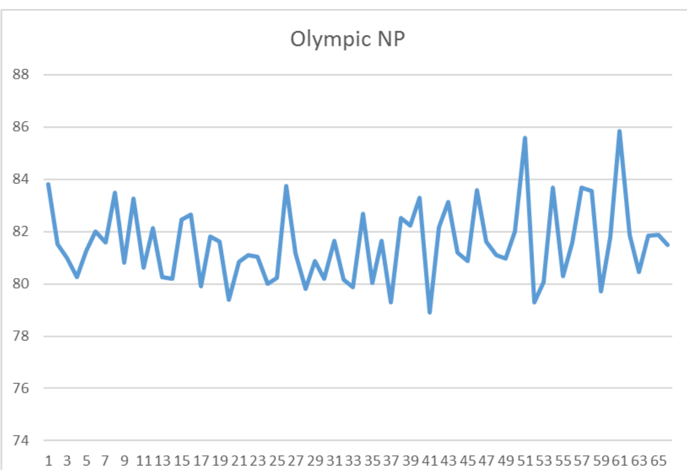
This graph covered a wide range, and it was inconsistent. Overall, given the pattern of fluctuation, the temperature score would be 8/10.

For Kenai Fjords, out of the air quality indexes over the time frame, 228 of them were good, and 20 of them were bad. 91.9% of them were good, leading us to assign an AQI score of 2/10.

In total, Kenai Fjords National Park accumulated a climate vulnerability score of 13/50, or 26% vulnerable.

3.5 Olympic National Park

The graph of Olympic National Park's average heat indexes from 1997 to 2016 is as follows:

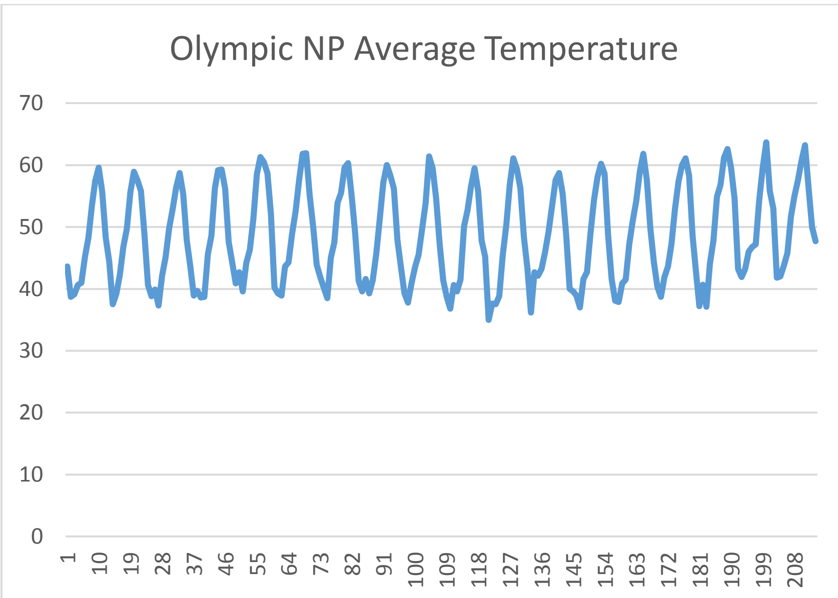


This graph was the 3rd most fluctuating graph out of all heat index graphs for all parks. The range for this graph is not as wide as those that outrank it, however. Therefore, we assigned a heat score of 5/10.

Using the NPS spreadsheet, we determined that Olympic National Park underwent 0 hurricanes in 20 years. Therefore, we assigned a hurricane score of 1/10.

Using the NPS spreadsheet, we determined that the area underwent 403 wildfires in 20 years. Of these, 39 were Class B, 5 were Class C, 5 was Class NR, 3 were Class D, 6 were Class E, 3 were Class F, and 342 were Class A. 22875.5 acres were burned in total. Wildfires were high in frequency, but low in severity; this park earned a wildfire score of 6/10.

The graph of average temperature is as follows:



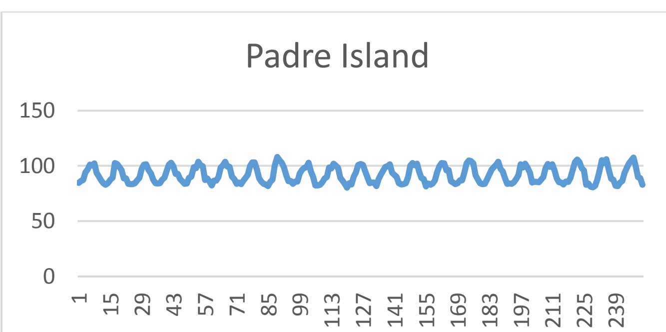
This graph covered a small range, and it showed slight variation. Overall, temperature score would be 3/10.

Out of the air quality indexes over the time frame, 222 of them were good, and 26 of them were bad. 89.5% of them were good, leading us to assign an AQI score of 2/10.

In total, Olympic National Park accumulated a climate vulnerability score of 17/50, or 34% vulnerable.

3.6 Padre Island National Seashore

The graph of Padre Island National Seashore's average heat indexes from 1997 to 2016 is as follows:

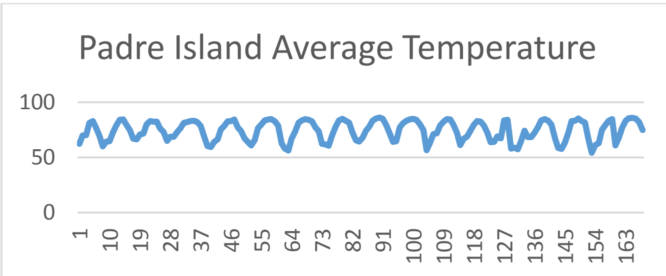


In comparison to the others, this graph had a pattern of relatively short range fluctuation. Therefore, we assigned a heat score of 3/10.

Based on the NPS Spreadsheet, this area experienced 11 hurricanes in 20 years. Of these, 1 was categorized as a TD, 7 as TS, 1 as H1, 1 as HS, and 1 as H4. Most of these are low damage hurricanes with the exception of one high damage hurricane, so while they are fairly frequent, the hurricane score would be a moderate 5/10.

Using the NPS spreadsheet, we determined that the area surrounding Padre Island underwent 41 wildfires in 17 years. Of these, 5 were Class A, 14 were Class B, 5 were Class C, 4 were Class D, 6 were Class E, 3 were Class F, and 4 were Class G. 62841.25 acres were burned in total. These fires were low in frequency, but very high in severity; this park earned a wildfire score of 8/10.

The graph of average temperature is as follows:



This graph covered the smallest range. Overall, given the narrow range and pattern of the graph, the temperature score would be 2/10.

Out of the air quality indexes over the time frame, 186 of them were good, and 62 of them were bad. 75% of them were good, leading us to assign an AQI score of 3/10.

In total, Padre Island National Seashore accumulated a climate vulnerability score of 21/50, or 42% vulnerable.

3.7 Vulnerability Scores

These are the vulnerability scores of each park and how they compare to each other.

Park	Climate Vulnerability Score (out of 50)	Rank (most vulnerable to least)
Acadia National Park	44%	2
Cape Hatteras National Park	54%	1
Kenai Fjords National Park	26%	5
Olympic National Park	34%	4
Padre Island National Seashore	42%	3

4 Let Nature Take its Course?

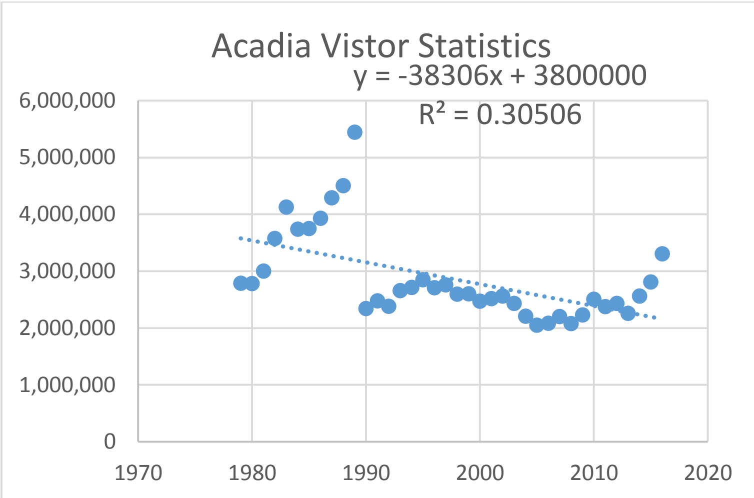
4.1 Background

The long-term changes that have been discussed will ultimately force National Park Service to make decisions regarding the prioritization of projects and the allocation of funds. The main factors that will play into this area will be the vulnerability scores generated and the visitor statistics of each park.

4.2 Visitor Statistics

First, we consulted the NPS Spreadsheet of Visitor Statistics to find the total number of visitors for each year for each park. We then proceeded to graph these numbers into a scatter plot and generate a line of best fit. We found the correlation between the two variables (R^2), as well. The graphs generated equations that would be able to predict long term changes in visitor attendance for each park. We used these equations to predict visitor attendance for the years 2030 and 2050.

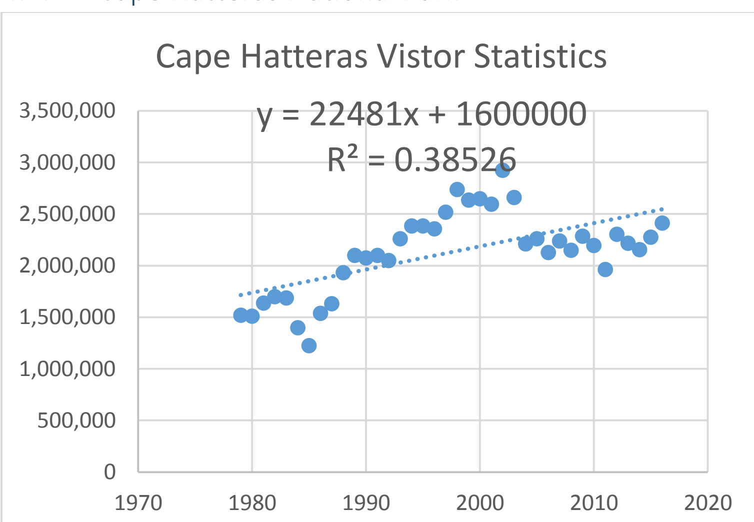
4.2.1 Acadia National Park



If Y is visitor attendance and X is in years since 1979:

X	Y
51	1846394
71	1080274

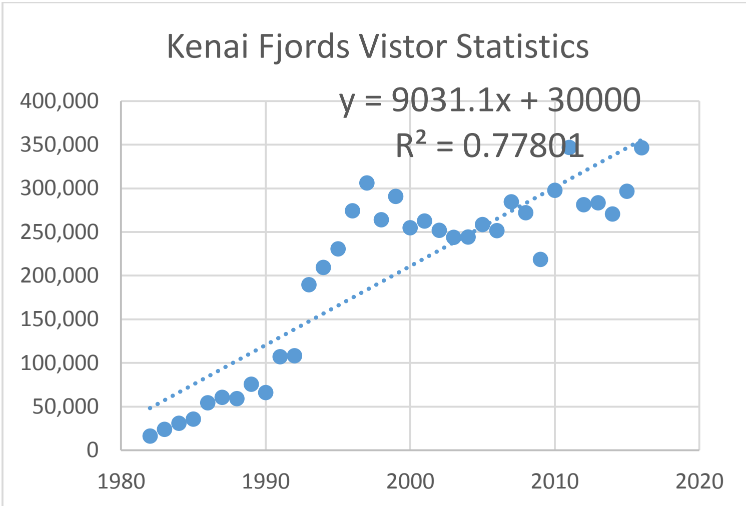
4.2.2 Cape Hatteras National Park



If Y is visitor attendance and X is in years since 1979:

X	Y
51	2746531
71	3196151

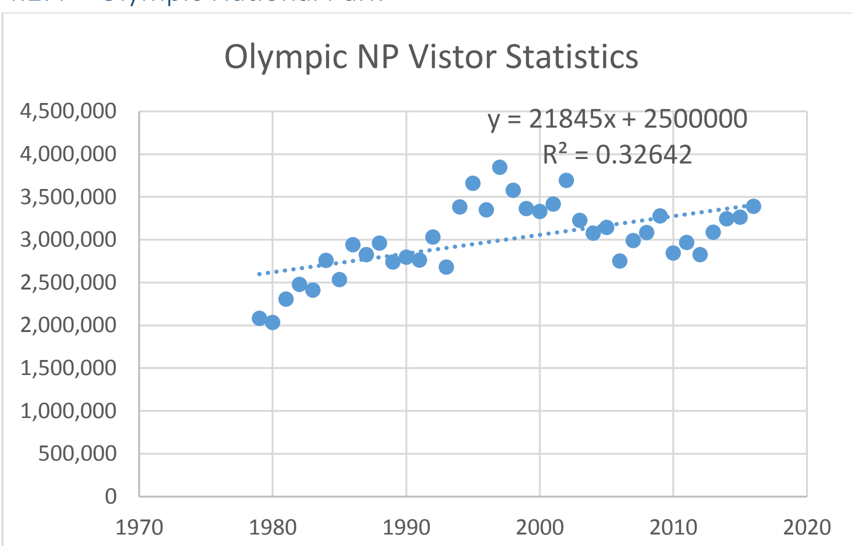
4.2.3 Kenai Fjords National Park



If Y is visitor attendance and X is in years since 1982:

X	Y
48	463492.8
68	644144.8

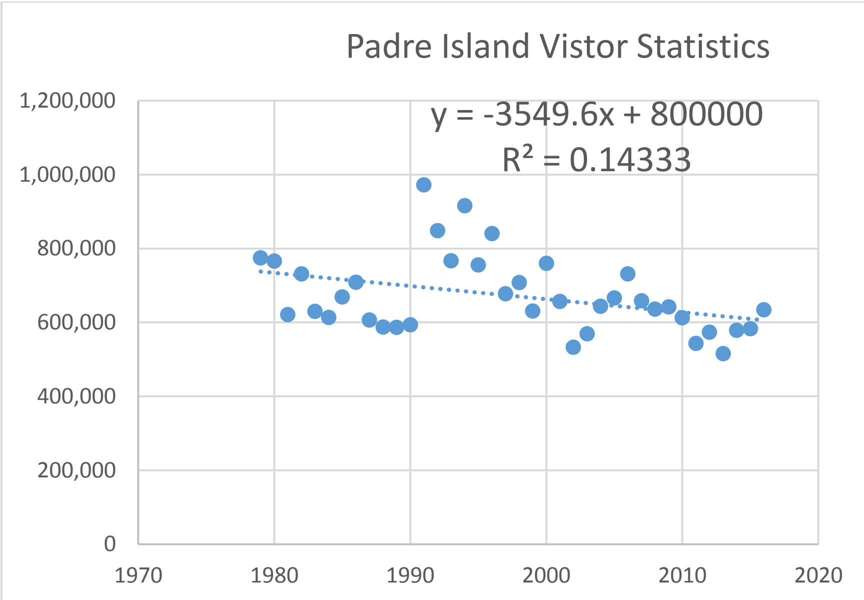
4.2.4 Olympic National Park



If Y is visitor attendance and X is in years since 1979:

X	Y
51	3614095
71	4050995

4.2.5 Padre Island National Seashore



If Y is visitor attendance and X is in years since 1979:

X	Y
51	618970.4
71	547978.4

4.3 Vulnerability

An important thing to consider is that these statistics already account for much of the parks' vulnerability, since they reflect actual attendance even during natural disasters and other fluctuations of climate.

However, if the NPS were to use these equations and find that visitor attendance is not a main concern, it may use the vulnerability scores to determine where funding should go. When visitor populations are relatively similar, parks with higher vulnerability scores should receive more money, and parks with lower vulnerability scores should receive less money. This accounts for the amount of maintenance and support that would be required for an area susceptible to climate as opposed to an area that is not as susceptible.

4.4 Recommendations

Taking into account both visitor attendance and vulnerability, we generated a ranking of the five parks for greatest funding to least funding:

Park	Ranking
Cape Hatteras National Seashore	1
Acadia National Park	2
Olympic National Park	3
Padre Island National Seashore	4
Kenai Fjords National Park	5

5 Model Assessment

5.1 Strengths

The strengths of our model were that we were able to draw from real data from the NPS itself, over a span of 20 years. The spreadsheets provided were highly helpful as we created and interpreted graphs, and generated equations to predict future events.

Our vulnerability score scale, based on the categories of various environmental factors, was very sound, as well. We tailored each scale uniquely according to the characteristics that were important in each factor. Not only that, but we were also able to generate a percentage of vulnerability, which was very concrete and easy to compare across the five parks.

5.2 Weaknesses

Our model, while we believe it to be solid and mathematically sound, contains flaws, as with every model. Most importantly, it is absolutely impossible to account for every single factor that influences climate change, especially the impact that humans have on it. We used only a relatively small group of categories to create our model and predict the risks for the five parks. In other words, this problem required great simplification and definition of seemingly straightforward terms.

Additionally, the correlation between the two variables when finding a model for change in visitor attendance was closer to 0 than to 1, so the resulting equation may not have been reliable. Our calculations and equations may have differed slightly in accuracy due to human error and the fact that some data was missing from the spreadsheets.

6 Conclusion

In conclusion, Cape Hatteras National Park should receive the greatest amount of funding, followed by Acadia National Park, Olympic National Park, Padre Island National Seashore, and Kenai Fjords National Park, respectively.

We arrived on this conclusion primarily due to the factors of vulnerability and projected visitor attendance. Cape Hatteras National Park has a climate change vulnerability score of 54%, which is the highest among all five parks. It also has the highest projected visitor attendance for 2030 and 2050. Therefore, it should receive the most funding to help with potential damage, and because it is predicted to be one of the most populous parks, it will generate more revenue and is worth more time and investment.

Acadia National Park is 44% vulnerable, which is less vulnerable than Cape Hatteras, but still very significant. The visitor attendance trend is currently downward sloping, but this could be temporary, and attendance could still be very prosperous.

Olympic National Park is only moderately vulnerable at 34%, but it attracts millions of visitors, and that number is projected to increase in the future.

Padre Island is 42% vulnerable, and while the trend of attendance is negative, this, too, could be a temporary fluctuation.

Finally, Kenai Fjords should receive the least funding because the vulnerability scores were unable to be accurately computed. Many of the environmental categories that we used were not relevant to Alaska, so our analysis may not be completely reliable. Also visitation is positive sloping, but it is still low to be significant in the long run.

Climate change will continue to be a problem that plagues societies around the world, but mathematical models such as these will be a huge asset in learning to adapt to and deal with it. Ultimately, through reasoning and hard statistical analysis, we may be able to conquer these problems that we currently face in our day and age.

7 References

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