Climate Change Impacts on Visitation in National Parks in the United States

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Tourism is one of the largest industries in the world and it continues to grow at a rapid pace. Tourism is dependent upon weather and climate, particularly the length and quality of the outdoor recreation season for nature-based tourism, since it is directly affected by weather. Indirectly, the natural biophysical resources that outdoor tourism is based upon can also be altered by climate. Thus, climate change has the potential to affect nature-based tourism that takes place in national parks and other protected areas. Of the studies that analyse the impacts of climate change in national parks, the vast majority focus on conservation policy and planning rather than tourism. This study applies a single variable regression analysis technique to empirically evaluate the affects of climate change on the quantity and seasonal patterns of visitation to United States national parks under a range of climate change scenarios for the 2020s, 2050s, and 2080s (The Met Office Hadley Centre CM3 B21 (United Kingdom) and Commonwealth Scientific and Industrial Research Organisation MK2B A11 (Australia) climate models were used for the Alaskan parks, and the National Center for Atmospheric Research PCM B21 (United States) and Centre for Climate Systems Research NIES A11 (Japan) models were used for the contiguous states). Fourteen parks are included in the study, representing 12 different climate regimes across the country and 58% of total visitation to all national parks in the United States in 2005. In general, the number of visits to parks in the northern regions of the country, excluding Alaska, is projected to increase annually, with the majority of increases occurring in the spring and fall shoulder seasons. In Alaska, there is no consistent pattern on an annual basis due to projections being calculated for only the low season (winter) for Denali, and for the high season (summer) for Glacier Bay. Based on these projections, visitation may increase during the low season and decrease during the high season for Alaskan parks. Parks in the south are projected to experience decreased annual visitation as temperatures become uncomfortably hot, particularly under high emissions scenarios. The largest changes in visitation are projected to occur in the 2080s, although some parks may experience noticeable changes as early as the 2020s in particular seasons. Small to moderate changes in visitation (up to 10% annually) are projected with the low emission climate change scenarios, even into the 2080s. Small to large visitation changes (up to 47% annually) are projected using the higher emission climate change scenarios. These visitation changes could lead to the need for substantial management changes in certain US national parks as revenue collected from user fees and operational costs are altered. Additional ecological and social impacts resulting from increased visitation will also need to be critically considered. Where fewer visits are projected, decreased revenue may lead to an inability to properly manage the park. The results of the study can be used by the National Park Service and regional and park managers to plan for visitation changes that might occur as climate change continues over the 21st century.

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List of Acronyms

CCIS – Canadian Climate and Impacts Scenarios
CCSR – Centre for Climate Systems Research (Japan)
CO_2 – Carbon dioxide
CSIRO - Commonwealth Scientific and Industrial Research Organisation (Australia)
EPA – Environmental Protection Agency (United States)
GCM – General Circulation Model
GHG – Greenhouse gas
HAD – Met Office Hadley Centre (United Kingdom)
IPCC – Intergovernmental Panel on Climate Change
NCAR – National Center for Atmospheric Research (United States)
NCDC – National Climatic Data Center (United States)
NPS – National Park Service (United States)
OECD - Organisation for Economic Co-operation and Development
TCI – Tourism Climatic Index
UK – United Kingdom
UNEP – United Nations Environment Programme
US – United States of America
VEC – Valued ecosystem component
WMO – World Meteorological Organisation
WTO – World Tourism Organisation
WWF – World Wildlife Fund

1 Introduction

Tourism is one of the largest industries in the world, and it continues to grow at a rapid pace. Tourism is affected by weather and climate, particularly most outdoor tourism that is based upon natural biophysical resources that can be altered by climate (Smith 1993). Altered weather patterns may directly affect the comfort and safety of tourists, while longer term climatic and seasonal changes can alter the biophysical resources upon which many recreational activities depend. Outdoor, or nature-based, tourism is an important sector of international tourism (Eagles 2002). Climate change can alter the length and quality of the recreation season, which may be more pronounced for nature-based tourism than other types of tourism that take place indoors. Climate change also has the potential to alter the resources upon which nature-based tourism relies, including for instance, natural landscape features and wildlife populations. The implications of climate change for altering tourism resources and the volumes and patterns of visitation are therefore potentially enormous, and will require active management on the part of tourism operators, particularly protected area managers. Such management will require sound scientific research to inform decision-making processes.

Limited research assesses the affects of climate change on tourism (Hall and Higham 2005). In fact, only recently has the topic been recognized as an important focus of research in the academic community (Scott *et al.* 2005). Concern has been expressed by some researchers regarding the linkages between climate change and tourism (Wall 1998; Braun *et al.* 1999; Maddison 2001; Viner and Amelung 2003; Richardson and Loomis 2004; Scott *et al.* 2005), and some (Braun *et al.* 1999; Maddison 2001; Scott *et al.* 2004) cite the limited number of existing studies in this field and discuss the shortcomings of those that do exist. Of the studies that analyse the impacts of climate change in national parks, the vast majority focus on conservation policy and planning rather than nature-based tourism (Scott and Lemieux 2005), with studies by Richardson and Loomis (2004), Konopek (2005), and Jones and Scott (2006a; 2006b) being the exceptions.

This study builds on research conducted by Jones and Scott (2006a) assessing the impacts of climate change on visitation in Canadian national parks by extending the research into the United States (US). The US contains 14 climate regions across the country, compared to the six found in Canada, which may result in different magnitudes and types of climatic changes than those projected for Canada, thereby affecting national park visitation differently. To date, the climate change research emphasis for national parks in the US has been on biophysical changes, with only one study examining how climate change may affect visitation (Richardson and Loomis 2004), in which only one park and one future timeframe were included in the analysis. This study takes a broader approach by exploring the diversity of climates across the national park system in the US to see how seasonal patterns of visitation currently differ, the ability of climate variables to predict visitation, and to examine the different potential impacts of future climate change on visitation in the near (2020s), intermediate (2050s), and more distant (2080s) future. Single variable regression analysis technique is used. Additional factors known to influence visitation were not accounted for due to a lack of consistent and complete data for each park in the study, including for example, effects of population growth and other demographic shifts, economic fluctuations, energy prices, and transportation infrastructure. Only the most recent decade of visitation data was used for the analysis in order to minimize the effects of factors such as these, while still providing enough data to discern the influence of climate on visitation. Fourteen parks representing the major climatic zones of the country are included in the study, which together account for approximately 58% of total visitation to all US national parks in 2005 (National Park Service (NPS) 2006m). Two climate change scenarios are used for each park in order to capture the full range of uncertainty in future temperature changes (*i.e.*, scenarios representing greatest and least projected warming). (The Met Office Hadley Centre CM3 B21 (United Kingdom (UK)) and Commonwealth Scientific and Industrial Research Organisation MK2B A11 (Australia) climate models were used for the Alaskan parks, and the National Center for Atmospheric Research PCM B21 (United States) and Centre for Climate Systems Research NIES A11 (Japan) models were used for the contiguous states).

1.1 Structure of Thesis

This thesis is divided into seven chapters. Chapter two sets the context for the research by describing the economic importance of national park tourism and the US national park system. Chapter three provides an overview of the literature on climate change, tourism, and protected areas. The results of studies on the effects of climate change on tourism in national parks are the main focus, and gaps in the literature are identified. Chapter four describes the methods used in the study, including from where data was obtained and how the empirical analysis of the climate and visitation data was conducted. Emphasis is placed on the rationale behind which parks were included in the study and how climate change projections were used to project future visitation levels. Chapter five describes the results of the study. In this chapter, seasonal patterns and regression models of park visitation are identified, and projected temperatures and visitation levels are provided for each park. In chapter six, a discussion of projected direct climate changes and possible biophysical changes at each park in the study under climate change helps to put the results of the study in context. Possible climate and visitation analogues are also presented for Canada in this chapter. Chapter seven concludes the study by briefly summarizing the main findings and setting out some directions for future research.

2 Context: Tourism and National Parks

2.1 The Economy of Global Tourism

Tourism is a large global industry that continues to grow rapidly. According to the World Tourism Organisation (WTO) (2003b), the number of international tourism arrivals increased from 25 million in 1950 to an estimated 808 million in 2005 (WTO 2006). This substantial growth indicates that tourism is very important from both an economic and a social perspective (WTO 2003b). In 2003, tourism represented 6% of worldwide exports of goods and services combined, or 30% of service exports alone (WTO 2003d). By the year 2020, global international arrivals are projected to reach 1.6 billion, with the Americas being the third highest receiver of tourists (WTO 2003c). Any shifts in tourism patterns and volumes as a result of changing climates worldwide could have widespread impacts on the economy, the environment, and society in general (Scott *et al.* 2004; Hamilton *et al.* 2005a).

In 2004, the US was third in the world in terms of international arrivals (behind France and Spain) (WTO 2005b). In terms of market share, the US was by far first in North America, with a revenue of US$74.5 billion in tourist receipts, compared to US$9.8 billion for Canada and US$8.2 billion for Mexico (WTO 2005a).

2.2 National Parks and Tourism

National parks play an important role in nature-based tourism. By 1996, parks and protected areas were established in 225 countries and territories and covered approximately 13 million square kilometres, or 8.8% of the globe's total land area (Eagles 2003). Unfortunately, the economic significance of park tourism is not well documented and poorly communicated (Eagles 2002), making it impossible to provide any accurate global figures. Eagles (2002) attests that the name national park has a strong association with nature-based tourism, and it is a symbol of high quality natural environments with strong tourist infrastructures. Similar to the use of logos by corporations, the name national park has been used as a brand name by Canadian ecotourism companies as a symbol to indicate the quality and status of their products (Eagles 2002).

2.3 National Parks in the US

The US has the longest history of national parks worldwide, dating back to the first designation in 1872 in the western mountainous region of the country (Foster 1998). The NPS is now responsible for the management of 58 national parks, the majority of which are located in the west, and 330 other nationally protected areas (NPS 2004a) throughout seven administrative regions across the country. Figure 1 illustrates the locations of 56 of the 58 national parks within the seven NPS administrative regions (Virgin Islands National Park and National Park of American Samoa are excluded).

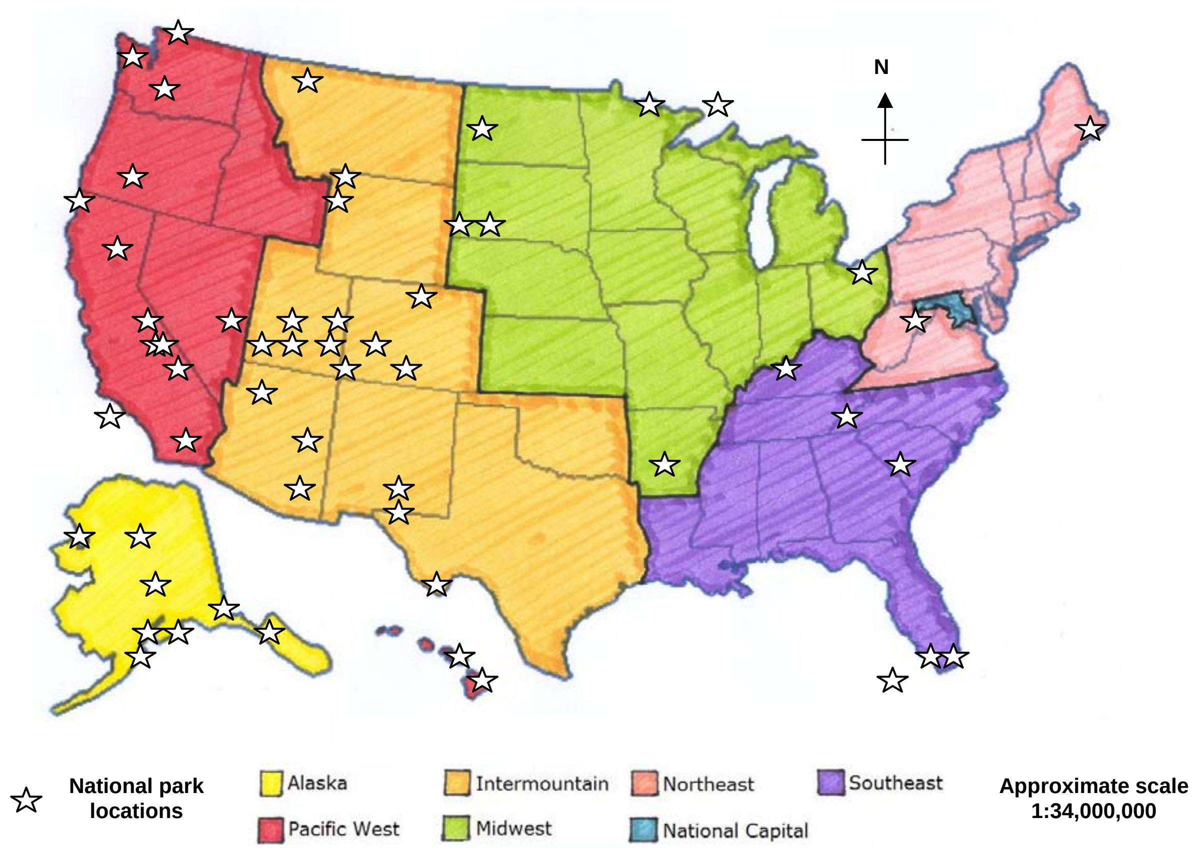
The primary purposes of these protected areas are conservation and public recreation (NPS 2000). In 2003, these 330 protected areas covered 342,000 km^2 (84 million acres) of land, with national parks constituting 210,000 km^2 (52 million acres) (NPS 2006b).

2.3.1 Tourism and US National Parks

In 2005, 273 million recreation[1] visits were made to protected areas in the US (65% of total[2] visits to all protected areas), with 65 million recreation visits to national parks

[1] A recreation visit is defined as, "the entry of a person onto lands or waters administered by the NPS for recreational purposes excluding government personnel, through traffic (commuters), trades-person, and a person residing within park boundaries" (NPS 2005:73)
[2] Total visits include all recreation and non-recreation visits combined. Non-recreation visits include "through traffic, persons going to and from inholdings, tradespeople with business in the park, and government personnel (other than NPS employees) with business in the park" (NPS 2005:72).

Figure 1 - National Park Service Regions and Locations of US National Parks



Adapted from NPS (2006m)

alone (74% of total visits to national parks) (NPS 2006m). In 2001, total spending in local areas surrounding the protected areas equaled US$10.6 billion, and 267,000 jobs were supported (Stynes 2005).

Visitation levels and patterns differ for each national park in the US, although mountain parks generally tend to attract slightly higher volumes of visitors annually. One possible reason for this is a wider diversity of recreation activities for visitors to partake in at mountain parks, as compared to smaller parks that were designed to protect a specific landscape feature. Each national park attracted between less than one and 5% of total visits to all national parks in 2005, with the sole exception of Great Smoky Mountains National Park, which accounted for 23% of total visits (NPS 2006m). The high volume of visitation at this park may be attributed to a number of factors, in particular its location in the eastern part of the country, which makes it more easily accessible to a large portion of the country's population than western parks. Additionally, there is less competition amongst national parks in the east simply because there are so few of them compared to the west, and Great Smoky Mountains is the only eastern park with mountains as a significant portion of its landscape.

3 Review of Relevant Literature

This chapter reviews the literature on climate change, tourism, and protected areas worldwide. The chapter begins by establishing the importance of climate for tourism, and then discusses how climate change has affected the tourism industry, and how it may continue to impact tourism in the future. Emphasis is placed on protected areas as tourism destinations, with a particular focus on the study area, US national parks. Implications of climate change for tourism operators and managers are summarized, followed by the identification of major gaps in the literature, and how this study contributes to the field of knowledge.

3.1 Climate and Tourism

There is a strong link between tourism and the climate of the destination region. This is especially true for outdoor and nature-based tourism where the recreation resources can be directly altered by changes in the climate. Climate change will have repercussions for tourism patterns and the number of visitors to particular destinations.

3.1.1 Nature-Based Tourism

Nature-based tourism is an important sector of international tourism (Eagles 2002), and is heavily dependent on the climate and the biophysical resources it supports. Eagles (2003) identifies four niche markets of nature-based tourism, including ecotourism, wilderness use, adventure travel, and car camping.

Each of these niche markets depends upon the natural environment of the destination, and each involves differing goals and levels of personal safety of the participants (Eagles 2003). For instance, ecotourism focuses on learning about the natural environment, wilderness travel is more primitive and recreation-motivated, adventure travel is generally about personal accomplishment, and car camping is safe and fairly civilized (Eagles 2003). It follows then that perhaps the largest changes in tourism due to climate change will be felt in the nature-based sector.

3.1.2 Tourist Behaviour

Understanding how tourists decide when and where to vacation is important for the tourism industry as a whole, and particularly for destination managers. Motivations for tourist behaviour have been the topic of a wide number of studies (Mayo 1975; Crompton 1979; Crandall 1980; Bieger and Laesser 2002; Canadian Tourism Commission 2003a).

Crandall (1980) identifies two general types of leisure motivation research that have been conducted, including asking people either why they participated in or enjoyed leisure, and the more direct measurement of needs or satisfactions.

Tourist attitudes or lifestyle characteristics have been analysed to better understand tourist behaviour (see Mayo 1975; Um and Crompton 1990; Silverberg *et al.* 1996). For instance, Silverberg *et al.* (1996) segmented the nature-based travel market according to lifestyle characteristics of travelers, and then determined differences between the resulting segments in terms of travel behaviour, environmental attitudes, and demographic characteristics. Other studies have looked at consistent differences between visitors and non-visitors to the same destinations (see Baloglu and McCleary 1999; Galloway 2002), or between those who choose to remain in a particular location versus those who stop temporarily on their way to other destinations (see McKercher 2001).

Another method used is the analysis of market segmentation based on tourist motivations (see Crompton 1979; Bieger and Laesser 2002; Galloway 2002) or preferred activities (see Canadian Tourism Commission 2003a). Galloway (2002), for instance, looked for consistent differences between clusters of visitors to parks in Ontario, Canada, within the same general motivation segment of sensation seeking.

Push and pull factors have been employed as a framework to analyse the elements that motivate people to travel for holidays, and their choice of destination (Dann 1977; Crompton 1979; Dann 1981; Hamilton *et al.* 2005a). Dann (1977:186) defines push factors as the factors that predispose an individual to travel, such as escape or nostalgia, while pull factors are the qualities of the destination that attract the tourist, such as sunshine or the sea. Crompton (1979) suggests nine motives for travel, seven of which are socio-psychological, such as exploration or relaxation, and two of which form the alternate cultural category, including novelty and education. A study by Backman (1994) of market segmentation in recreation and tourism validates Crompton's suggestions for travel motives. Crandall (1980) also lists 17 motivational categories for leisure, with the first category being 'enjoying nature, escaping civilization.'

Heung *et al.* (2001) identified multiple vacation motives for tourists visiting a single destination, which leads to the conclusion that tourists are motivated to travel to a particular place based on more than one of the attributes it offers. Understanding what motivates people to travel to particular destinations is important in destination management, where tourist motivations are often used to determine which attributes of the destination to promote (Kozak 2002).

3.1.3 The Link between Climate and Tourism

Tourism is directly affected by weather and climate, particularly outdoor tourism. Outdoor, or nature-based tourism, can also be indirectly affected by climate through alterations to the renewable biophysical resources upon which it depends, such as forests, lakes, or beaches (Smith 1993). Mayo (1975) identifies a pleasant climate as one of the three most important attributes of an ideal summertime vacation destination. Winter tourism, on the other hand, depends on natural snowfall or low temperatures for artificial snow production (Smith 1993). Thus, climate is a pull factor motivating tourists to visit particular destinations.

Ideal climatic factors for recreation activities have been speculated upon for a number of years (Paul 1972; More 1988). More (1988) looked at ideal climatic factors for eight summer and four winter recreation activities, which include for instance air temperature, wind speed, precipitation, water temperature, and snow depth. More recently, Gómez-Martín (2005) argues that temperature, number of sun hours, precipitation, wind, humidity, and fog are the climatic elements that have the greatest influence on tourism.

Mieczkowski (1985) developed a tourism climatic index (TCI) to evaluate world climates for tourism. He used seven climate variables, including monthly means for maximum, mean, and minimum daily temperature, minimum and mean daily relative humidity, total precipitation, total hours of sunshine, and average wind speed. These variables were then weighted and incorporated into an equation to determine a TCI rating between -30 and 100. The TCI is inevitably subjective, but Scott *et al.* (2004) feel that it could be strengthened through validation against stated tourist climate preferences.

Maddison (2001) identifies climate as a major factor in destination choice and time of departure, with a possible goal of obtaining a short-term climatic advantage while on recreational trips. For instance, a portion of retired US citizens may head south to Mexico for the winter season, while in Australia, some retired people may head north to Queensland and the Gold Coast (Maddison 2001).

A survey of German summer travelers assessed the relative importance of various weather factors according to destination choice (Lohmann and Kaim 1999). It was found that overall, weather was third in importance behind landscape and price in a list of 10 criteria in deciding on a destination (Lohmann and Kaim 1999). The most popular preferred conditions for summer holidays were sunny, blue skies, mostly warm temperatures, and light breezes (Lohmann and Kaim 1999). Climate was ranked second of 16 destination attributes by recreation tourists in a survey conducted by Hu and Ritchie (1993), where the destinations included Hawaii, Australia, Greece, France, and China. A survey by Heung *et al.* (2001) of 406 Japanese leisure travelers to Hong Kong was conducted to determine, amongst other goals, the relative importance of different motives for vacations. The motive of 'experiencing pleasant climate/temperature' ranked 14th of 25 possible vacation motives overall, with higher rankings assigned to this category by first-time visitors than by those who had previously visited Hong Kong (Heung *et al.* 2001).

Globally, the optimal temperature for tourists originating in OECD (Organisation for Economic Co-operation and Development) countries was found by Lise and Tol (2002) to be 21°C, calculated as the average of the hottest month of the year, although the optimal climate preferred by tourists differs by age and income group. However, in a more recent study by Scott *et al.* (In press), optimal climates for three major tourism environments (beach-coastal, urban, and mountain) in Canada, New Zealand, and Sweden were found to differ. The four climatic factors of temperature, precipitation, sunshine, and wind differed in terms of their importance according to the tourism environment, and although there were some similarities in the climatic preferences of tourists from the three countries, there were also some significant differences (Scott *et al.* In press). Thus, this study challenges the identification of any one 'optimal climate' for global tourism.

In a study focused specifically on outdoor recreation-based tourism, Loomis and Crespi (1999) attempted to quantify the direct effects of climate on participation in seasonal activities. They found that they could not quantitatively model all activities, but for those that they could model (including golf, beach use, and reservoir recreation activities), climate change was projected to have a positive effect by increasing visitation for these activities (Loomis and Crespi 1999). Clearly, this study has limitations if only a few select types of activities could be modeled through the methods employed. Additionally, the ability of researchers to model future golf course use based on current conditions is questionable, since it is likely that golf courses would adapt to a changing climate by extending the golf season (Scott and Jones 2006).

Meyer and Dewar (1999) modeled the link between daily precipitation and visitation to the Franz Josef Glacier visitor centre in Westlands National Park in New Zealand. They found that rainfall is associated with an initial increase in visitors, followed by a decline two days later, and that rainfall has a greater effect on visitor levels in the summer months than during the winter season (Meyer and Dewar 1999).

In another outdoor recreation-based study, Ploner and Brandenburg (2003) examined how weather and day of the week affected various types of activities in an urban national park in Vienna, Austria, in an attempt to apply the results to nature conservation areas in general. The study found that weather was a critical factor in modeling visitor numbers for certain activities, such as biking and hiking, while it had no influence on other activities, such as jogging (Ploner and Brandenburg 2003). Again, this study is limited, since it was conducted on only one park in an urban setting with easy access by a large number of people.

In terms of nature-based and related outdoor tourism, Jones and Scott (2006a) assert that climate is a strong influence. They go on the say that both the physical resources upon which many tourism and recreation activities depend, and the length and quality of the tourism season can be affected by climate (Jones and Scott 2006a).

Thus, climate is intrinsically linked to tourism, particularly when time is spent outdoors.

3.2 Anthropogenic Climate Change

The Earth has experienced natural changes to its climate throughout history. Since the pre-industrial era, however, human activities including the clearing of forested areas, agriculture, and use of fossil fuels have increased concentrations of atmospheric greenhouse gases (GHGs – carbon dioxide, nitrous oxide, methane, and tropospheric ozone) beyond their natural levels, resulting in rising global temperatures for the past 50 years (Intergovernmental Panel on Climate Change (IPCC) 2001). The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to study the scientific basis of climate change, its impacts, and options for mitigation and adaptation (IPCC 2004). In 2001, the IPCC (2001) reported that it is likely that the 1990s was the warmest decade on record, with 1998 the warmest year, since instrumental records began (*c.*1861). The report stated that in the Northern Hemisphere, temperatures increased more in the 20th century than in any other century over the past millennium, and global mean surface temperature increased 0.6°C±0.2°C over the same period (IPCC 2001). In fact, the fourth quarter of the 20th century experienced warming two times that of the entire first half of the century, with significantly more warming occurring in high latitudes than in temperate or tropical zones (Burkett *et al.* 2005). By 2100, the overall change in global mean surface temperature is projected to be anywhere from 1.4°C to 5.8°C higher than the 1961-1990 baseline, reflecting a warming rate two to 10 times that of the 20th century (IPCC 2001). An increase of this magnitude is unparalleled in the past 10,000 years (IPCC 2001).

Climate change will have a number of implications in terms of weather patterns and events, as well as associated impacts on physical and biological resources.

3.3 Climate Change Impacts on Tourism

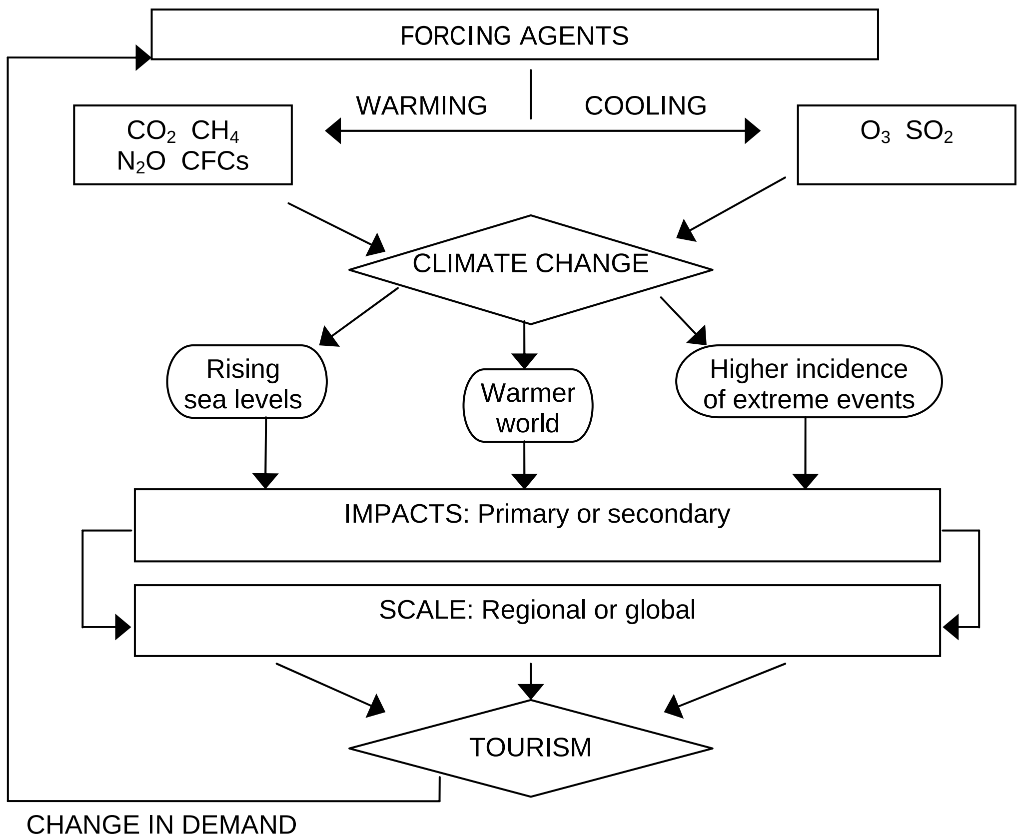
By studying the relationship between climate and tourism and projecting future climatic and biophysical changes for a location using various climate change models and timeframes, possible changes in patterns and volumes of tourism can be discerned. However, in their timeline outlining the evolution of climate change as an issue in the tourism industry and research community, Scott *et al.* (2005) indicate that only recently has the issue gained recognition as an important topic of research. A number of researchers express concern over the relationship between climate change and tourism (Wall 1998; Braun *et al.* 1999; Maddison 2001; Viner and Amelung 2003; Richardson and Loomis 2004; Scott *et al.* 2005; Gössling and Hall 2006), and others (Braun *et al.* 1999; Maddison 2001; Scott and McBoyle 2001; Scott *et al.* 2004) lament that research into the potentially profound effects of climate change on the tourism industry remains highly limited.

A better understanding of how climate change may impact tourism destinations would contribute to improved planning by tourism managers and operators. Hence, a larger number and wider range of research activities that address climate change and tourism would be beneficial. A recent advancement in the acknowledgement of climate change as an issue for tourism occurred with the First International Conference on Climate Change and Tourism in Tunisia in 2003, which was hosted by the WTO (2003a). One of the primary objectives of the conference was to ensure that tourism operators and others involved in the industry were aware of the climate change issue and of impacts that have already become noticeable in some locations. The focus was not only on the impacts of climate on tourism, but also on how tourism itself drives further climate change, particularly through greenhouse gas emissions. The need for further research into the linkages between tourism and climate change were stressed, with an emphasis on the instigating role of the tourism sector. At the conclusion of the conference, its participants (government and industry representatives and scientists) from 45 countries signed the Djerba Declaration (WTO 2003a), which encourages countries to adopt a sustainability-based approach to tourism.

A cyclical relationship between climate change and tourism is illustrated by Giles and Perry (1998), where the only effects of warming from elevated greenhouse gas concentrations worldwide included are those of rising sea levels, higher temperatures, and a higher incidence of extreme weather events. According to their analysis, these effects are felt at either a regional or global scale (the model omits local and national scales, for example), and tourism flows are impacted (Giles and Perry 1998). This, in turn, alters greenhouse gas concentrations in the atmosphere (Figure 2) (Giles and Perry 1998). Unfortunately, the model is limited since it only includes three effects of climate change, neglects other scales at which impacts are felt, and omits the supply side of tourism.

Tourism and recreation can be affected directly and indirectly by climate change. Altered weather patterns may directly affect the comfort and safety of tourists, while longer term climatic and seasonal changes can alter the biophysical resources upon which many recreational activities depend. According to Loomis and Crespi (1999), direct effects of climate change on recreation take place through the participants' desired demand, and indirect effects on demand occur through changes in the quantity and quality of natural resources used for recreation (Loomis and Crespi 1999). The next section examines how climate change may directly alter tourism patterns around the world, followed by an overview of potential indirect effects of climate change on tourism.

Figure 2 - The Relationship between Climate and Tourism in a Globally Warmed World



Adapted from Giles and Perry (1998)

3.4 Direct Effects of Climate Change on Tourism

Tourism can be directly affected by climate change through alterations to weather patterns that can cause disruptions to plans, such as high levels of rainfall, or discomfort for visitors, for instance from high temperatures. The following subsections identify how tourism in various regions of the world may be directly affected by climate change.

3.4.1 Seasonality

Butler (2001) identifies seasonality as one of the most distinctive features of tourism, with 'natural' and 'institutionalized' components. The former is defined as, 'regular temporal variations in natural phenomena, particularly those associated with climate and the true seasons of the year' (Butler 2001:6), while the latter is caused by human actions and policies, such as school vacations in summer. 'Natural' seasonality characteristically includes patterns of variations or cycles in sunlight, temperature, and forms of precipitation, which are regular and recurring, as opposed to daily fluctuations, for a particular location (Butler 2001). As distance from the equator increases, so does natural seasonality (Butler 2001). Climate change will result in changes to seasonal variability (IPCC 2001), with many potential consequences for tourism.

Climate change may extend the length of the summer season for many destinations, allowing a longer tourist season. For instance, overall warming and decreased precipitation during the summer months in the UK could produce a more favourable climate for tourism during the busy holiday season (Giles and Perry 1998). Evidence of such a trend was observed in the unusually warm year of 1995, when a high number of domestic tourists chose to remain in the region rather than travel abroad to traditionally warmer holiday destinations (Giles and Perry 1998). Similarly, in

Scotland, the projected trend is towards increasing summer dryness, which will allow visitors to enjoy the outdoor scenery on more frequent days without precipitation, particularly in the Upland areas (Harrison *et al.* 1999). Warmer daytime summer temperatures in northern Germany are expected to bring more tourists to coastal areas, as long as rain does not become more frequent (Lohmann and Kaim 1999).

Scott *et al.* (2004) employed Mieczkowski's (1985) Tourism Climate Index (TCI) to analyse how tourism in North America may change in relation to changes in the spatial and temporal distribution of climate resources using two climate change scenarios for the 2050s and 2080s. Significant changes are projected for the locations and timing of vacation destinations with 'excellent' or 'ideal' TCI ratings (Scott *et al.* 2004). For travelers escaping the winter in search of a warmer climate, a number of new destinations may become popular in future, in addition to the currently popular destinations of Florida and Arizona (Scott *et al.* 2004). This means that the market for retirees from Canada and the northern parts of the US who spend some or all of the winter season 'down south' could become more competitive (Scott *et al.* 2004). Mexico, on the other hand, was found to have lower TCI ratings in the future, making it a less competitive destination for winter sun holidays (Scott *et al.* 2004). During the summer months, travel patterns may be reversed, with some individuals from the southern US heading north to escape higher temperatures (Scott *et al.* 2004).

In the US, warming has been observed in the Northeast, West, and northern Midwest, while the Southeast has experienced slight cooling since 1997 (Lu *et al.* 2005), resulting in an overall rise in temperature of 0.6°C (1°F) across the country (US Department of State 2002). As for the spring season (represented by April in the study), Canada's TCI ratings improve markedly in the future, while there is little difference projected for the fall season (represented by October in the study) (Scott *et al.* 2004).

A number of studies have examined how seasonal changes may impact recreation, with a greater focus on the winter season, which may be particularly vulnerable (Scott *et al.* 2003). Harrison *et al.* (1999) carried out regional analyses of Scotland's future climate, and found that spatial variation plays a large role in how the winter season may be affected. A simplistic general analysis for all of Scotland suggests that winters will become wetter and windier, thus negatively impacting winter recreation (Harrison *et al.* 1999). However, when the spatial variation of the country is taken into account, the prospects are more positive that snowfall in the mountains of sufficient levels for recreation will continue, while access roads at lower elevations will be less prone to snow and ice (Harrison *et al.* 1999).

Europe may experience shorter winter seasons and less reliable snow cover, thereby threatening snow-dependent activity centres, especially those at lower altitudes, as evidenced by the following examples. In Austria, Breiling (1994) projects approximately 15 fewer days for the ski season without snowmaking capabilities. In Switzerland, a lack of snow during the winter ski season in the late 1980s had negative implications for resorts, and generated concern regarding the future (Koenig and Abegg 1997; Elsasser and Bürki 2002). Koenig and Abegg (1997) project that the percentage of all Swiss ski areas that operate using natural snowfall will decrease from 85% to 63% under a 2°C warming scenario. Another more recent study found that over the next few decades, if the altitude at which natural snowfall in Switzerland sufficient for skiing rises from the current line of 1,200 metres above sea level to 1,800 metres above sea level, only 44% of resorts may continue to be able to operate without suitable adaptation strategies (Elsasser and Bürki 2002).

Similar problems are projected in other parts of the world. For instance, in Japan, approximately one-third of visits for the purpose of skiing may be lost throughout the country, including one-half of visits to the southern regions, under 3°C of warming (Fukuskima *et al.* 2003).

The winter snow season in the Snowy Mountains of southeastern Australia has shortened significantly since 1962 as a result of global warming, as observed through records of decreased snow depth, which indicates that snow cover could continue to decrease in duration into the future (Nicholls 2005). A loss of 64-81% of the ski season in Australia could occur under 2°C of warming and 20% less precipitation (Galloway 1988). Another projection for Australia is a drop in the number of reliable ski areas from 8 to 5 under 1.3°C warming and 8% less precipitation, or from 8 to 0 under 3.4°C warming and 20% less precipitation (Koenig 1998). Another possibility is that Australia could realize a decrease in potential volume of snowmaking capacity of anywhere from 27-55% if temperatures rise by 0.6°C to 3.0°C and precipitation changes by an increase of 2% to a decrease of up to 24% (Hennessey *et al.* 2003).

In eastern North America, a number of studies have examined impacts on the ski industry resulting from a changed climate (McBoyle *et al.* 1986; Lamothe and Periard Consultants 1988; Badke 1991; Lipski and McBoyle 1991; Scott *et al.* 2002; Scott *et al.* 2003). Despite winters in the 1990s being warmer on average than in the 1970s-80s, the ski season in the Great Lakes region of southern Ontario was longer in the 1990s due to the introduction of snowmaking technologies in the 1980s and 1990s (Scott *et al.* 2002). Even with a decrease in the number of days with a natural snow base of 30 cm in Ontario (from 71 days in the baseline scenario down to 7-43 days in the 2020s, 3-26 days in the 2050s, and 1-14 days in the 2080s), Scott *et al.* (2003) argue that resorts could remain operational with additional snowmaking capacity. Another study by Scott and Jones (2005) supports this finding through an assessment of resorts' abilities to adapt to warming with snowmaking technology in Banff National Park, Canada.

In Canada, Scott and Suffling (2000) expect climate change to generally improve climatic conditions for park recreation through warmer temperatures, less precipitation, and a longer summer season for activities such as hiking, camping, golfing, and rafting. For instance, the golf season across most of the country may be lengthened with a longer warm weather season, particularly in southern Ontario and on the east coast (Scott and Jones 2006), with an increasing number of days becoming suitable for golf farther into the future. Golf courses located on the west coast of Canada may notice little change under a warmer climate, since the golf season is already year-round (Scott and Jones 2006). A little further east, however, in Banff National Park, the golfing season is also projected to be extended under two different climate change scenarios for the 2050s and the 2080s (Scott and Jones 2005).

Natural seasonality is directly related to the recreational activities available for tourism. As seasons shift temporally and are affected by varying weather patterns, tourism will be impacted in turn.

3.4.2 Hazards of Climate Change for Tourism

Extreme weather events such as heat waves, tropical cyclones, avalanches, floods, and mid-latitude storms are likely to occur in the future in increasing frequency and intensity as the world's climate continues to change (IPCC 2001). Due to their lack of familiarity with foreign vacation destinations, tourists in particular may be vulnerable to extreme events, predominantly in the case where they are unable to communicate effectively in the language of the host country, and may not properly interpret hazard warnings (Scott et al. 2007a).

Many tourism destinations could suffer from the impacts of extreme events, as a number of studies demonstrate. Becken (2005) discusses the vulnerability of the island state of Fiji in the South Pacific to extreme events such as cyclones and floods.

A number of risks exist for tourism when cyclones occur, including lost holiday time, interrupted transportation, cancelled flights, stranded visitors, devastated infrastructure, and generation of the perception that Fiji is not a safe and attractive destination (Becken 2005). The greatest amount of damage during cyclones is often caused by large volumes of water that are pushed ashore, called storm surges, and the problem may be exacerbated by enormous tides following the event (Becken 2005). McInnes *et al.* (2000) project the risk of storm surges to increase with global warming as a result of changes in cyclone characteristics and higher sea levels. Risk of drought is also an increasing possibility in Fiji, with implications for freshwater supply on the island (Becken 2005).

The warmest, and currently most popular, months for tourism in Europe may become too hot for many vacationers, placing individuals at risk of heat stress and mortality. For example, a heatwave affecting several northern European countries that lasted for at least 10 days in August of 2003 is blamed for the deaths of approximately 35,000 people (Larsen 2003). According to Perry (2005), the most vulnerable group of tourists at this time were campers and caravaners, some of whom were injured, and others of whom were killed in related forest fires. The same heatwave undoubtedly played a role in the unprecedented forest and scrub fires that ignited in Portugal and Spain in the same time period (Hall and Higham 2005). It is not clear how many tourists were included in the statistics for the number of fatalities resulting from the heatwave as compared to the number of deaths of those residing in the region at the time; nor is it clear how the heatwave affected tourism numbers in the years following the event. Thus, although heatwaves have the potential to impact tourism, it is unclear whether or not the 2003 European event had a significant effect.

Forest fires can release large quantities of smoke and ash into the air that can be carried into popular tourist areas by the wind, and cause irritation to eyes and lungs.

This is particularly a problem for tourists already experiencing health problems, such as asthmatics, as well as for the elderly. Forest fires resulting from decreased precipitation and increased temperatures are a risk during the summer season for many mid-continental locations, even in the absence of a drastic heatwave. Drought is already a risk for eastern parts of Scotland, and with anticipated drops in rainfall in the summer, Harrison *et al.* (1999) are concerned about increased fire hazards in this region. On average across Canada, and under a scenario of three times more CO_2, Flannigan *et al.* (2005) project burned area to increase by 74-118% by the end of the century.

Another type of hazard associated with climate change is the spread of disease to tourist destinations. For instance, Becken (2005) cites the more frequent occurrence of cholera and dengue fever, as well as biotoxin poisoning as a potential risk for tourists in Fiji. In Spain, which has traditionally been viewed by tourists as a risk-free holiday destination, the recent resurfacing of malaria may concern some potential visitors to the country (Agnew and Palutikof 2001).

The US Department of State (2002) produced a report discussing how climate change is expected to affect the various geographic regions and economic, social, and environmental sectors of the country. The report demonstrates that each of the dangers associated with climate change discussed above are possibilities for various regions of the US due to the climatic diversity of the country. Cyclones and storm surges are most likely to occur in the southern coastal states, as the recent Hurricane Katrina displayed, and the Pacific islands (US Department of State 2002). Extreme high temperatures were already a problem in 1995, as evidenced by a five-day heatwave in Chicago that caused an estimated 700 deaths (US Department of State 2002) (However, there have been no major reports of heatwave-related mortality since 1995, which could mean that there has since been an adaptation to this type of climatic event).

Droughts are an issue for interior continental locations, particularly where agriculture is practiced and the reliance for irrigation is on dwindling groundwater supplies. Wildfires can occur anywhere there are drought conditions and sufficient fuel, such as fields or forested locations. The introduction of new types of disease can also occur anywhere, particularly as winters become warm enough to allow year-long survival of disease vectors (US Department of State 2002). Each of these potential climate change-related hazards in the US could affect tourism in different parts of the country.

3.5 Indirect Effects of Climate Change on Tourism

As climates around the world continue to change, the biophysical resources dependent on them will be affected. Shifts are expected to occur in the ranges and abundance of various species. Biodiversity will be impacted and local and global extinctions will continue to occur. Since tourism is heavily dependent on natural scenery and biophysical resources for the recreation opportunities they provide, changes to biophysical resources will alter tourism and recreation patterns (Eagles 2002). A number of studies have examined climate change and its affects on biophysical resources. The results of these studies are summarized in the following subsections.

3.5.1 Observed Impacts of Climate Change Worldwide

Global mean sea level rose at an average annual rate of 1-2 mm throughout the 20th century, and it is likely to continue to rise for thousands of years after (if) the climate is stabilized due to a delayed reaction of ice sheets to warming (IPCC 2001). In colder regions, including high altitudinal and latitudinal areas, glaciers, sea ice, snow cover, and permafrost are melting (IPCC 2001).

McCarty (2001) takes a broader approach to studying the effects of climate change from an ecological perspective, with a number of global observations. For instance, there have been observed increases and decreases in population sizes of various species, with the net effect being negative (*i.e.* increases in exotic invasives, disease vectors, and pests outweighing any gains in valued species) (McCarty 2001). Temporal disruptions in synchrony between food demand and availability have resulted in increased stress to threatened species in particular, and changes in geographic ranges of species have occurred, including the loss of native species in particular locations and invasion by species from other locations (McCarty 2001). For instance, Classen *et al.* (2005) found a link between drought-affected plants and new insect infestations. Finally, there is evidence of species extinctions due to higher temperatures and changes in precipitation patterns (McCarty 2001), such as increased occurrences of coral bleaching (IPCC 2001).

Walther (2003) reviewed a number of studies that report on recent observations of vegetation changes in behaviour, ranges, and interactions associated with climate change. He points out that despite generally consistent patterns of change within species, instances where changes vary or are inconsistent should be taken as evidence of a general warming trend due to uneven local effects of warming and the complexity of living organisms themselves and their feedback mechanisms (Walther 2003). Similarly, Burkett *et al.* (2005) demonstrate through 10 case studies how changes in climate can produce nonlinear threshold-type responses in ecological systems. For example, in the case of plant communities that generally fluctuate as water levels rise or decline, the presence of groundwater can neutralize otherwise linear reactions (Burkett *et al.* 2005). Thus, climate change can actually redistribute eutrophication and acidification effects to terrestrial environments from aquatic environments in mountainous areas (Burkett *et al.* 2005).

3.5.2 Projected Impacts of Climate Change Worldwide

Under climate change, the IPCC (2001) projects an increase in the frequency and severity of precipitation events, drought and related forest fires, hurricanes and tornadoes for various parts of the world, and a rising number of days with high temperatures paralleled by a decrease of days with cold temperatures. On a more positive note, the Northern Hemisphere will experience a longer growing season as the climate warms (IPCC 2001).

A general shift towards the poles and to higher elevations is a likely future possibility for various species of plants (Walther 2003), insects, birds, and fish (IPCC 2001). The IPCC (2001) also projects earlier flowering of plants, migration of birds, animal breeding seasons, and emergence of insects in the Northern Hemisphere. Possibly related to these changes, Thomas *et al.* (2004) projected future species' distributions under different climate scenarios into the 2050s to assess extinction risks in sample regions that cover approximately 20% of Earth's terrestrial surface. Under the smallest climatic change scenario, 18% of species were found to be 'committed to extinction,' while the largest change scenario projected as many as 35% of species to be at risk (Thomas *et al.* 2004).

In Mediterranean island ecosystems, alien plant species invasions are an increasing problem that is only projected to worsen with climate change, to the point where exotic plants could become dominant in the future (Gritti *et al.* 2006). In North America, significant northward expansion of ticks into Canada is likely in the future as the climate becomes more suitable for the Lyme disease vector (Ogden *et al.* 2006).

Incessant sea-level rise is an issue for island and coastal areas to contend with in future, particularly if relocating activity centres to higher ground is not an option

(Becken 2005). This is particularly the case for the Maldives and Kiribas Island states (Becken 2005).

The destruction of forested areas worldwide through wildfire will likely occur more often with climate change. For instance, Flannigan *et al.* (2005) project burned area to increase by 74-118% on average across Canada by the end of the century.

As sea ice disappears from the Hudson Bay region of Canada, a corresponding decline in polar bear and arctic fox populations could occur (Hansell *et al.* 1998). Also in the Canadian Arctic, there could be a general northward movement of the treeline, flooding of coastal saltmarsh communities, interruption of northern migration of waterfowl with anomalous cooling in the east, destabilization of soils as permafrost and ice melts (Janke (2005) found that permafrost is sensitive to a 2°C temperature increase, but it will likely respond slowly to change), and drainage pattern alterations as surface vegetation is altered (Hansell *et al.* 1998).

3.5.3 Observed Impacts of Climate Change in Protected Areas around the World

A number of researchers have studied how climate change has impacted the biophysical resources present in national parks and other protected areas throughout the world, although the vast majority of work in the English language appears to focus on locations in Canada and the US. Observed impacts in US national parks are discussed in a subsequent subsection, while those in the rest of the world are summarized below.

The World Wildlife Fund (WWF) (2003) reported on the effects of climate change in protected areas worldwide. Some of the identified impacts to date include extensive coral bleaching from warmer sea temperatures around the Seychelles Islands, threatened polar bear populations in a Russian nature reserve as sea ice is lost, declines of amphibious species and cloud forests in Australia and Central America, drought conditions in wetland areas of Keoladeo National Park of India, rapid glacier loss in

Kilimanjaro National Park in Africa, and insect range shifts in Japan (WWF 2003). Further climate-induced changes are projected to occur in protected areas worldwide.

3.5.4 Projected Impacts of Climate Change in Protected Areas around the World

A few studies have been conducted on projected climate-induced biophysical changes in national parks in Canada. Similar studies for protected areas in other parks of the world are currently lacking in the literature.

In a system-wide study of Canada's national parks, Scott and Suffling (2000) identified a wide range of potential ecosystem changes, including lower water levels and an associated decline in biodiversity in the Great Lakes – St. Lawrence Basin parks and more frequent droughts in prairie parks. Elevational species shifts and increased avalanche activity in parks in the Western Cordillera region may become more common, as will more frequent red tide blooms in coastal Pacific region parks as sea temperatures rise (Scott and Suffling 2000). Glaciers in Kluane National Park Reserve may advance, and in Arctic regions, tundra plants may colonize as permafrost melts, and polar bears may be extirpated from Wapusk National Park (Scott and Suffling 2000). There are many more possible biophysical changes identified for Canada's national parks, and the authors come to the general conclusion that ecological conservation goals for these protected areas and the strategic role of Parks Canada must be rethought.

More recently, Suffling and Scott (2002) constructed seasonal temperature and precipitation scenarios for Canada's national parks for 2050 and 2090. Widespread, regional, and park specific impacts on physical systems, ecosystems, species, and people were assessed, with similar findings. A number of large knowledge gaps were identified by the authors that limited their ability to fully assess certain aspects of climate-induced changes in some parks, such as conclusions regarding glacial mass balance, and the Labrador Current and effects of extra iceberg formation (Suffling and Scott 2002). Once again, the authors make recommendations regarding further areas of research, and park planning and management.

In a study of Canada's system of national parks, it was found that a novel biome type could appear in more than half of the parks in five of the six scenarios used (Scott *et al.* 2002). Based on their findings, Scott *et al.* (2002) identified weaknesses in existing policy and planning frameworks, including the national park system plan, individual park objectives, and fire and exotic species management plans.

In a similar study examining Canada's entire network of protected areas, Lemieux and Scott (2005) assessed potential terrestrial biome-type changes using six future climate scenarios and two different global vegetation models. Under a doubling of carbon dioxide (CO_2), 37-48% of Canada's protected areas could experience a terrestrial biome change, which would challenge the current management ethos of maintaining ecological stability (Lemieux and Scott 2005).

3.5.5 Observed Impacts of Climate Change in the US

Limited literature has been produced that assesses the effects of climate change in the US. According to the one study found, which was produced by the US Department of State (2002), an overall rise in temperature of 0.6°C (1°F) over the past century has had a number of implications for biophysical resources across the country. Effects of this temperature alteration have already been observed in the spring and the winter, with shorter frost and lake ice seasons, a northward shift of some butterfly species' ranges, changes in timing for bird migration, and a longer growing season (US Department of State 2002). Further details of these observed biophysical changes were not included in the report.

3.5.6 Projected Impacts of Climate Change in the US

Since 1997, the US Global Change Research Program has sponsored a number of assessment activities to better understand potential impacts of climate change during the 21st century consistent with IPCC projections (US Department of State 2002). A summary of the results of these assessment activities indicates a number of climatic changes for the US, including mean warming of 1.7-5.0°C (3.0-9.0°F) by 2100, increased precipitation and evaporation, and more frequent occurrences of elevated temperatures and extreme wet and dry conditions (US Department of State 2002). Generally, existing climates and weather systems will likely shift northwards, similar to the previous century but in a more pronounced fashion (US Department of State 2002). For instance, states in the northern parts of the country may experience a climate similar to the current conditions of the central states, and the climate of the central states may become more similar to that currently existing in the southern states (US Department of State 2002). However, climate change is not expected to affect the country uniformly due to its diverse climatic zones (US Department of State 2002). For instance, rising humidity levels may cause the summertime heat index to rise sharply across the southern and eastern states in particular (US Department of State 2002). Furthermore, in the winter months, precipitation in the southwest may increase, while projections for agricultural areas of the US are uncertain (US Department of State 2002).

The US Environmental Protection Agency (USEPA) produced four separate reports containing projected regional changes throughout the country with global warming. Sea level rise is cited as a problem for the Chesapeake Bay and Assateague Island region in the east, along with increased precipitation, more frequent floods and coastal storms, and lower water quality in the bay (USEPA 2001a). Sea level rise is also an issue for southern Florida and the interior freshwater Everglades with its diverse range of species, due to increasing salinity (USEPA 2001b). In the interior Great Lakes and upper Midwest region, drastic drops in water levels along with warmer water temperatures could be detrimental to cold water fish and waterfowl habitats, amongst other species impacts, which in turn could impact the multibillion-dollar recreation industry supported by the region (USEPA 2001c). The western mountains and plains of the US will likely fall under a warmer and drier climate, meaning that glaciers could melt, forest fires could become more common, some plant species distributions could change, and some plant and animal species could be extirpated from the region (USEPA 2001d).

Additional biophysical changes have been projected by other researchers based on future climate conditions in the US. For instance, the upper timberline in the Greater Yellowstone Ecosystem will likely migrate upslope with increased temperatures, and the extent of alpine vegetation could decrease under three future climate models (Romme and Turner 1991). McDonald and Brown (1992) revealed that a temperature increase of 3°C could result in the extinction of three of 14 montane mammalian species in the Great Basin region of the US. An increased number and intensity of forest fires are projected for the Pacific Northwest of the US with increasing climate variability, particularly linked to intensified summer drought conditions (Fagre *et al.* 2003; Whitlock *et al.* 2003). Additionally, shrinking permafrost zones in the Colorado Front Range may lead to debris flows or rockslides as slopes become less stable (Janke 2005). More specific projected changes are made in the following subsections for national parks in the US.

3.5.7 Observed Impacts of Climate Change in US National Parks

Both the observed and projected biophysical impacts of climate change in US national parks discussed in this and the following subsection are summarized in Table 1.

Balling Jr. *et al.* (1992) found a link between increasing temperatures, decreasing precipitation, and variations in wildfire burn areas in Yellowstone National Park. In Glacier National Park in the northwestern US, seven species of arctic-alpine trees were found to have declined in abundance between 1959 and 2002 with a corresponding 0.6°C increase in temperature (Lesica and McCune 2004). In a similar study, Driscoll et al. (2005) observed that patterns of tree growth were inconsistent within and between study sites in Lake Clark National Park and Preserve on the Alaskan Peninsula as a result of recent climatic changes. The data indicate that some trees may be suffering from temperature-induced drought stress (Driscoll et al. 2005), which can result in the eventual decline and extirpation of affected species as warming continues.

3.5.8 Projected Impacts of Climate Change in US National Parks

Due to the diversity of climatic regimes across the country, the impacts of future climate changes will vary between US national parks depending on their locations.

The Yellowstone National Park region of the US consists of mountainous terrain and valleys that create variability in climate over a regional area. In modeling future vegetation in this region, Bartlein *et al.* (1997) projected both directional and elevational range adjustments, along with the regional extirpation of some species, while new species from nearby regions may begin to populate the area. Parks in the western Great Lakes region of the US could also be in danger of losing plant and animal species that are sensitive to changes in the moisture regime as precipitation increases (Davis *et al.* 2000).

Table 1 - Summary of Major Biophysical Impacts of Climate Change in US National Parks

	Region	Reference	Impacts
Observed	Yellowstone National Park, Wyoming	Balling Jr. *et al.* 1992	• link between increasing temperatures, decreasing precipitation, and variations in wildfire burn areas
	Glacier National Park, Montana	Lesica and McCune 2004	• decreased abundance of seven species of arctic-alpine trees between 1959 and 2002 with a corresponding 0.6°C increase in temperature
	Lake Clark National Park and Preserve, Alaska	Driscoll *et al.* 2005	• temperature-induced drought stress on trees over time
Projected	Yellowstone National Park, Wyoming	Bartlein *et al.* 1997	• directional and elevational range adjustments of vegetation
			• regional extirpation of some species of vegetation
			• invasion by vegetation species from nearby regions
	Western Great Lakes region	Davis *et al.* 2000	• loss of plant and animal species sensitive to changes in the moisture regime with increased precipitation
	Rocky Mountain National Park, Colorado	Wang *et al.* 2002	• 50-100% increases in elk populations with warmer winters
	Glacier National Park, Montana	Hall and Fagre 2003	• loss of glaciers by 2030 under a CO_2 doubling scenario
			• upslope migration of vegetation, with an increase in area covered and changes in species composition
	Continental US	Burns *et al.* 2003	• high rate of mammalian species turnover
			• inability of parks to protect current biodiversity within their boundaries
			• up to 20% loss of species and massive influxes of new species with a doubling of CO2

Table 1 continued – Summary of Major Biophysical Impacts of Climate Change in US National Parks

	Western US	Saunders *et al.* 2006	• loss of glaciers and summer snow on mountain peaks in Glacier, North Cascades, Grand Teton, Rocky Mountain, Yosemite, and Mount Rainier national parks • establishment of new plant species in the currently treeless alpine tundra of Rocky Mountain National Park • destruction of entire forests as a result of drought and high temperatures in Mesa Verde National Park • extirpation and extinction of some wildlife species in all western parks, particularly those with habitats at high elevations • loss of meadows and wildflowers in all mountain parks as forest migrate upslope and new plant species invade • loss of Saguaro cacti from Saguaro National Park with increased wildfires • increased instance and severity of wildfire in Glacier, Grand Teton, and Yellowstone national parks in particular • rising sea levels in Channel Islands and Olympic national parks • reduced summer water flow, increased water temperatures, earlier snowmelt, and increased drought in all western parks • loss of some coldwater fish species in all western parks

In Rocky Mountain National Park in Colorado, populations of elk are projected to increase by 50-100% as winters become warmer, which would result in population regulation implications for managers (Wang *et al.* 2002).

Glacier response to climate change in Glacier National Park, Montana, was modeled by Hall and Fagre (2003), with the conclusion that glaciers may disappear from the park by 2030 under a CO_2 doubling scenario, or by 2277 under a linear-extrapolation scenario that ignores the effects of human-induced climate changes, and is therefore less realistic. As a result of climate change, this national park is likely to lose the very features it was designed to protect. Furthermore, vegetation was projected to move upwards in elevation in a varied pattern and increase somewhat in area, with likely changes in species composition (Hall and Fagre 2003).

A study that incorporated eight national parks in the US found that the future rate of mammalian species turnover will probably be high (Burns *et al.* 2003). The conclusion was reached that national parks are not likely to meet their goal of protecting current biodiversity within their boundaries, with a projected 20% loss of species and massive influxes of new species (Burns *et al.* 2003).

More recently, Saunders *et al.* (2006) compiled an analysis of projected biophysical changes in national parks in the American west. Glaciers could be lost entirely from Glacier and partially from North Cascades national parks, and the snow-capped mountain peaks in Glacier, Grand Teton, Mount Rainier, North Cascades, Rocky Mountain, and Yosemite national parks in the summer could become a thing of the past (Saunders *et al.* 2006). Shorter and milder winters with reduced snowfall may also limit the ability of visitors to experience a true winter environment and associated recreational activities in western US parks (Saunders *et al.* 2006). The treeless alpine tundra environment of Rocky Mountain National Park could be lost as new plants begin to take root, and entire forests could be destroyed by drought and high temperatures in Mesa Verde National Park (Saunders *et al.* 2006). Numerous wildlife species could become locally or entirely extinct as their habitat disappears, particularly those residing at or near the tops of mountains (Saunders *et al.* 2006). Meadows and wildflowers could be threatened by higher temperatures in all mountain parks, as forests migrate upslope and new plant species invade (Saunders *et al.* 2006).

Summer temperatures in southwestern national parks like Death Valley could become intolerably hot for extended periods of the year (Saunders *et al.* 2006). These high temperatures could contribute to increasing instance and severity of wildfires that could wipe out the saguaro cacti for which Saguaro National Park is named, and disrupt summer vacations in other parks (Saunders *et al.* 2006). Wildfire is particularly a risk for parks in the northern Rocky Mountain region, including Glacier, Yellowstone, and Grand Teton (Saunders *et al.* 2006).

In the coastal parks of Channel Islands and Olympic, rising sea levels could threaten beach tourism (Saunders *et al.* 2006). As summer water flows are reduced and water temperatures rise with less snowfall, earlier snowmelt, and increased drought, boating could be threatened, and cold water fish species popular with anglers could decline in number or disappear altogether from some water bodies (Saunders *et al.* 2006).

Clearly, human-induced climate change is increasingly a challenge for protected areas managers worldwide (Hannah et al. 2002b; Scott and Lemieux 2005), particularly where the natural resources contained within provide the basis for tourism. As the natural features and species that park lands were designed to protect become increasingly threatened by shifting climates, and as noticeable alterations occur to the landscape and plant and animal communities, tourism will be impacted in turn. The next section assesses how tourists may respond.

3.6 Tourist Responses to Climate Change

As biophysical resources throughout the world are altered by climate change, the tourism industry that depends on them will respond through changed patterns and volumes of visitors. People's psychological and sociological responses to climate change and its impacts will help to determine how they react in terms of altering behaviour patterns such as tourism (Stehr and von Storch 1995). To date, few studies have assessed as their primary objective how climate change may affect tourism, and even fewer have focused on nature-based tourism in protected areas such as national parks. Nonetheless, it has been recognized that recreation opportunities and visitation patterns in national parks will be altered by shifting climate regimes, which will have implications for the tourism economy (Suffling and Scott 2002). This section begins by summarizing research findings on global tourist responses to climate change, followed by responses for national parks in Canada and the US. There were no other studies at the time of writing that focused on tourist responses to climate change in protected areas in any other parts of the world.

3.6.1 Tourist Responses to Climate Change Globally

Braun *et al.* (1999) assessed through the use of a psychological pilot study how tourism demand for the coasts of the North and Baltic Seas in Germany may be influenced by climate change as weather patterns and ecological resources were altered. Using five experimental future climate scenarios including no change, and negative and positive effects with and without any response from the tourism industry, it was found that tourists were less interested in traveling to Germany's coastal areas as compared to under current climatic conditions (Braun *et al.* 1999). An interesting result of this study is that perceived overcompensation by the tourist industry in the form of progressively more tourist facilities may exacerbate decreased visitation rather than resulting in the intended effect of increasing tourist volumes .

In a large-scale study of direct impacts of climate change on tourism, Hamilton *et al.* (2005b) modeled tourist flows between 207 countries for the period from 2000 to 2075, based on 1995 data. They found that preferred destinations may shift to higher latitudes and altitudes as temperatures increase, and tourists from temperate climates may begin to spend more holidays in their own countries (Hamilton *et al.* 2005b). This finding somewhat contradicts the previous study's (Braun *et al.* 1999) finding that Germany's coastal areas will become less attractive for tourists, since it implies that Germans will spend more time in their own country, at least a portion of which would likely be spent in coastal tourist areas.

Gössling and Hall (2006) identify a number of criticisms regarding current models of projecting tourist flows under climate change. For instance, the data used to project tourism flows are weak, temperature is used as an indicator of demand even though human comfort is more complex and depends on more than one climate variable, and the role of non-climate parameters are unclear (Gössling and Hall 2006); thus, projections of these models should be used with caution.

3.6.2 Tourist Responses to Climate Change in Canada's National Parks and Protected Areas

Climate change may have positive implications for national parks in Canada. In two separate assessments of Canada's national parks (Scott and Jones 2005; Jones and Scott 2006a) and an assessment of Ontario's provincial parks (Jones and Scott 2006b), overall increases in visitation are projected for the future. For Banff National Park, overall visitation is expected to increase 3% by the 2020s, and 4-12% by the 2050s based on two different climate change scenarios and empirical analyses of visitor-climate relationships (Scott and Jones 2005). On a seasonal basis, ski tourism is expected to decline as natural snowfall decreases unless snowmaking is adopted as an adaptation technique, while the golf industry will benefit from a longer warm weather season stretching into the spring with an increase 46-49% by the 2020s and 50-86% by the 2050s (Scott and Jones 2005). In terms of environmental resource change impacting visitation, it was found through surveying visitors that it takes very substantial environmental change to have an effect, and thus direct climatic impacts are of higher concern and uncertainty for the future (Scott and Jones 2005).

Recent research on Canada's system of national parks found likely increases in visitation with warmer temperatures and a longer peak season extending into the spring and fall months (Jones and Scott 2006a). Multiple regression analysis of the climate-visitation relationship in 15 high-visitation parks was carried out using two climate change scenarios for the 2020s, the 2050s, and the 2080s (Jones and Scott 2006a). The results indicated overall visitation increases of 6-8% for the 2020s, with some parks experiencing increases as high as 30% (Jones and Scott 2006a). For the 2050s, increases in visitation were projected to be between 9% and 29%, and for the 2080s, between 10% and 41% (Jones and Scott 2006a). If such drastic tourist increases are realized, the management implications for the park system and for individual parks are extensive. For instance, under the revenue retention business model of Parks Canada, longer-term planning will be possible using increased income from higher visitation; however, the ecological implications of increased visitation may be a challenge for managers, as could issues of overcrowding.

Jones and Scott (2006b) also projected future visitor numbers for Ontario's provincial parks using a similar multiple regression analysis technique as in the previous study. Using six representative parks, projected overall annual increases in visitation range from 11-27% in the 2020s and 15-57% in the 2050s (Jones and Scott

2006b). Again, the management implications of such a large increase in visitation are substantial.

Another study by Scott *et al*. (2007b), based in part on research conducted by Konopek (2005), resulted in conflicting long-term projections for visitation in Rocky Mountain national parks in Canada through a case study analysis. For Waterton Lakes National Park, both the direct and indirect influences of climate change were examined (Scott *et al.* 2007b). Based on a statistical model of monthly visitation and climate, direct climate change was projected to have a positive impact of visitation, with increases of 6-10% for the 2020s, and 10-36% for the 2050s (Scott *et al.* 2007b). However, survey results assessing how indirect climate-induced environmental change may affect visitation were negative, with small changes projected for the 2020s and 2050s, and more significant declines for the 2080s under the warmest scenario (Scott *et al.* 2007b). For the 2080s, 19% of respondents indicated that they would cease to visit the park, and 37% indicated that they would visit less often (Scott *et al.* 2007b). The authors recognize that limitations exist to current methods of analyzing the effects of climate change on visitation to national parks.

In a similar study (Scott *et al.* 2007a) exploring how climate-induced environmental changes in Rocky Mountain national parks in Canada may affect visitation, a survey was administered to visitors in Banff and Waterton Lakes national parks. Similar to the previous study, changes for the 2020s and 2050s were minimal, while more significant changes were projected for the 2080s, which reflected the warmest climate change scenario (Scott *et al.* 2007a). Under this scenario, 60% of visitors indicated that they would visit less often or not at all, with those most likely to be influenced being ecotourists from overseas (Scott *et al.* 2007a).

To date, research on the influence of climate change on visitation to Canada's national parks has produced contrasting projections, with more confidence in projections on direct impacts.

3.6.3 Tourist Responses to Climate Change in US National Parks

In the US, one study to date (Richardson and Loomis 2004) explicitly examines the effects of climate change on visitation patterns and volumes in a national park. Using a contingent visitation analysis approach, Richardson and Loomis (2004) estimated the effects of climate and resource changes on nature-based recreation demand in Rocky Mountain National Park. Hypothetical climate scenarios for the 2020s were described in surveys to gauge respondents' reactions through questions about how their visitation behaviour might change (Richardson and Loomis 2004). With the combined weather-related and resource-related changes described in the surveys, few respondents indicated that their behaviour would change, and for those that did indicate anticipated changes, the result was slightly positive overall (10-14% higher) (Richardson and Loomis 2004). However, since this study only examined the 2020s, rather than farther into the future when more substantial impacts of climate change will be felt, its contribution to the literature is limited.

There have been many attempts to project how tourism flows and patterns will be impacted by climate change worldwide. Researchers have used historical patterns of tourism flows, empirical relationships between climate and visitation data, and survey techniques, combined with future climate projections to analyse what changes might occur in the future. Using these projections, a number of suggestions for adaptation strategies have been made for tourism operators and managers, which are reviewed in the following section.

3.7 Management Implications of Climate Change for Tourism

3.7.1 Management Implications for Global Tourism

Given both the demonstrated potential positive and negative impacts of climate change on the tourism industry, the policy, planning, and management implications are considerable. It is possible, however, that the tourism industry may be able to successfully adapt to climate-induced changes.

A few authors (Gyimóthy 2006; Hamilton and Lau 2006; Scott 2006a, 2006b; Scott *et al.* In press) propose methods for the tourism industry to adapt to climate change. For instance, tourism information providers can tailor the information they present to better meet the preferences of tourists (Hamilton and Lau 2006), and destinations can revise their infrastructure and marketing activities to reflect the new and more diverse opportunities they are able to offer tourists under a changing climate (Gyimóthy 2006). From the more specific perspective of the ski industry, a number of adaptation strategies can be adopted, such as utilizing snowmaking technologies where natural snowfall decreases in future years, and changing the operational season to better reflect changing climates (Scott 2006b).

Scott (2006a) suggests some general strategies that can be implemented by the tourism industry worldwide to adapt to the adverse effects of climate change. For instance, the tourism industry may adapt by improving emergency warnings and plans for extreme weather events, and construct infrastructure that anticipates climatic changes, such as improving building designs and building coastal structures to combat rising sea levels (Scott 2006a). Freshwater can be used more efficiently, and desalination plants can aid coastal areas in increasing their access to this precious resource (Scott 2006a). Alternate activities can be marketed for tourists, such as the use of all-terrain vehicles in place of snowmobiles, and marketing can be improved to attract potential tourists to new locations that may become more attractive under climate change (Scott 2006a). The timing of tourism events and the operational periods of parks and resorts can be adjusted to correspond to changing climatic conditions (Scott 2006a). Finally, environmental management can be altered to better suit tourism. Initiatives may include the stocking of game fish in freshwater lakes, and the creation of reservoirs for recreation (Scott 2006a).

Scott *et al.* (In press) suggest a number of adaptive strategies that can be implemented over the short to long term, by both tourism providers and other stakeholders in the industry, and tourists themselves. Adaptations described by the authors fall under the categories of technical/structural, behavioural, business management, policy, and research and education (Scott *et al.* In press). For instance, tourists can adapt to a windy day at the beach by erecting temporary windscreens and wearing more layers of clothing, they can adapt to less snowfall by switching their activity from snowmobiling to using all terrain vehicles, and they can wear wetsuits to dive in cooler waters (Scott *et al.* In press). Tourism operators, for instance, can adapt to less snowfall at ski resorts by incorporating the use of snowmaking technologies, construct desalination plants to provide drinking water where supplies are limited, and close down resorts during the low season to save costs (Scott *et al.* In press). Additionally, simply changing the timing of annual tourist events to coincide with changing climatic conditions could be a successful strategy (Scott *et al.* In press). There are a number of additional suggestions for adaptive measures that the tourism industry and tourists themselves can take under climate change, and it is suggested that adaptive strategies are not used in isolation, but rather in combination with each other (Scott *et al.* In press).

3.7.2 Management Implications for Protected Areas

Possibly due to a lack of exposure to climate change or a lack of analogues for planning purposes in protected areas, a limited number of publications address how managers may incorporate climate change into their plans, policies, and management strategies (Scott and Lemieux 2005). No publications to date review attempts at implementation of any plans, policies, or management strategies that address climate change, or assess how they have succeeded or failed, and their advantages and disadvantages in various parts of the world, likely due to the infancy of the field.

Management options for adapting to climate change in protected areas are addressed by Bridgewater (1991), based on his experience in the field in Australia. Three principles upon which to base a strategy for nature conservation using a landscape ecology framework include, 1) conserving and expanding areas of natural habitat, 2) conserving wildlife habitat outside of protected areas, and 3) developing wildlife corridors (Bridgewater 1991).

Staple and Wall (1996) estimated recreational impacts of climate change for Nahanni National Park Reserve in Canada. To respond to these impacts, two complementary adaptive management strategies are recommended, ecological and visitor monitoring (Staple and Wall 1996). Ecological monitoring would contribute to baseline data collection, function as an early warning system by indicating deviations from the norm, serve as a means to assess ecological integrity, monitor the broader areas surrounding the park, and decrease uncertainty of changes from climate to assist in management decisions (Staple and Wall 1996). Monitoring human activities would also help to reduce uncertainties associated with climate change and inform ecological and visitor management decisions (Staple and Wall 1996).

Bartlein *et al.* (1997) draw attention to possible weaknesses with the strategy of connecting habitats based on the fact that climatic changes may exceed the ability of species to adjust their ranges.

Scott (2001) identifies the weakness of the planning basis of Canada's national park system, which assumes steady-state biogeography, and calls for the inclusion of climate change in future planning and management. He also draws attention to the fact that some adaptation strategies will not be suitable for some locations because they will conflict with existing policy and planning regulations (Scott 2001). Federal and provincial-territorial leadership to address climate change in protected areas, along the same lines as the Kyoto ratification, is identified as necessary (Scott 2001).

Four possible policy directions for Canada's national parks in response to climate change are identified by Suffling and Scott (2002). Adaptive management is asserted to be the most plausible option (as opposed to static, passive, or hybrid management), whereby the capacity of species and ecological communities to adapt to climate change is maximized through active management, such as fire and invasive species suppression (Suffling and Scott 2002).

Hannah *et al.* (2002b) developed a general set of climate change-integrated conservation strategies (CCS) for biodiversity that can be tailored to specific regions. The five key elements include, 1) regional modeling of biodiversity response to climate change, 2) systematic selection of protected areas, 3) management of biodiversity across landscapes, 4) mechanisms to support regional coordination of management, and 5) provision of resources by wealthier countries to those with fewer resources to respond to climate change (Hannah et al. 2002b).

Lemieux and Scott (2005) recognize that incorporating climate change into protected area system planning and individual park management decision-making processes will be a challenge that will take time and patience, but it is necessary. For

Canada's national parks, strategies to adapt to biome changes resulting from climate change may include rethinking the basis of park establishment, which assumes permanent biome types, while the provincial park systems will face a similar task (Lemieux and Scott 2005). Invasive species management strategies will also require review as non-native species move beyond their historical ranges and into parks, and fire management plans will have to be reviewed for effectiveness under changing climatic conditions (Lemieux and Scott 2005). Many conservation stakeholders will need to be consulted, and in Canada success will depend on many factors including financial commitment, capacity enhancement, cooperation, direction, and communication amongst institutions (Lemieux and Scott 2005). International leadership is also recommended in terms of developing adaptation strategies for climate change in protected areas (Lemieux and Scott 2005).

A second study by Scott and Lemieux (2005) addresses protected area policy and planning adaptation strategies for climate change in Canada in more detail. First they identify that adaptation will require acceptance of natural systems' responses to climate change, and second, they discuss a number of possible planned adjustments in socio-economic processes, practices, and structures to moderate risks and capitalize on benefits of climate change (Scott and Lemieux 2005). The applicability of different strategies will vary by location, and some that are suggested in the literature are identified as being inappropriate anywhere due to the increased risks they create for certain species (*e.g.* corridor creation can lead to the introduction of competitive species), leading to the need for further and more locally-relevant research (Scott and Lemieux 2005). Recommended adaptation strategies for protected area managers to deal with climate change are divided into four categories including system planning and policy, management, research and monitoring, and capacity building and awareness (Scott and Lemieux 2005). Table 2 summarizes these adaptation strategies.

Table 2 - Climate Change Adaptation Strategies for Protected Areas Managers

System Planning and Policy	• Expand the protected areas network where possible and enlarge protected areas where appropriate. • Improve natural resource planning and management to focus on preserving and restoring ecosystem functionality and processes across regional landscapes. • Selection of redundant reserves. • Selection of new protected areas on ecotones. • Selection of new protected areas in close proximity to existing reserves. • Improve connectivity or protected area systems. • Continually assess protected areas legislation and regulation in relation to past, anticipated or observed impacts of climate change.
Management (including active, adaptive ecosystem management)	• Include adaptation to climate change in the management objectives and strategies of protected areas. • Implement adaptive management. • Enhance the resiliency of protected areas to allow for the management of ecosystems, their processes and services, in addition to "valued" species. • Minimize external stresses to facilitate autonomous adaptation. • Eliminate non-climatic in-situ threats. • Create and restore buffer zones around protected areas. • Implement ex-situ conservation and translocation strategies if appropriate. • Increased management of the landscape matrix for conservation. • Mimic natural disturbance regimes where appropriate. • Revise protected area objectives to reflect dynamic biogeography.
Research and Monitoring	• Make resources available to aid research on the impacts of past (e.g., paleo-ecological change) and future climate change (e.g., projected species composition changes). • Utilize parks as long-term integrated monitoring sites for climate change (e.g., monitoring of species, especially those at risk or extinction-prone). • Identify specific "values" at risk to climate change. • Regional modelling of biodiversity response to climate change. • Incorporate climate change impacts in protected areas "state-of-the-environment" reporting.
Capacity Building and Awareness	• Strengthen professional training and research capacity of protected area staff with regards to climate change. • Capacity building and awareness should proceed with the goal of securing public acceptance for climate change adaptation. • Partnerships/collaboration with greater (regional) park ecosystems stakeholders to respond to the need for climate change adaptations. • Improved collaboration/stewardship from local to international scales. • Make resources available for investing in active, adaptive management. • Develop precautionary approaches (such as disaster preparedness and recovery systems) through forecasting, early warning and rapid response measures, where appropriate.

Compiled from: Peters and Darling (1985), Graham (1988), Halpin (1997), Scott and Suffling (2000), Hannah *et al*. (2002a), Scott *et al*. (2002), Suffling and Scott (2002), IUCN (2003), Hannah *et al.* (2005), Lemieux and Scott (2005), Welch (2005).

Adapted from Scott and Lemieux (2005)

Welch (2005) recommends a number of adaptation policies and strategies for Parks Canada to deal with climate change, which are founded on a set of core principles. These principles include ensuring alignment with Kyoto targets and teaching visitors about climate change, risk management that incorporates reducing or eliminating tractable stresses, maintaining a focus on the system mandate while establishing partnerships, and connected landscapes to enable movement of wildlife (Welch 2005). Short, medium, and long-term goals should be defined that allow progress to be measured and assessed (Welch 2005). For adaptation strategies to be effective, staff, stakeholders, and the general public must be aware of ongoing efforts and the theories behind them in order to ensure support (Welch 2005). Canada's national parks should also lead by example in the reduction of greenhouse gases produced, encouraging staff to adopt climate-friendly practices in their personal lives, adapting a natural region representation strategy to maximize site diversity and landscape porosity, addressing climate change adaptation in park management plans, and continued reporting on natural and management adaptations to climate change (Welch 2005). Active ecosystem management is promoted, where non-climate *in-situ* threats are eliminated or mitigated, adaptive management is adopted so that intervention is conducted as scientific experiments in the lack of full knowledge, the results of published studies are utilized as guidance, and park boundaries are adjusted to accommodate smaller range changes resulting from climate change (Welch 2005). Research should also be conducted by Parks Canada to better understand both past and future climate changes, in addition to identifying values at risk of being significantly impacted (valued ecosystem components, or VECs), and downscaling climate models to be more park-specific (Welch 2005). Finally, parks should be used as long-term integrated monitoring sites for climate change, where data is gathered and reported on-site (Welch 2005).

Welch (2005) also suggests what should not be done by Parks Canada as the climate changes. Parks should not be moved to anticipated biomes to avoid setting a precedent for moving parks for other reasons, such as natural resource extraction, and also due to the practical issues of a lack of land for new establishment and no guarantee that relocation would be successful (Welch 2005). Parks should not be used as buffers to mitigate other impacts, again due the risk of opening the door to the commercialization of natural resources in parks; and natural region boundaries should not be modified to fit future biomes to avoid further endless modifications of regions for practical purposes (Welch 2005).

For the US, Sasidharan *et al.* (2001) recommend various options for protected areas managers to adapt to climate change from the perspective of recreation. Shifts in recreation will require managers to diversify the resources they offer, taking into account higher temperatures in general and increasingly extreme and unpredictable weather (Sasidharan *et al.* 2001). Using the example of the ski industry, some options may be to increase usage of snowmaking technology, as well as instituting activities like hang-gliding and music festivals or business conventions to improve summertime revenues and hence compensate for decreased winter income (Sasidharan *et al.* 2001).

There have been a number of suggestions made by a limited group of researchers on how protected areas managers can adapt to climate change. To date, however, there are no studies reporting on the success or failure of attempts to actually implement any of these strategies. Perhaps because most of the literature on this topic has been produced within the past few years, there has not been sufficient time to implement and report on these strategies. This will likely be a popular research direction in the near future.

3.8 Gaps in Literature

As described in the literature on climate change and tourism, some destinations will benefit and others will suffer as a direct result of a changing climate, and as destination attributes are altered by climate change. A number of adaptation strategies can be implemented by tourism operators and other stakeholders around the world to minimize the negative impacts of climate change on visitation.

More research is required to better assess climate change impacts on tourism at all scales, and particularly for individual destinations, to assist managers in making informed decisions. There has been a large volume of research conducted on the theory of anthropogenic climate change, and a number of studies have addressed climate in relation to tourism, yet there is a lack of knowledge regarding the linkages between climate change and tourism, particularly in protected areas. To date, the focus of national park research in relation to climate change has been on biophysical impacts. Multiple studies recommend further research into the impacts of climate change on national park resources (Bridgewater 1991; Halpin 1997; Scott and Suffling 2000; Suffling and Scott 2002), but few recommend further areas of research into the impacts of climate change on tourism, and even fewer make this suggestion specifically for protected areas.

Both localized and wide scale assessments of the impacts of climate change on tourism in protected areas are lacking for most of the world, including the US, which has a well-established system of managing national parks. Since climate regions vary across the globe, climate change will impact the protected areas of each country differently. For this reason, separate studies must carried out for each country’s park system to be able to project possible future visitation changes related to climatic changes. Both park-specific and system-wide studies on the impacts of climate change on visitation could contribute to the ability of tourism operators and managers to create and implement more effective plans, policies, and management strategies to deal with visitation changes related to continued accelerated climatic changes.

3.9 The Contribution of this Study to Protected Areas Research

The research described in the following chapters of this paper assesses the effects of climate change on tourism in national parks in the US. The methodology follows closely to that of Jones and Scott (2006a), which employed multivariate regression analysis to empirically assess tourism changes in Canada's national parks into the 2020s, 2050s, and 2080s. The results of the study could be useful to managers at the individual park level, as well as at the regional and national levels to better inform policy, planning, and management decisions into the future. At the time of writing, there were no similar studies published with a focus on US national parks, or other protected areas in the US.

4 Methodology

To determine possible future changes in the volume and seasonal distribution of visitation to US national parks as a result of climate change, the empirical relationship between visitation and climate was examined. A representative sample of the 58 national parks in the US was selected for the analysis due in part to a restriction on the time available for the research, and due to the fact that it was an exploratory study to determine how well the method carried over from the study of Canada's national parks conducted by Jones and Scott (2006a) to the national parks of the US before a larger study of all 58 parks was attempted. Fourteen national parks were selected to be representative of each major climate region in the country. Multiple parks were chosen to represent the larger climate regions, while some of the smaller climate regions were not represented due to a lack of a park fitting the criteria for park selection outlined in the remainder of this chapter. The 14 selected parks draw a combined total of approximately 50 million total visits (58% of total visits to all 58 national parks), or 30 million recreational visits each year (47% of total recreational visits to all 58 national parks). Table 3 summarizes the 14 national parks included in the study, the nearest meteorological station from which climate data was obtained, and the number of days of missing climate data for each station for the baseline period (1961-90).

To choose which parks to include, the climate regions of the country were used as a starting point. Administrative regions of the NPS were not used as the basis for park selection since they are not representative of the country's climate regions and thus would not provide a relevant basis for the study of climate and its relationship to visitation. A map of the US divided into its various climate classes was used to determine the climatic regime of each national park. The climate classification system employed was designed by Köppen, where the globe is divided into climatic regimes

Table 3 - Summary of National Parks Included in the Study

National Park	NPS Region[1]	State	% of Total NP Visits in 2005[2]	Visitation Data Record	Climate Station[4]
Denali	Alaska	Alaska	1.3	1979-2005	Talkeetna WSCMO AP (508976)[a]
Glacier Bay	Alaska	Alaska	0.4	1979-2005	Yakutat WB Airport (509941)[b]
Olympic	Pacific West	Washington	4.5	1979-2005	Forks 1 E (452914)[c]
Yosemite	Pacific West	California	3.9	1979-2005	Yosemite Park HQ (049855)[d]
Channel Islands	Pacific West	California	0.5	1979-2005[3]	Santa Barbara (047902)[e]
Grand Teton	Intermountain	Wyoming	4.5	1979-2005	Moran 5 WNW (486440)[f]
Rocky Mountain	Intermountain	Colorado	3.4	1979-2005	Grand Lake 1 NW (053496)[g]
Mesa Verde	Intermountain	Colorado	0.6	1979-2004	Cortez (051886)[h]
Saguaro	Intermountain	Arizona	4.1	1979-2005	Tucson University of Arizona (028815)[i]
Hot Springs	Midwest	Arkansas	4.3	1979-2005	Hot Springs 1 NNE (033466)[j]
Cuyahoga Valley	Midwest	Ohio	2.9	1979-2005	Akron Canton Regional Airport (330058)[k]
Acadia	Northeast	Maine	2.4	1979-2005	Belfast (170480)[l]
Great Smoky Mountains	Southeast	North Carolina	23.3	1979-2005	Gatlinburg 2 SW (403420)[m]
Everglades	Southeast	Florida	1.5	1979-2005	Tamiami Trail 40 Mi Ben (088780)[n]
Sample Total			**57.6**		

1) NPS administrative regions

2) Total visits to all 58 US national parks in 2005 was 87,612,456

3) Monthly recreation visits: excludes December 2005

4) Missing climate records (1961-90): a - 42 days; b - 35 days; c - 74 days; d - 571 days; e - 839 days; f - 7 days; g - 181 days; h - 853 days; i – 108 days; j - 47 days; k - 1 day; l - 9 days; m - 238 days; n - 629 days (NCDC 2002, 2005a, 2005b). Days with missing data not included in monthly mean calculations.

by average monthly temperatures and precipitation, and total annual precipitation (Christopherson 2004). In the US, 14 distinct climatic regimes are present, and national parks are located in twelve of them.

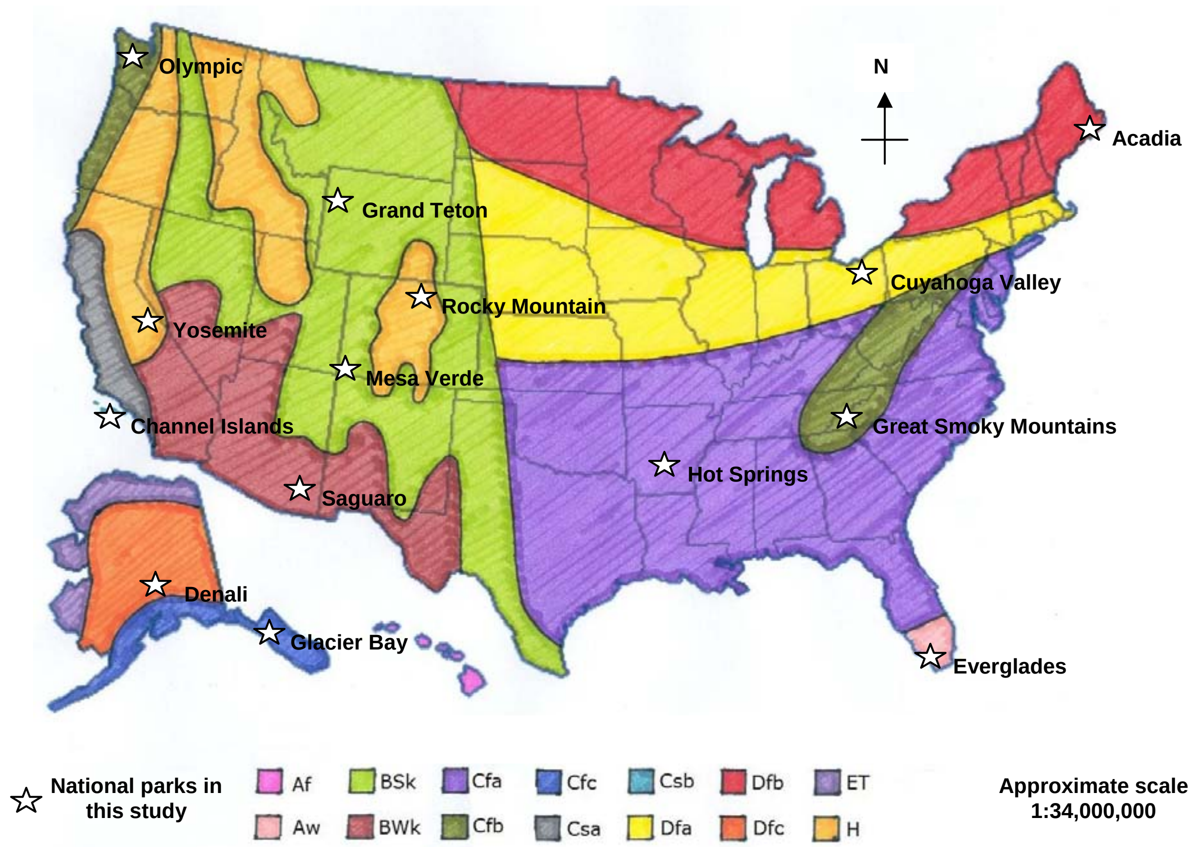
The climates of the national parks differ substantially across the continental US and Alaska. In Alaska, the climate ranges from that of a cold tundra environment typical of the arctic, to a subarctic climate with cool summers, and in the south, a mesothermal climate typical of the marine west coast, where it is moist all year with cool to warm summers (Christopherson 2004). Along the west coast of the continental states, the climate in the northern portion of the country is similar to that of southern Alaska, with moist conditions year-round and cool to warm summers (Christopherson 2004). Further south, the climate is typical of the Mediterranean, with dry summers that are warm to hot (Christopherson 2004). Throughout the mountain ranges in the west and south to the border of Mexico, the climate is that of a semiarid steppe environment at lower elevations, with a tropical or subtropical climate in the southern regions, and colder temperatures in the midlatitudes (Christopherson 2004). At higher elevations, ice caps and ice sheets are typically found (Christopherson 2004). The far southwest corner of the US is typified by an arid desert climate, which is hot at tropical and subtropical latitudes, and cooler at its northern limit (Christopherson 2004). The northern portion of the US from the midlongitudes to the east coast experiences a humid continental climate with mild summers and high moisture content year-round. Further south, conditions are similar, although summers are generally hot rather than mild. From the southern range of this climate to the country's southern border, the US is characterized by a humid, subtropical climate that is moist all year, with hot summers (Christopherson 2004). Slightly west of the east coast, and in the middle latitudes of the country, is a relatively small region where the climate is more similar to that of the marine west coast, with moist conditions year-round and cool to warm summers

(Christopherson 2004). The southern tip of the eastern peninsula has a tropical savanna climate, with the rainy season lasting fewer than six months (Christopherson 2004). Figure 3 illustrates the 14 climatic regimes present in the US and where the 14 national parks included in the study are located in relation to them.

Recreation visitation data for each park was then obtained from the NPS (2006m), which operates national parks and other national protected lands in the US. The NPS keeps records of recreational, non-recreational, and total visits to all national parks on a monthly and an annual basis, but not the activities that visitors participate in during their visits. These activities differ throughout the parks based on the amenities available at each. The general climate and the presence and length of various recreation seasons also differ by park depending on their locations within the country. For instance, parks located in the northern regions of the country experience winters with cold weather and snow, making activities such as skiing and snowmobiling possible, while southern parks are warm or hot year-round, thus being more conducive to tourism during the cooler months.

Recreation visits were used in the study because they are more likely to be influenced by climate than non-recreational visits. Of the 14 parks in the study, recreation visits accounted for 60% of total visits in 2005 (NPS 2006m). Parks with moderate to high visitation and full records for the period between January 1995 and December 2005 were chosen as possibilities to include in the study to represent the largest possible volume of visitation across the entire park system. Hence, parks with low visitation and records with major gaps were eliminated from consideration. Where recreational visits in a record were duplicated over successive years, signifying estimates in lieu of actual observed data, the park was also eliminated from the study. Ten years of the most recent available data were considered to be sufficient for the

Figure 3 - US Climatic Regimes and Locations of 14 National Parks in Study



Adapted from Christopherson (2004)

study since this period is long enough to capture climate variability and many of the warmest seasons on record, which provide insight into the potential impacts of climate change, while also being short enough to minimize the effects of population growth and economic changes on visitation trends, and new park development on the competitive relationship between park destinations. Hence, the period from 1995 to 2005 was used, as this ensured that parks with data records ending in 2004 still had 10 years of data, while also including the most recent data from 2005 for the remaining parks (Eleven years of data were included for these parks). Channel Islands National Park is included in the study despite a minor gap in its visitation record for December 2005, as is Grand Teton, for which the record for 2005 was unavailable. Channel Islands was included since it is the only national park in that climate region and its exclusion would result in that region not being represented in the study. Grand Teton was included because it has the highest volume of visitation of any national park in the same climate region. Although national parks in Alaska generally experience low visitation compared to the parks in the lower states, in part due to accessibility, visitation was still sufficiently high to include two Alaskan parks in the study to represent the climate regions in the far north.

Climate data was obtained from the US National Climatic Data Center (NCDC) (2002; 2005b; 2005a) meteorological station closest to each park with full temperature and precipitation records from 1995-2005, as well as historical records from 1961-1990. There are minor gaps (up to 629 days – see footnote 4 in Table 3) in some records used, including for some the entire year of 2005. These parks were still included since they met the rest of the criteria for park selection, and their elimination could have meant that a climate region would not be represented. Data for 1961-1990 was obtained to create baseline values for climate, and data for 1995-2005 was obtained to statistically model the relationship between climate and visitation. Where climate data was missing for one or more days of a month, the monthly mean was calculated based on the number of days with data recorded (*e.g.,* if data was only recorded for 26 days of a month, the mean was calculated by adding the values for those 26 days and dividing by 26 – See footnote 4 in Table 3).

Once all necessary data was compiled, an annual climate-visitation model was created for each park using multiple equations to determine the empirical relationship between visitation and climate for the most recent decade (1995-2005). Initially, the four climate variables of minimum, maximum, and mean monthly temperature, and total monthly precipitation were included in the analysis. The climate variable with the strongest relationship to visitation (*i.e.*, highest R-squared value – see Appendix A) was then plotted against the number of visits in a single variable regression analysis, either by individual month or by a group of consecutive months of the year depending on which relationship was strongest. A monthly timeframe was used due to the availability of monthly, rather than daily visitation data. A daily analysis may provide more specific results, but unfortunately daily data was not available. In the case of Olympic National Park, both precipitation and minimum temperature appeared to have a moderate to strong relationship with visitation when modeled separately (with the visitation relationship with minimum temperature being stronger than that of precipitation). When the two climate variables were plotted against visitation in the same graph, however, their relationship with visitation proved to be weaker than for minimum temperature alone. There were no other cases where precipitation demonstrated even a moderately strong relationship with visitation. Hence, all 14 national parks were modeled using a single climate variable (*i.e.*, temperature). Maximum temperature proved to have the strongest relationship for 11 of the parks, while the remaining three parks demonstrated a stronger relationship with minimum temperature.

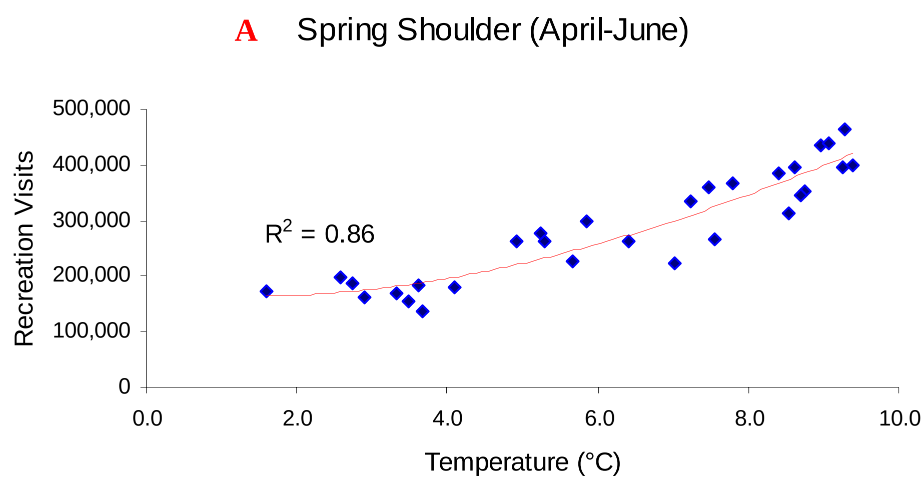
The number of equations used to model annual visitation for each park was determined by the strength of the relationship (R-squared value) between climate and observed visitation for individual months versus groups of consecutive months that generally represented either a distinct season or a steady transition between seasons. If the climate-visitation relationship was stronger for a single month than it was for a group of consecutive months, then a model was created for that month alone. If the climate-visitation relationship was stronger for a group of consecutive months than it was for a single month, then a model was created for that group of months together. For instance, Rocky Mountain National Park demonstrates clear summer and winter seasons where visitation increases steadily with increasing temperature, although at different rates. Thus, one equation is sufficient to represent the summer season, while another represents the winter season. For the shoulder months of May and October, which do not match either the winter or the summer pattern, two additional equations are used. Where a high number of equations were used to create an annual model, a weak climate-visitation relationship existed on both a seasonal and an annual basis.

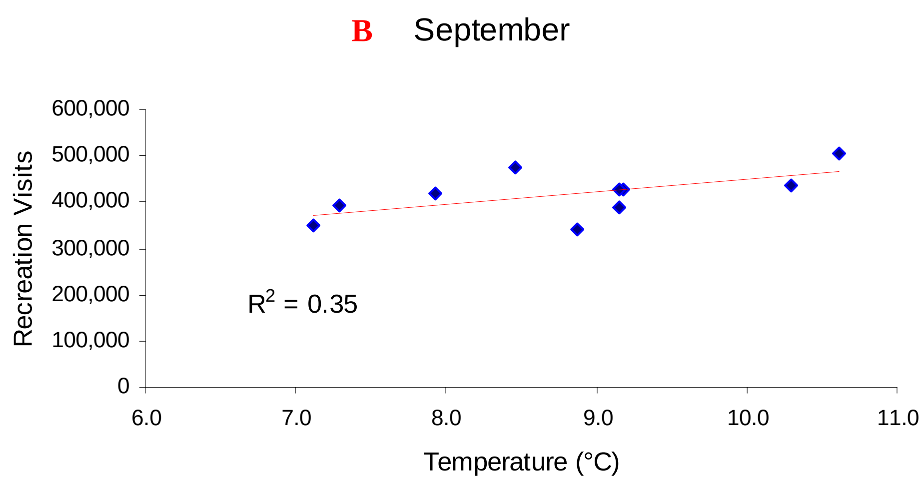
An R-squared value of 0.2 was chosen as the cutoff point to determine whether or not to use a monthly equation in the annual visitation model because this value allowed at least three months to be retained for the annual model for each park while still recognizing that a low R-squared value has little to no statistical meaning. An R-squared value of less than 0.2 means that less than 20% of the variation in visitation is explained by temperature, or that temperature has no substantial influence on the number of visits. In this case, factors other than climate (*e.g.*, holidays, accessibility, storm activity) have a strong influence on visitation; hence, climate at a monthly level is not a good predictor of visitation. Use of a lower R-squared value than 0.2 would result in the inclusion of equations with little or no statistical meaning in the annual visitation model. Use of a higher R-squared value than 0.2 would result in less than three months of the year being included in the annual visitation model for some parks.

To best represent the general pattern of visitation for each month or season, the strength of the relationship between the climate and observed visitation variables was improved by removing data points (*i.e.*, observed visitation values) from the analysis that appeared to be outside of the general range of observed visitation levels. To ensure that the models remained representative of the data, no more than three years of data for each month (*i.e.*, monthly visitation values for each year between 1995 and 2005) were removed from each analysis. The observed visitation values to be eliminated were determined by the value of the percentage difference between observed visits and modeled visits as calculated through the equation of the trendline created in each analysis. Generally, the observed visitation values with the highest percentage difference from the modeled visitation values were removed, which resulted in a higher R-squared value, and thus a stronger relationship between the climate variable and observed visitation. A stronger climate-visitation relationship resulted in a stronger model for visitation for each month or season.

A limitation that emerged during the regression analysis results from the use of a linear regression technique. In a linear relationship, the number of visits continues to rise as temperature rises. Such a situation is logically unrealistic, since at some critical temperature it would become uncomfortably hot for most visitors, at which point the number of visits would plateau and possibly begin to decline. Occasionally, a cubic relationship between climate and visitation was stronger than a linear one for particular months of the year at some of the parks. In a cubic relationship, the number of visits rises with temperature until a critical temperature is reached, at which point the number of visits begins to decline. Figure 4 illustrates a cubic (spring season – April to June) versus a linear (September) climate-visitation regression model for Olympic National

Figure 4 - Cubic versus Linear Regression Models for Olympic National Park





Park.

Once regression analysis was complete and an annual climate-visitation model was created for each park, baseline values for annual visitation were calculated using these models and the average monthly temperature (minimum or maximum depending on the model) for each park from 1961-90. This 30-year period is a standard timeline used by climatologists to determine climatic averages. The intent is not to model actual visitation for any month or year within the 1961-90 period, but rather to establish visitation levels in a climatically average baseline period. Major factors other than climate that affect visitation, such as population growth, economic changes, accessibility, and fuel prices were not included in the analysis. The mean monthly minimum or maximum temperature was inserted into each of the equations for each park to determine the average number of monthly visits in a climatologically average year. Equations with an R-squared value of less than 0.2 were used to calculate baseline visitation in the absence of a stronger model for those months, so that there were no gaps in the baseline model for each park. Another option was to substitute the average number of visits between 1995 and 2005 where regression models were weak, but this option was not chosen since the annual average over the most recent decade of visitation does not necessarily reflect average annual visitation levels between 1961 and 1990 due to factors such as new park development and changes in population over that time period. A chart was created for each park to illustrate the average baseline visitation from 1961 to 1990 by month as produced through the models (Appendix B).

The next step was to determine how much these average monthly visits might change in the future with climate change. To determine the average number of monthly visits to each park in the future under different climate change scenarios, global climate models (GCMs) were taken from the Canadian Climate and Impacts Scenarios (CCIS) Project (1999). The CCIS Project follows the recommendations of the United Nations IPCC Task Group on Scenarios in the creation of its scenario data. The IPCC (1999) recommends that more than one GCM and greenhouse gas emission scenario be used when assessing future impacts in order to cover the largest range of possible future changes throughout the same geographic region. Thus, the GCMs that generally forecasted the smallest and the largest temperature change across all of the national parks in the study were used. It was necessary to use one set of GCMs for the 12 parks in the contiguous states, and a second set of GCMs for the two Alaskan parks, since climate models projecting the smallest and largest temperature changes were not the same for both regions. For the 12 parks in the contiguous states, the US National Center for Atmospheric Research (NCAR) PCM B21 model (NCARPCM B21) was used for the smallest climate change projection, while the model used for the largest change was the Japanese Centre for Climate System Research (CCSR) NIES A11 model (CCSRNIES A11). For the Alaskan parks, the UK Met Office Hadley Centre CM3 B21 model (HADCM3 B21) was used to project the smallest change, and the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) MK2B A11 model (CSIROMK2B A11) was used to project the largest change. The greenhouse gas emissions scenarios are consistent between the smallest (*i.e.*, B21) and highest (*i.e.*, A11) change GCM scenarios for all 14 parks.

Three future timeframes were studied, following the guidelines set out by the IPCC. Each timeframe is based on 30-year periods of climate data, and represents change relative to the 30-year normal period (1961-90). These timeframes include 2010-2039 (the 2020s), 2040-2069 (the 2050s), and 2070-2099 (the 2080s). Table 4 shows the GCM scenarios projecting the smallest and largest temperature changes for the meteorological station nearest each park. The temperature change projected by the chosen GCM scenario for each timeframe for each park is shown in Table 5. These temperature changes were then added to the monthly baseline temperatures calculated

Table 4 - Projected Range of Changes in Annual Temperature (°C) under Climate Change

			Least Change Scenario						Most Change Scenario					
National Park	**Latitude (N)**	**Longitude (W)**	**2020s**		**2050s**		**2080s**		**2020s**		**2050s**		**2080s**	
Denali	63°20'00"	150°30'02"	ECHAM4 A21	+0.5	HADCM3 B11 HADCM3 B21	+1.3	HADCM3 B11	+2.4	CSIROMK2B B21	+2.7	CCSRNIES A11	+6.1	CCSRNIES A1FI	+10.4
Glacier Bay	58°30'02"	137°00'02"	CCSRNIES A21	0.0	HADCM3 B21	+0.2	HADCM3 B21	+1.3	CSIROMK2B B21	+2.7	CSIROMK2B A11	+4.1	CCSRNIES A1FI	+7.0
Scenario used in Study			HADCM3 B21						CSIROMK2B A11					

			Least Change Scenario						Most Change Scenario					
National Park	**Latitude (N)**	**Longitude (W)**	**2020s**		**2050s**		**2080s**		**2020s**		**2050s**		**2080s**	
Olympic	48°15'59"	124°40'35"	CCSRNIES A1FI	+0.3	NCARPCM B21	+1.5	NCARPCM B21	+1.9	CSIROMK2B B21	+1.6	CCSRNIES A11	+3.7	CCSRNIES A1FI	+6.4
Yosemite	37°50'60"	119°34'04"	NCARPCM A21	+0.5	NCARPCM A21 NCARPCM B21	+1.4	NCARPCM B21	+1.8	HADCM3 B21	+2.2	CCSRNIES A11	+4.6	CCSRNIES A1FI	+7.4
Channel Islands	34°00'15"	119°23'50"	NCARPCM A21	+0.5	NCARPCM A21 NCARPCM B21	+1.4	NCARPCM B21	+1.7	CCSRNIES A11	+2.1	CCSRNIES A11	+4.6	CCSRNIES A1FI	+7.4
Grand Teton	43°49'60"	110°42'03"	NCARPCM A21	+0.6	NCARPCM B21	+1.5	NCARPCM B21	+2.1	CCSRNIES A11	+2.3	CCSRNIES A11	+5.4	CCSRNIES A1FI	+8.6
Rocky Mountain	40°20'00"	105°42'32"	NCARPCM A21	+0.4	NCARPCM A21 NCARPCM B21	+1.2	NCARPCM B21	+1.7	CCSRNIES A11	+2.6	CCSRNIES A11	+5.9	CCSRNIES A1FI	+9.1
Mesa Verde	37°14'00"	108°28'47"	NCARPCM A21	+0.5	NCARPCM B21	+1.3	NCARPCM B21	+1.8	CCSRNIES A11	+2.9	CCSRNIES A11	+5.8	CCSRNIES A1FI	+9.4
Saguaro	32°16'43"	111°10'57"	NCARPCM A21	+0.6	NCARPCM A21 NCARPCM B21	+1.6	NCARPCM B21	+2.0	CCSRNIES A11	+2.3	CCSRNIES A11	+4.7	CCSRNIES A1FI	+7.8
Hot Springs	34°31'00"	093°03'11"	NCARPCM A21	+0.5	NCARPCM A21	+1.4	NCARPCM B21	+2.0	HADCM3 A22	+2.1	CCSRNIES A11	+5.3	CCSRNIES A1FI	+7.8
Cuyahoga Valley	41°14'30"	081°32'59"	NCARPCM A21	+0.5	NCARPCM B21	+1.5	NCARPCM B21	+2.3	CCSRNIES A11	+3.1	CCSRNIES A11	+6.3	CCSRNIES A1FI CCSRNIES A21	+9.4
Acadia	44°21'00"	068°16'58"	CGCM2 B23	+0.4	CGCM2 A23 CGCM2 B22 CGCM2 B23 CGCM2 B2X	+1.1	CGCM2 B21 CGCM2 B23 CGCM2 B2X	+1.6	CCSRNIES A11	+2.2	CCSRNIES A11	+4.6	HADCM3 A1FI	+7.0
Great Smoky Mountains	35°36'02"	083°30'32"	NCARPCM A21	+0.5	NCARPCM A21 NCARPCM B21	+1.4	NCARPCM B21	+1.9	CCSRNIES A11	+2.9	CCSRNIES A11	+6.4	CCSRNIES A21	+9.5
Everglades	25°18'46"	080°56'14"	CGCM2 B22 ECHAM4 A21 NCARPCM A21	+0.6	NCARPCM A21 NCARPCM B21	+1.1	NCARPCM B21	+1.4	CCSRNIES B21 CCSRNIES A11	+1.1	CCSRNIES A11	+2.3	HADCM3 A1FI	+3.9
Scenario used in Study			NCARPCM B21						CCSRNIES A11					

Data source: (Canadian Climate Impact Scenarios Project 2002)

Table 5 - Selected Climate Change Scenarios for each Park (Change in °C)

National Park	2020s HADCM3 B21	2020s CSIROMK2B A11	2050s HADCM3 B21	2050s CSIROMK2B A11	2080s HADCM3 B21	2080s CSIROMK2B A11
Denali	+0.9	+2.2	+1.3	+4.1	+2.8	+6.0
Glacier Bay	+0.3	+2.4	+0.2	+4.1	+1.3	+5.2
	NCARPCM B21	**CCSRNIES A11**	**NCARPCM B21**	**CCSRNIES A11**	**NCARPCM B21**	**CCSRNIES A11**
Olympic	+1.1	+1.1	+1.5	+3.7	+1.9	+5.6
Yosemite	+1.0	+2.1	+1.4	+4.6	+1.8	+6.3
Channel Islands	+1.0	+2.1	+1.4	+4.6	+1.7	+6.3
Grand Teton	+1.2	+2.3	+1.5	+5.4	+2.1	+7.3
Rocky Mountain	+0.9	+2.6	+1.2	+5.9	+1.7	+7.6
Mesa Verde	+1.0	+2.9	+1.3	+5.8	+1.8	+7.5
Saguaro	+1.1	+2.3	+1.6	+4.7	+2.0	+6.2
Hot Springs	+0.9	+2.0	+1.5	+5.3	+2.0	+6.0
Cuyahoga Valley	+1.0	+3.1	+1.5	+6.3	+2.3	+8.4
Acadia	+1.3	+2.2	+2.0	+4.6	+2.5	+6.0
Great Smoky Mountains	+0.9	+2.9	+1.4	+6.4	+1.9	+8.4
Everglades	+0.7	+1.1	+1.1	+2.3	+1.4	+3.1

earlier (monthly average from 1961-90), resulting in future monthly average temperatures for the 2020s, the 2050s, and the 2080s. The climate-visitation models were then re-run with projected future temperatures, resulting in the number of visits per month to each park in each future timeframe. Equations with an R-squared value of less than 0.2 were considered to have too weak of a correlation between climate and visitation to be carried through this step of the analysis; hence, modeled baseline visitation was substituted for each future timeframe for these months, resulting in no projected change in visitation. The difference between the baseline visits and the projected visits was calculated as a percentage increase or decrease, both by month and over the course of the year. The annual difference in visits for each future timeframe was then plotted against the baseline visits to gain a visual representation of the potential changes. The results of these analyses are presented in the following chapter.

5 Results

5.1 Seasonal Patterns in Park Visitation

Both the level and pattern of visitation differ substantially amongst individual national parks in the US. There is no consistent pattern to visitation on a seasonal or an annual basis across all of the parks, although some parks in the same regions (NPS administrative regions were used for this analysis) demonstrate similar patterns. Figure 5 shows observed monthly visits throughout the year 2004 (2005 data was missing for Grand Teton National Park) by NPS region for each of the 14 parks in the study.

National parks in the Alaska region demonstrate highest annual visitation levels in June through August, with a significant decline in the winter months. Similarly, Olympic and Yosemite national parks in the Pacific West region of the country tend to experience a peak in visitation during the summer months of July and August. Channel Islands National Park (California) is the exception, with fairly consistent levels of visitation from April to September and a slight decline over the cooler months of November to March.

The Intermountain region includes Grand Teton (Wyoming), Rocky Mountain (Colorado), Mesa Verde (Colorado), and Saguaro (Arizona) national parks. Visitation in the first two parks peaks in July, while Mesa Verde experiences a much smaller peak, also in July. At Saguaro National Park, on the other hand, which is located in the southern part of Arizona, the peak occurs in March, possibly due to uncomfortably high temperatures in the summer months.

Hot Springs (Arkansas) and Cuyahoga Valley (Ohio) national parks are located in the Midwest region of the US. Visitation is fairly consistent throughout the year at Hot Springs National Park, although a slight decrease occurs from November through to February. A somewhat sporadic pattern of visitation exists for Cuyahoga Valley

Figure 5 - 2004 Observed Recreation Visits by National Park Service Region

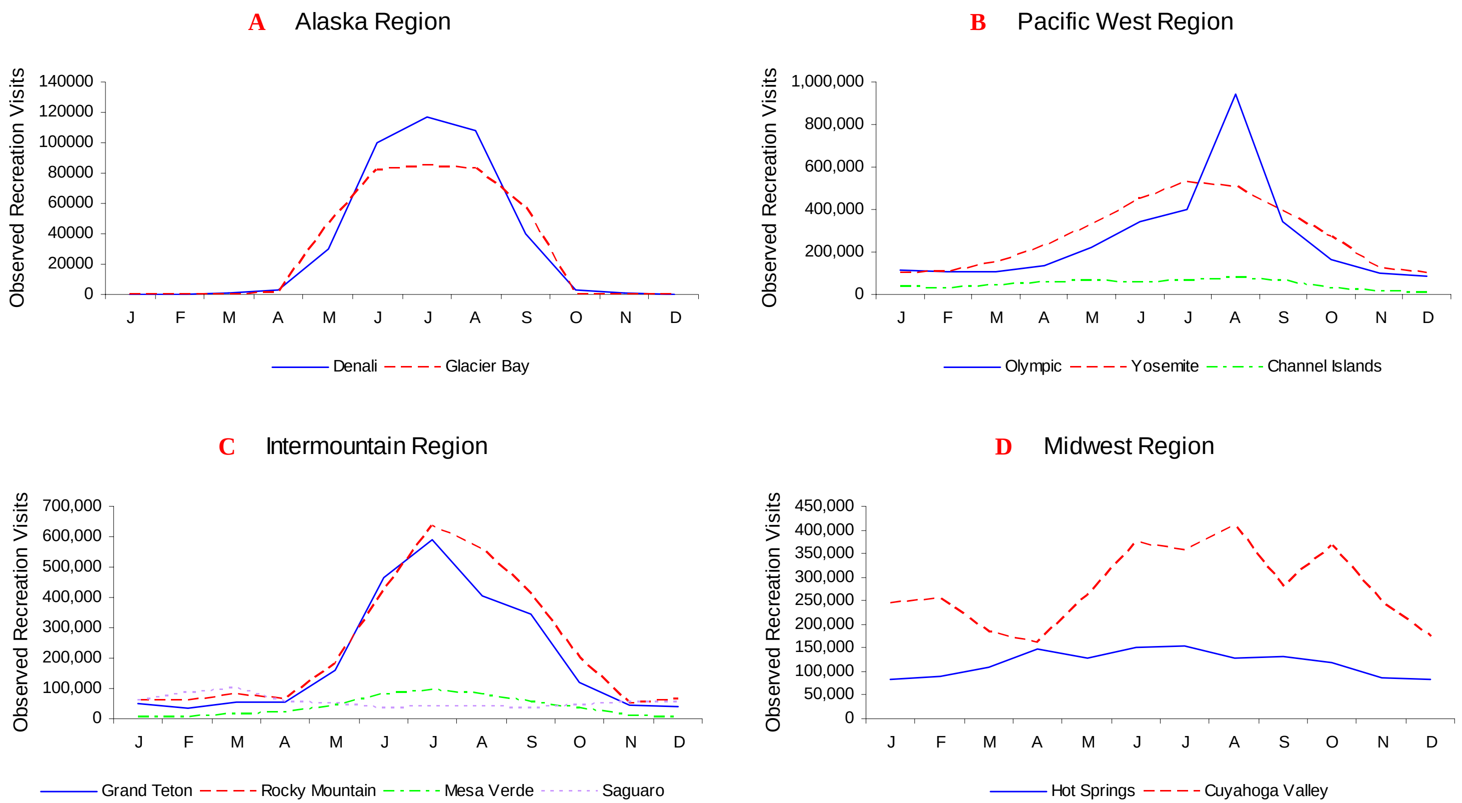
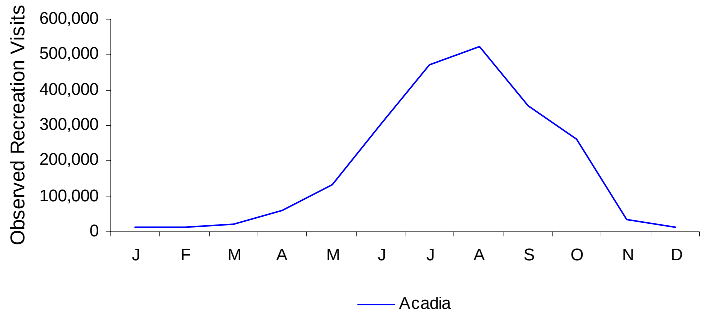
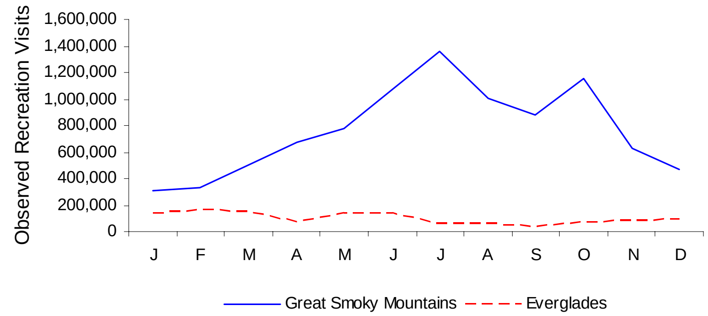


Figure 5 continued – 2004 Observed Recreation Visits by National Park Service Region

E Northeast Region



F Southeast Region



National Park, with a first peak occurring from June through August, a second peak evident in October (possibly due to the beautiful natural display of the forests as the leaves turn colour), and a significant drop occurring in December, and again in March and April.

Acadia National Park (Maine) is the only park in the Northeast region of the US included in the study. Its pattern of visitation is similar to that of Grand Teton and Rocky Mountain national parks, where the peak in visitation is experienced in the summer months of July and August. The volume of visits is low throughout the colder months of November through March.

There is no discernible regional pattern of visitation for the two parks in the Southeast region. Great Smoky Mountains National Park (North Carolina) is located significantly farther north than Everglades National Park, which is at the southern tip of Florida. The former has a primary peak in July and a secondary peak in October, with a decline in visits occurring in the winter months, particularly in January and February. Everglades, on the other hand, experiences a pattern similar to Saguaro, where a slight peak occurs in March, and June through August attracts the lowest number of visitors.

5.2 Regression Models of Visitation

Based on the regression analysis, maximum temperature proved to have the strongest relationship with visitation for 11 of the parks, while the remaining three parks demonstrated a stronger relationship with minimum temperature. The first of these three parks is Olympic, which is located in northwestern Washington, where precipitation occurs often (although the relationship between precipitation and visitation was not strong enough to utilize multiple regression analysis, *i.e.*, precipitation and temperature data together rather than just temperature). The remaining two parks are Saguaro and Everglades, which are both located in the southern reaches of the country, where it is generally hot year-round.

A table summarizing the climate variable used to model visitation, the type of relationship between the variables (linear or cubic), the strength of the relationship (*i.e.*, R-squared value), and the monthly or seasonal equations for the annual climate-visitation regression models created for each of the 14 national parks in the study are located in Appendix C. As demonstrated in the table, there was not a single case where one equation was sufficient to model visitation over the entire course of the year. In fact, the smallest number of equations used to model any park was four (for Rocky Mountain), and the largest number was 11 (for Grand Teton and Mesa Verde). There were a number of instances where consecutive months were modeled as a group, but these groups did not always reflect traditional seasons. For instance, January and December are grouped together to model part of the winter season at Hot Springs National Park in Arkansas, but February is modeled separately. These results differ significantly from those for Canada's national parks and Ontario's provincial parks, where a maximum of two equations modeled the annual relationship between climate and visitation for each park studied (Jones and Scott 2006a, 2006b). The higher number of equations necessary to model the climate-visitation relationship in national parks in the US may reflect a higher degree of climatic complexity across the country as compared to Canada.

The difference between observed and modeled visitation for each park between 1995 and 2005 was calculated to demonstrate how well the climate-visitation models duplicated observed visitation values. Modeled visits are not compared to observed visits on an annual basis since there are a number of weak monthly or seasonal models for a number of parks. An annual comparison could therefore result in an annual model appearing strong even if certain months are modeled poorly, since a monthly or seasonal model that calculates substantially lower visits than those observed could be offset by a model that calculates significantly higher visits for another month or season. Where climate or visitation data was missing from data records for an entire month, these months were excluded from the annual visitation totals for both observed and modeled visits so that a comparison could still be made. Although the results of this analysis generally provide a good indication of the strength of the correlation between the climate variable and visitation levels, there are instances where a monthly or seasonal model may appear strong in its ability to predict visitation levels based on temperature, but this is not actually the case. For instance, where visitation levels remain fairly constant despite fluctuations in temperature, there will be a small difference between observed and modeled visits as long as the temperature remains in the same range. However, if temperature deviates significantly, the model will continue to calculate visitation levels in the same range, which may not necessarily be the case in reality. Such a model is therefore a poor indication of how visitation may change in the future with higher temperatures. Though the climate-visitation relationships for certain months of the year for some parks are weak, this does not mean that climate change is not an issue for these parks, as mean temperature changes may still affect visitation in future years. There are simply other variables in addition to climate affecting visitation in these instances, such as accessibility, institutional holidays, and storm events. For instance, visitation at Glacier Bay National Park in Alaska is very low in winter due to the inability of many potential visitors to access the park. At Grand Teton National Park in Wyoming, visitation is at a fairly consistent level during the months of July and August despite temperature fluctuations, indicating that conditions are generally suitable for outdoor recreation throughout the summer season, and that visitation levels may be higher than they would be otherwise due to institutional holidays. At Everglades National Park in southern Florida, hurricane activity and the rainy season limit visitation in the summer and fall months despite the temperature being fairly consistent and otherwise suitable for outdoor recreation. The difference between observed and modeled visitation for each park between 1995 and 2005 is summarized in Appendix D.

Each park was ranked in terms of the confidence level of the annual model created through single variable regression analysis. The number of months of the year with an equation where the R-squared value was 0.2 or higher determined if the level of confidence in the annual model was low (0-4 months), medium (5-8 months), or high (9-12 months). The confidence levels of the annual models for each park in the study are shown in Table 6.

There are three parks where confidence in the annual climate-visitation model is weak. At two of these parks, Glacier Bay and Olympic, only four months of the year demonstrate a relationship with visitation where the R-squared value is 0.2 or greater. Grand Teton is the third case, where the models for only three months of the year have an R-squared value of at least 0.2. Despite the weak level of confidence in the annual climate-visitation models for each of these three parks, future visitation was still projected for the months where the analysis resulted in a stronger relationship (*i.e.*, R-squared value of 0.2 or greater). Although an annual trend in future visitation cannot be projected for these parks, an idea of how visitation may change in certain months can still be valuable information for park managers. This is particularly the case for Glacier Bay, where future visitation levels are modeled for four of the five most heavily visited months by far over the course of the year.

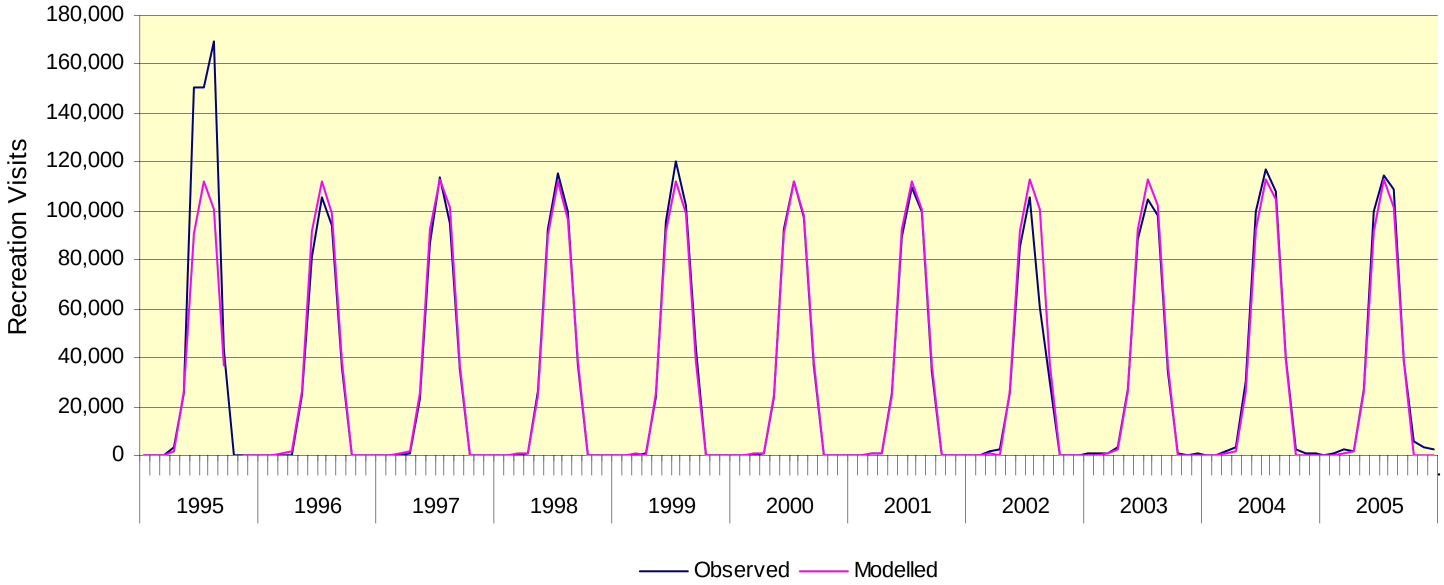
As illustrated in Figure 6 using the most recent decade of observed versus modeled visitation at Denali National Park, the visitation models created through regression analysis for each park using a single climate variable cannot capture anomalies that occur in NPS visitation records. In the example, observed visits in the

Table 6 - Level of Confidence in Annual Visitation Regression Models

Park	Low[1]	Medium[2]	High[3]
Denali		✓	
Glacier Bay	✓		
Olympic	✓		
Yosemite			✓
Channel Islands			✓
Grand Teton	✓		
Rocky Mountain			✓
Mesa Verde		✓	
Saguaro		✓	
Hot Springs		✓	
Cuyahoga Valley		✓	
Acadia		✓	
Great Smoky Mountains			✓
Everglades		✓	

1) 0-4 monthly models with R^2 at least 0.2
2) 5-8 monthly models with R^2 at least 0.2
3) 9-12 monthly models with R^2 at least 0.2

Figure 6 - Observed versus Modeled Recreation Visits to Denali National Park 1995-2005



summer of 1995 by far exceeded those for the rest of the decade, an anomaly that could not be captured by the climate-based visitation model. Anomalies such as this one do not follow the regular pattern of visitation, and while it is possible that they may be at least partially explained through corresponding anomalies in the weather, there were clearly other factors influencing visitation at the time, possibly forest fires or one-time special events such as a sporting event. The model represented visitation reasonably well in the other years.

There were eight instances where obvious anomalies existed in NPS records of actual recreation visits that could not be captured by the models. These anomalies are found in records for Denali (1995), Glacier Bay (1995), Mesa Verde (2002), Saguaro (1996), Hot Springs (2003), Cuyahoga Valley (1996 and 1997), and Everglades (2005) national parks (See Appendix E).

5.3 Potential Impact of Climate Change on Park Visitation

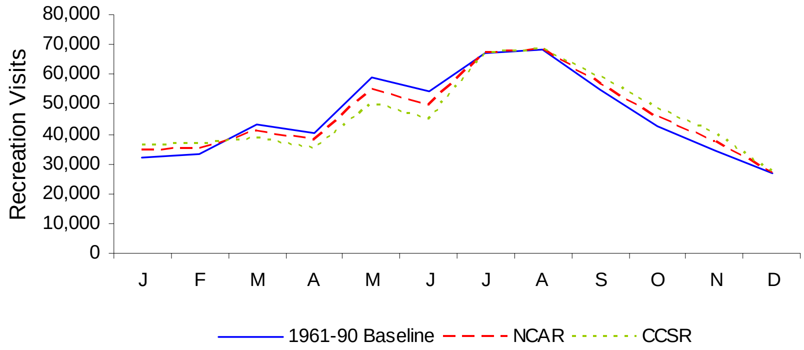
The two climate change scenarios chosen to project future average temperatures for each park in the study were run through the climate-visitation regression models developed earlier, resulting in projections of the number of people visiting these parks in three future time periods (2020s, 2050s, and 2080s). In this way, potential future changes in the climate could be assessed in terms of their potential influence on park visitation. As demonstrated in Table 7 and Figure 7 for Channel Islands National Park, only models with an R-squared value of 0.2 or higher were used to project future monthly or seasonal changes to visitation at each park. Where the relationship between climate and visitation was weak (*i.e.*, R-squared less than 0.2) for any month or season, the equation was not used for future projections, resulting in no change in visitation from the modeled baseline value for that particular month or season. This is the case for July, August, and December in the example.

Table 7 - Projected Visitation Changes for Channel Islands National Park

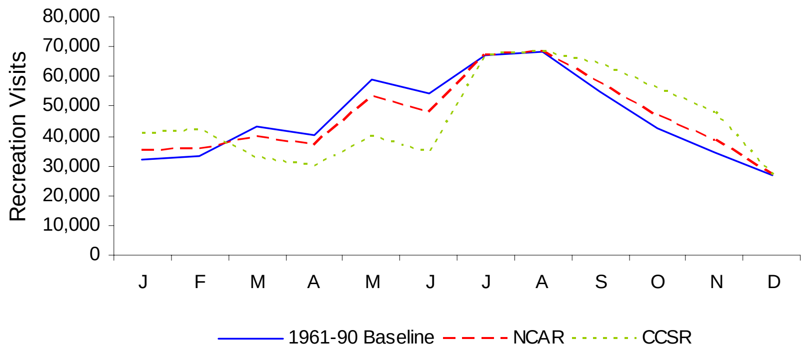
	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	32,398	34,295	5.9	35,054	8.2	35,623	10.0	36,382	12.3	41,125	26.9	44,351	36.9
F	33,064	34,961	5.7	35,720	8.0	36,289	9.8	37,048	12.1	41,791	26.4	45,017	36.2
M	43,140	40,843	-5.3	39,925	-7.5	39,236	-9.0	38,317	-11.2	32,576	-24.5	28,672	-33.5
A	40,115	37,819	-5.7	36,900	-8.0	36,211	-9.7	35,293	-12.0	29,552	-26.3	25,648	-36.1
M	59,189	54,940	-7.2	53,240	-10.1	51,966	-12.2	50,266	-15.1	39,643	-33.0	32,419	-45.2
J	54,047	49,798	-7.9	48,098	-11.0	46,824	-13.4	45,124	-16.5	34,501	-36.2	27,277	-49.5
J	67,093	67,093	0.0	67,093	0.0	67,093	0.0	67,093	0.0	67,093	0.0	67,093	0.0
A	68,464	68,464	0.0	68,464	0.0	68,464	0.0	68,464	0.0	68,464	0.0	68,464	0.0
S	54,785	56,843	3.8	57,666	5.3	58,283	6.4	59,106	7.9	64,252	17.3	67,750	23.7
O	42,443	45,347	6.8	46,509	9.6	47,380	11.6	48,542	14.4	55,804	31.5	60,742	43.1
N	34,398	37,303	8.4	38,464	11.8	39,336	14.4	40,498	17.7	47,759	38.8	52,697	53.2
D	26,745	26,745	0.0	26,745	0.0	26,745	0.0	26,745	0.0	26,745	0.0	26,745	0.0
Annual	**555,881**	**554,451**	**-0.3**	**553,880**	**-0.4**	**553,451**	**-0.4**	**552,879**	**-0.5**	**549,306**	**-1.2**	**546,877**	**-1.6**

Figure 7 - Projected Visitation Changes for Channel Islands National Park

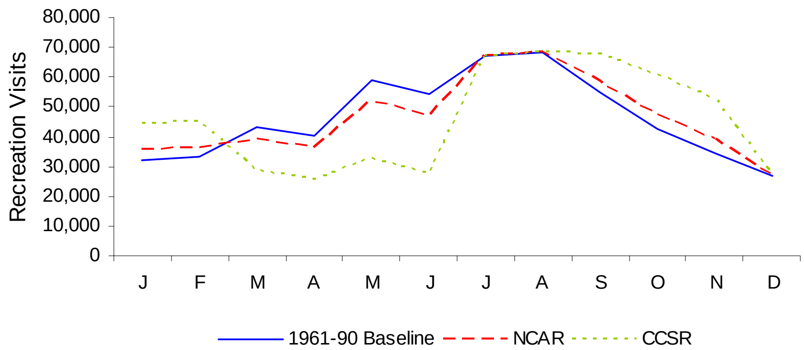
A 2020s



B 2050s



C 2080s



Compared to baseline values of annual visitation, five parks may experience decreased future visitation, while nine parks may see an increase. There appears to be a general pattern whereby parks in the northern areas of each geographic region *(i.e.*, Olympic, Grand Teton, Cuyahoga Valley, and Acadia) may experience a higher increase in visitation than those farther to the south (*i.e.*, Yosemite, Rocky Mountain, Hot Springs, and Great Smoky Mountains), and those parks located along the southern reaches of the US (*i.e.*, Channel Islands, Mesa Verde, and Saguaro) are the ones projected to see decreases in visitation. For parks where visitation was only projected for a few months of the year (*e.g.*, Olympic and Grand Teton), the results are generally consistent with parks in the same geographic region for which a higher number of months were modeled. These results appear to be theoretically correct and are consistent with other studies modeling the potential influence of climate change on international tourist flows (Hamilton *et al.* 2005a; Jones and Scott 2006a, 2006b). The major exception to this pattern occurred in the Alaska region, where the number of visits to Glacier Bay National Park is projected to drop in the future, despite minor increases projected for Denali. This difference may be explained by the fact that future visitation for only four months of the year were projected for Glacier, all during the high visitation season (May, and July through September), while the high visitation season for Denali was not projected (May through July, and September), but the low visitation season was projected (October through April, with the exception of March). Thus, the annual models for the two parks may in fact demonstrate a similar pattern if visitation for all months of the year could be projected using stronger climate-visitation models.

The remainder of this section highlights the major projected visitation changes for each park. A full account of projected temperature changes for each park is located in Appendix F, and all projected changes in recreation visits for each future timeframe

(2020s, 2050s, and 2080s) for each park are summarized in appendices G and H. A discussion of how climate changes may affect the recreation seasons of each park, and therefore also potentially affect visitation patterns, is located in the next chapter.

5.3.1 Alaska Region

Visitation changes at Denali National Park are only projected for the months when the number of visits is low (i.e., October through April, with the exception of March), and for August when visits are high. Overall, changes in projected visits are small under both climate change scenarios (HADCM3 B21 and CSIROMK2B A11), with a less than 1% increase under the lesser change scenario, and an increase of about 3% under the larger change scenario by the 2080s. The largest projected increase equates to a mere additional 10,000 visits each year, which may go unnoticed by park managers, as it could occur gradually over the next 70 years. Conversely, visitation at Glacier Bay National Park is projected only for the busiest season from May to September (with the exception of June). Overall, visitation during this time is projected to drop in the future from anywhere between 1% and 4% under the smaller change scenario (HADCM3 B21) and between 7% and 15% under the larger change scenario (CSIROMK2B A11). If the larger visitation changes are realized at this park, management may face challenges in the future from decreased annual revenue. If these two parks are indeed an indication of future visitation changes to all Alaskan parks, it appears that the number of visits may decrease during the high season of the summer (when the majority of visits occur) and increase very slightly during the remaining months of the year (for which visitation is currently very low).

5.3.2 Pacific West Region

In the Pacific West region, Olympic National Park is located in the far northwestern corner of Washington. Changes in visitation for this park are only projected for the months of April through June, and September, for which increases may be around 4% by the 2020s, anywhere between 6% and 17% by the 2050s, and between 8% and 29% by the 2080s. These increases would result in approximately 200,000-580,000 additional visits by the 2050s, and 260,000-960,000 by the 2080s, which would equate to an approximate doubling of the number of visits over the baseline, and could lead to potential people and wildlife conflicts if not properly managed.

Yosemite National Park to the south of Olympic is projected to gain at most an extra 12% increase in visitation over the baseline under the most change scenario into the 2080s for the 10 months of the year for which projections were made (excluding April and August). By the 2050s, the gain could be as high as 9%, or 230,000 visits. However, as these increases will likely be distributed fairly evenly throughout the year, there may not be a large impact in any particular season of visitation.

Farther to the south, future visitation changes at Channel Islands National Park were projected for nine months of the year (excluding July, August, and December), and will likely be minimal overall. Under the smallest change scenario for the 2020s, visitation could be reduced by less than 1%, while the largest change scenario for the 2080s projects a decrease of 2%. Monthly and seasonal changes could be more significant from a management perspective, since the spring months of March through June may experience reduced visitation while the fall and winter months could see an increase. Regardless, no single month is projected to increase or decrease its visits by 20% or higher until the 2050s under the larger change scenario, giving managers time to plan for changes.

5.3.3 Intermountain Region

Grand Teton, Rocky Mountain, Mesa Verde, and Saguaro national parks are located from north to south within the Intermountain region. For Grand Teton, only the months of April, May, and October were included in future visitation projections. For these three months, the maximum difference between baseline and future visits is 3% under the most change scenario into the 2080s. At Rocky Mountain National Park, for which only the month of May was excluded from visitation projections, visits could increase by anywhere from 6% to 16% as soon as the 2020s (consistent with a projected increase of 10-14% by Richardson and Loomis (2004)), between 7% and 36% by the 2050s, and as high as 10% to 47% by the 2080s. A 36% increase would equate to approximately an extra 1 million visits each year over the baseline, and a 47% increase would add over 1.3 million visits to the baseline. While these extra visits would likely be somewhat spread out over the course of the year, most could occur between June and October, which are currently the busiest months for tourism at Rocky Mountain. For the two common months that visitation projections are made for both Grand Teton and Rocky Mountain National Parks (April and October), the percentage increases in visits are similar.

For Mesa Verde National Park, the busiest months for tourism (May through October) were not included in the visitation projections, with the exception of July. Although the overall number of people visiting the park on an annual basis is projected to decrease slightly under climate change to a maximum of 9%, or approximately 55,000 visits by the 2080s under the most change scenario, July is the only month demonstrating a projected decrease in visits. As early as the 2020s, the most change scenario projects almost a quarter decrease in July visitation (around 34,000 visits), followed by a 47% drop by the 2050s (approximately 68,000 visits), and up to 61%

fewer visits by the 2080s (around 88,000 visits). The least change scenario is more conservative, with the projected decreases being 8%, 11%, and 15% respectively for the month of July. According to the projections, these possible losses in summer visitation could be almost fully compensated by increases in the months of November through April, resulting in less than 10% maximum overall change in annual visitation at this park. However, if visitation changes in future years during the remaining busy months at this park follow the pattern projected for July, overall visitation at this park could be substantially lower than it is now on an annual basis.

Future visitation changes at Saguaro National Park were projected for the months of April, May, July, September and October. For these months combined, only decreases in visitation are projected, of 3%, 4%, and 5% under the smallest change scenario for the 2020s, 2050s, and 2080s respectively, while under the largest change scenario, visits may decrease by 6%, 12%, and 16% respectively.

5.3.4 Midwest Region

Cuyahoga Valley National Park in the Midwest region is projected to gain visits in both of the seasons for which projections were made, the spring and the fall (including the months of March through June, and October and November). Overall, these increases could be between 3% and 6% from the 2020s through to the 2080s under the smallest change scenario, and up to 8% by the 2020s to 22% by the 2080s under the larger change scenario. A 17% increase by the 2050s under the larger change scenario could result in close to an additional 600,000 visits, while the largest increase could be equal to 700,000 visits over the baseline. Management challenges may arise in the future, as the bulk of these extra visits are projected to occur in October and November.

Located south and west of Cuyahoga Valley in the same geographic region is Hot Springs National Park. At this park, future visitation was projected for March and

April, and August through January. Projections were not made for the busiest months of May through July, although visits in these months are only slightly higher than for August through October, for which projections were made. For this park, the 2080s may see an increase of up to 4% more visits under the least change scenario, and up to 10% under the most change scenario, with smaller projections for the 2020s and the 2050s. As these increases could be spread out throughout the course of the year, they will likely not cause any significant problems if realized.

5.3.5 Northeast Region

The lone national park in the Northeast region of the US included in the study is Acadia, which is located on the east coast of Maine. Future visitation was projected for six months of the year for this park, including April, June through August, and October and November. Visitation for the winter season was not projected. For the six months for which projections were made, annual increases in visitation at this park follow the established pattern of the other parks in the northern parts of the climate regions. However, increases are not uniform for all six months. April and July through August are the only months demonstrating increases, while decreases are projected for October and November. All of these monthly changes in visitation are projected to remain below 25% over or under baseline values until the 2050s under the larger change scenario, and the largest change projected for any individual month at Acadia is a 51% drop in visits in November in the 2080s. When all monthly projected increases and decreases are combined, the 2020s may experience between 4% and 6% more visits, the 2050s may see a 6-13% increase, and an additional 7-18% visits may occur by the 2080s, according to the least and most change scenarios, respectively.

5.3.6 Southeast Region

The Southeast region contains Great Smoky Mountains and Everglades national parks. For Great Smoky Mountains, visitation for the months of July, October, and December were not projected. For the remaining months of the year, the number of people visiting the park may increase slightly in the future according to the least change scenario used, between 2% by the 2020s and 3% by the 2080s. Under the most change scenario, increases in visitation may reach anywhere from 5% in the 2020s up to 15% by the 2080s, which would mean up to an additional 1.4 million visits annually. The highest increases in visitation are projected to occur in January and February (up to 54% and 47% respectively by 2080), which currently draw the fewest visits year-round.

Visitation for the spring and fall seasons were projected for Everglades National Park at the southern tip of Florida. January, February, and June through September were excluded from the projection analysis. For the six months for which projections were made, slightly fewer visits may occur in the future. The maximum decrease under the most change scenario for the six months combined into the 2080s is only 8% less than the baseline value, equal to a difference in annual visits of less than 90,000.

5.3.7 National Park System

When the projections for all 14 parks in the study are combined, there is an overall increase in the number of projected visits for every month of year for which projections were made. This increase may be between 2% under the smaller climate change scenario (HADCM3 B21 for the Alaskan parks and NCARPCM B21 for the others) and 5% under the larger climate change scenario (CSIROMK2B A11 for the Alaskan parks and CCSRNIES A11 for the others) into the 2020s. For the 2050s, projected increases range from 3% (HADCM3 B21 and NCARPCM B21) to 12% (CSIROMK2B

A11 and CCSRNIES A11), and the biggest changes are seen into the 2080s, with overall increases of between 4% (HADCM3 B21 and NCARPCM B21) and 16% (CSIROMK2B A11 and CCSRNIES A11). However, these combined visitation changes must be viewed with caution due to the exclusion of a number of months in many parks' annual projected visitation values, where baseline visits for those months were substituted. Thus, these changes are not necessarily representative of visitation projections for each park over the entire course of the year. Table 8 summarizes the overall annual projected percentage changes in visitation by individual park and for the 14 parks combined, noting which months were included in the annual projection changes for each park.

The 14 national parks analysed in the study draw a combined total of approximately 30 million recreational visits each year, which is equal to approximately 47% of total recreational visitation across all 58 national parks in the US. Although the smallest change scenario overall projects only 691,483 additional visits to these 14 parks by the 2020s, the largest change scenario for the 2080s projects in excess of five million more visits each year. Such a significant potential increase in visitation could have far-reaching consequences for park management, particularly for those parks that could gain a disproportionately high number of these additional visits. For parks where the busiest visitation time occurs in the summer, a possible increase in visitation in the spring and fall seasons could lead to the need for an extended period where all facilities remain open and available for public use. Parks projected to experience a decrease in the number of people visiting could also face management challenges in the years to come, particularly where a parallel decrease in revenue is realized.

Table 8 - Projected Changes in Annual Park Visitation under Climate Change

National Park[1]	1961-90 Average	HADCM3 B21 2020s	HADCM3 B21 2050s	HADCM3 B21 2080s	CSIROMK2B A11 2020s	CSIROMK2B A11 2050s	CSIROMK2B A11 2080s
Denali[a]	367,288	+0.3%	+0.5%	+0.7%	+0.9%	+1.7%	+2.6%
Glacier Bay[b]	381,797	-0.9%	-0.6%	-3.8%	-7.0%	-11.9%	-15.1%
		NCARPCM B21 2020s	**NCARPCM B21 2050s**	**NCARPCM B21 2080s**	**CCSRNIES A11 2020s**	**CCSRNIES A11 2050s**	**CCSRNIES A11 2080s**
Olympic[c]	3,316,735	+4.2%	+6.0%	+7.9%	+4.2%	+17.5%	+28.9%
Yosemite[d]	3,701,050	+1.9%	+2.7%	+3.4%	+4.0%	+8.8%	+12.0%
Channel Islands[e]	555,881	-0.3%	-0.4%	-0.4%	-0.5%	-1.2%	-1.6%
Grand Teton[f]	2,653,002	+0.4%	+0.6%	+0.8%	+0.9%	+2.0%	+2.7%
Rocky Mountain[g]	2,807,067	+5.6%	+7.4%	+10.5%	+16.1%	+36.5%	+47.0%
Mesa Verde[h]	594,360	-1.2%	-1.6%	-2.2%	-3.6%	-7.2%	-9.2%
Saguaro[i]	743,956	-2.8%	-4.0%	-5.1%	-5.8%	-11.9%	-15.7%
Hot Springs[j]	1,431,349	+2.0%	+3.0%	+3.9%	+3.9%	+8.8%	+9.6%
Cuyahoga Valley[k]	3,316,060	+2.7%	+4.0%	+6.1%	+8.3%	+16.8%	+22.4%
Acadia[l]	2,577,782	+3.8%	+5.9%	+7.3%	+6.4%	+13.5%	+17.6%
Great Smoky Mountains[m]	9,547,420	+1.6%	+2.4%	+3.3%	+5.1%	+11.2%	+14.7%
Everglades[n]	1,091,067	-1.8%	-2.9%	-3.7%	-2.9%	-6.0%	-8.1%
Total visitation	**33,084,814**	**33,776,297**	**34,093,543**	**34,450,284**	**34,703,869**	**36,922,098**	**38,298,770**
% change in visitation		**+2.1%**	**+3.0%**	**+4.1%**	**+4.9%**	**+11.6%**	**+15.8%**

1) Months for which visitation changes were projected: a – Jan, Feb, Apr, Aug, Oct-Dec; b – May, Jul-Sep; c – Apr-Jun, Sep; d – Jan-Mar, May-Jul, Sep-Dec; e – Jan-Jun, Sep-Nov; f – Apr, May, Oct; g – Jan-Apr, Jun-Dec; h – Jan-Apr, Jul, Nov, Dec; i – Apr, May, Jul, Sep, Oct; j – Jan, Mar, Apr, Aug-Dec; k – Mar-Jun, Oct, Nov; l – Apr, Jun-Aug, Oct, Nov; m – Jan-Jun, Aug, Sep, Nov; n – Mar-May, Oct-Dec

6 Discussion

6.1 Climate Change Impacts on US National Parks

This study projected future visitation patterns in US national parks based on direct climate changes. It did not examine the impacts of climate change induced biophysical changes on visitation. Because each national park is unique according to the biophysical resources it contains, and the range of recreation activities that can be enjoyed there, climate change will impact each park differently, thereby having disparate influences on visitation. This section explores how visitation patterns may be altered in US national parks through changes in recreation seasons both as a direct result of climate change and through the alteration of the biophysical resources present and the recreational opportunities available at each park. This discussion is based on previous studies of tourist reactions to similar changes in locations around the world, as summarized in the literature review. Only the biophysical changes most relevant to each park, and therefore most likely to have the biggest influences on visitation, are considered. The section begins with a general discussion of how both direct climate changes and major biophysical changes across the national park system resulting from climate change may impact visitation, followed by a discussion of each park individually based on its specific recreation attributes. The results of the climate-visitation analysis are integrated into the discussion to see where the projections are supported and where they may not prove correct.

Amongst the more obvious direct impacts brought about by a changing climate are changes to the temperature and precipitation patterns of a region. Since the study used mean maximum or mean minimum temperature data according to the strength of the climate-visitation regression model for each park, only the effects of temperature changes on visitation are discussed in this section. It is important to remember when discussing climate change impacts for each park that there is variability around the maximum and minimum temperatures used in the analysis, since the monthly mean was used for each. Thus, the highest and lowest baseline and projected temperatures provided in the study will not be the absolute highest and lowest temperature values observed at each park in future years.

As the climate warms and higher temperatures are generally experienced year-round across the US, at parks where the peak in visitation occurs in the summer months, high levels of visitation may become extended into the shoulder months of the spring and fall as the warm-weather recreation season is also extended. At parks where temperatures come close to or already reach uncomfortable highs in the summer months, an increasing occurrence of extreme temperatures may result in fewer visits since it could become too hot for guests to comfortably participate in various forms of outdoor recreation. For instance, Scott *et al.* (In review) found that the preferred temperature for beach tourism was 25-28°C, while for mountain environments, 15-26°C was preferred. Temperatures warmer than the upper limit of these ranges could be considered uncomfortably high by some tourists. In some instances, temperatures may soar high enough in the summer months that health risks from heat stroke and associated problems may deter people from visiting, particularly if extreme high temperatures persist and become the norm. This is particularly the case for those who use tent camping accommodations, as a retreat to an air-conditioned environment is not feasible.

Apart from direct changes to temperature as a result of climate change, indirect impacts on the biophysical resources present in national parks and other protected areas can also influence tourism. It is prudent when discussing these impacts to recognize that changes to the presence or distribution of one plant or animal species or natural feature could begin a chain reaction that may impact every other element of the natural system linked to it. This means that even if there are no projected impacts specifically to a species as a result of climate change, it may still be affected indirectly. These biophysical changes in turn affect the resources available for human outdoor recreation, which influences both the volume and pattern of visitation at each national park.

Other factors influencing visitation to national parks, such as population growth, energy prices, and economic fluctuations that were not accounted for in this study may work to either increase or decrease visitation. As demonstrated by Jones and Scott (2006a; 2006b) in two separate Canadian studies, projected increases in population are likely to act synergistically with climate change by further increasing protected area visitation. No other studies have been conducted to date on the affects of climate change combined with other factors on national park visitation, which makes it currently impossible to suggest conclusions for similar results for this study.

The recreation attributes and possible changes to the climate and the related impacts on park resources are discussed on an individual park basis in the following subsections. The most popular outdoor recreation activities at each park are summarized in Table 9. Although hot springs baths at Hot Springs National Park occur inside bathhouses, they are dependent on the natural resource of the hot springs, which is why this activity is included in the table.

6.2 Alaska Region

6.2.1 Denali National Park

Denali National Park is located slightly south of central Alaska, and is home to the tallest peak in North America, Mount McKinley (NPS 2006e). The Alaska Mountain Range runs through the park, and supports a number of glaciers and glacial streams and rivers at high elevations. Further down the mountain slopes and in the valleys are mixed forests of spruce, aspen, and birch (NPS 2006e). Mean monthly maximum

Table 9 – Most Popular Recreation Activities at Each National Park in the Study

Recreation Activity	National Park						
	Denali	Glacier Bay	Olympic	Yosemite	Channel Islands	Grand Teton	Rocky Mountain
Hiking	•	•	•	•		•	•
Backpacking	•	•	•				
Guided trips		•				•	
Camping			•	•		•	•
Cycling	•					•	•
Horseback riding						•	•
Wildlife-viewing	•	•				•	
Scenic drives			•	•		•	•
Golf							
Mountaineering	•	•					•
Rock climbing				•			•
Viewing cliff dwellings							
Scenic railroad rides							
Attend a concert							
Hot springs baths							
Swimming							
Fishing	•	•	•		•	•	•
Boating					•	•	•
Kayaking		•			•		
Canoeing							
Rafting		•					
Scuba diving					•		
Snorkeling					•		
Surfing					•		
Alpine skiing				•			
Cross-country skiing	•			•		•	•
Snowshoeing	•					•	•
Snowmobiling	•						
Icefishing							
Sledding							•
Skating							
Dog-mushing	•						

Table 9 continued – Most Popular Recreation Activities at Each National Park in the Study

Recreation Activity	National Park						
	Mesa Verde	Saguaro	Hot Springs	Cuyahoga Valley	Acadia	Great Smoky Mountains	Everglades
Hiking	•	•	•	•	•	•	•
Backpacking		•					
Guided trips							
Camping	•	•	•		•	•	•
Cycling		•		•	•	•	
Horseback riding					•	•	
Wildlife-viewing	•					•	
Scenic drives			•		•	•	
Golf				•			
Mountaineering							
Mountain climbing					•		
Viewing cliff dwellings	•						
Scenic railroad rides				•			
Attend a concert				•			
Hot springs baths			•				
Swimming					•		
Fishing					•	•	•
Boating					•		•
Kayaking							•
Canoeing							•
Rafting							
Scuba diving							
Snorkeling							
Surfing							
Alpine skiing				•			
Cross-country skiing				•	•		
Snowshoeing				•	•		
Snowmobiling					•		
Icefishing				•	•		
Sledding				•			
Skating				•			
Dog-mushing							

Sources of information: (NPS 2006e, 2006g, 2006n, 2006q, 2006c, 2006h, 2006o, 2006k, 2006p, 2006j, 2006d, 2006a, 2006i, 2006f) baseline temperatures range from -7°C in January to 20°C in July. This climate is suitable for a wide range of wildlife species, including moose, caribou, Dall sheep, wolves, and grizzly bears, in addition to 34 other mammalian species (NPS 2006e). Vegetation at Denali is unique to North America, containing a number of species of plants that originated in northeastern Asia and traveled to Alaska during periodic ice ages, but did not advance further into North America (NPS 2006e).

Although open year round, the main tourism season at this park runs from early May to mid-September, with few recreational visits occurring in the winter months (NPS 2006e). Due to its remote location apart from the main continental states of the US, access to Denali is more limited than other parks. An additional constraint to visitation is the fact that permanent human settlements in Alaska are significantly fewer and smaller than in the continental US, which limits the number of local visits to this park year-round.

Under a warmer climate, visitation at Denali is projected to increase slightly in the low season of October through April, with the largest increase occurring in the month of April. Visitation changes were not projected for March, May through July, or September. Warmer winters may cause glaciers to melt in the Alaska Range, which would eventually reduce the water supply to high elevation streams and rivers in the park. The loss of these natural features may deter some people from visiting, while potentially improved access to hiking and climbing routes may attract others to the park. Mean maximum temperatures are still projected to remain below the freezing mark for the entire months of January and December, so winter recreation activities requiring snow cover will likely still be plausible. However, the winter recreation season may be shortened as November and February reach above-freezing maximum temperatures under the larger climate change scenario. Warmer maximum temperatures in the winter months may be an incentive for some people to visit Denali, simply because it may be more comfortable than intensely cold conditions for outdoor recreation pursuits.

It is unlikely that the visible wildlife composition of the park will be altered drastically under projected climate changes, since many of the species (such as moose and grizzly bears) also exist in warmer locations further to the south, and thus will not likely relocate further north with warmer temperatures. Plants and trees may migrate within the park to more suitable microclimates, with some moving higher in elevation up the mountain slopes to where cooler temperatures are dominant. The summer months at Denali are not projected to become intensely hot, so severe drought is unlikely to become a major concern. Warmer temperatures in the spring and fall months may help to extend the warm weather recreation season in the park, as evidenced by the major increases in visits projected for the month of April.

6.2.2 Glacier Bay National Park

Located south of Denali, and along the coast of the Pacific Ocean in the Gulf of Alaska, is Glacier Bay National Park. Glaciers in the Fairweather Mountain Range are one of the main attractions at this park, in addition to the steep peaks and deep valleys carved from past glaciers (NPS 2006g). Mean monthly maximum baseline temperatures at Glacier Bay range from 0°C in January to 15°C in August. Icebergs that float in the bay usually last for a week or more, and are also attractions for tourists, particularly when they are utilized as perches by wildlife such as bald eagles and seals (NPS 2006g). Many species of marine wildlife can be spotted in the bay, including humpback, minke, and killer whales, as well as porpoises, sea lions and otters (NPS 2006g). Some of the terrestrial animals in the park include moose, bears, mountain goats, wolves, and beavers (NPS 2006g). In terms of plant life, nearly all communities have been established within the past 300 years, following the retreat of glaciers, with the newest communities currently located closest to existing glaciers (NPS 2006g). Mosses, lichens, wildflowers, and heath cover the mountain slopes, while near the mouth of the bay, and farthest from the glaciers, is a lush spruce and hemlock rainforest (NPS 2006g).

Similar to Denali, the remote location of Glacier Bay National Park limits access to the park, and this problem is further compounded by a complete lack of roads leading into it, making access possible only by boat or by plane (NPS 2006g). Most visitors arrive on large cruise ships, since many cruise lines touring southeast Alaska include a day in their itineraries to tour around the waters of Glacier Bay (NPS 2006g). However, these boats do not actually dock at the park; instead, they keep visitors onboard for the duration of the visit (NPS 2006g). Park rangers board cruise ships and other tour boats to inform onboard guests of the features and activities available to visitors at Glacier Bay National Park (NPS 2006g).

Visitation at Glacier Bay National Park is projected to decrease during the most heavily visited warmer months of May, and July through September (projections were not made for June or the cooler months of October through April, when visitation is low). Since the majority of visitors to this park arrive on cruise ships and remain on the boats to tour around the bay and view marine life and glacial features, warmer temperatures that may threaten the presence of these attractions, which could result in fewer visits. For instance, glaciers and icebergs are major natural attractions at this park that could disappear over the next few decades under a warmer climate. Aquatic life, particularly whales, which are likely a major draw for tourists, may be sensitive to warmer water temperatures in the bay in the future (either directly or through a lack of a reliable food source as the marine ecosystem changes), and cease to return to the bay when the water becomes too warm. Without these major attractions, Glacier Bay may lose its appeal to cruise ship operators, resulting in fewer ships, and thus fewer visitors, entering the park. Other biophysical changes will likely occur in the terrestrial environment of the park similar to those described for Denali National Park, but these changes will probably have less influence on visitation levels since the majority of visitors remain on boats.

6.3 Pacific West Region

6.3.1 Olympic National Park

Located in the northwestern continental US along the Pacific Ocean, Olympic National Park contains glaciated mountains, 117 kilometres (73 miles) of coastline, and extensive rainforest cover (NPS 2006n). Mean monthly minimum baseline temperatures vary by less than 10°C annually, with the coldest month being January, at 1°C, and the warmest month being August, at 10°C. The Pacific Ocean is home to many species of aquatic life, including whales, dolphins, sea lions, seals, and otters, many of which can be seen close to the shoreline of the park (NPS 2006n). Cougars, bears, and elk live further inland, and salmon abound in the many streams originating in the park that lead to the sea (NPS 2006n). Old growth forest provides rare habitat for some endangered species of animals, as well as various amphibious creatures and birds (NPS 2006n). On the Olympic peninsula where the park is located, endemic species can be found that exist nowhere else in the world, such as the Olympic torrent salamander (NPS 2006n). There is a large diversity of plant species in Olympic National Park as a result of the varied terrain and many microclimates it creates, including high elevation mountain environments, lowland temperate rainforests in the western sections of the park, and dry oak savannah to the northeast of the mountains (NPS 2006n).

Between April and June, and in September of each year, the number of visits at Olympic National Park is projected to rise. Visitation projections were not made for the remaining months of the year. It appears that warmer temperatures in the spring and fall seasons that are more conducive to warm-weather recreation activities may extend the peak summer tourism season. Not reflected in these projections is the potential for increased red tide blooms to occur as sea temperatures rise, similar to those expected to occur along the Canadian Pacific seashore (Scott and Suffling 2000). This would limit the ability of visitors to participate in beach activities in the summer months, and possibly result in fewer visits. Sea level rise would also decrease the area of beachfront available for tourists to enjoy, and fewer wildflowers may bloom as the meadows of Olympic are taken over by subalpine fir forests under warmer conditions (Saunders *et al.* 2006), possibly attracting fewer hikers in the spring through fall months. Also, under a warmer climate, the streams that provide habitat and spawning grounds for salmon and other fish may become too warm, which could lead to local extinctions of some species, and ultimately affect angling opportunities. An increase in drought conditions and the frequency and size of forest fires is projected to occur in the Pacific Northwest (Fagre *et al.* 2003; Whitlock *et al.* 2003), which could lead to hazardous and unattractive conditions for tourism. The disappearance of already retreating glaciers in the mountains (Saunders *et al.* 2006) could become a drawback for potential visitors in the future, but it appears that these are not the major attraction for visitors to Olympic, so the influence of glacial loss on visitation may be minimal.

6.3.2 Yosemite National Park

The enormous valley named Yosemite is the most obvious attraction for visitors to Yosemite National Park, with spectacular views from a number of vistas (NPS 2006q). Within the valley are numerous waterfalls fed by melting snow, including the majestic Yosemite Falls, which runs dry in the summer months when the snow is gone (NPS 2006q). Lakes are not easily accessible in the park, but there are streams running through the valleys that are easier for visitors to access (NPS 2006q). Mean monthly maximum baseline temperatures at this park range from 9°C in December to 32°C in August. Larger species of wildlife, including bears and coyotes, are usually difficult to find in the park, although deer and birds are more commonly spotted (NPS 2006q). Wildflowers grow in abundance in the spring, and can been seen along roadsides, though they are more common higher up the mountain slopes in the warmer summer months (NPS 2006q). There are three groves of massive sequoia trees in the park, all of which are ancient, and attract visitors mostly in the spring through fall seasons (NPS 2006q). The rest of the trees in the park are predominantly evergreen varieties, which do not display fall colours as do deciduous trees, and are therefore not a distinct source of attraction for tourism in the fall months (NPS 2006q).

Possibly the largest impact of a warmer climate in Yosemite National Park that would affect visitation would be changes to snowfall accumulations and snow cover during the winter months. The ongoing retreat of glaciers and a projection of less snowfall could also leave mountain tops bare in the milder months (Saunders *et al.* 2006). Visitation is projected to increase by a small to moderate amount for every month of the year at Yosemite, with the exceptions of April and August for which projections were not made, and July, where a minor decrease is projected to occur. If snowfall increases, waterfalls would rush more violently over cliffs, and the ski area of the park would benefit, both of which may attract more visitors. If snowfall decreases, as is more likely under a warmer climate, it may be possible to keep park roads open for longer periods of time throughout the year, thereby improving access to various areas of the park for walking, hiking, and touring activities in personal vehicles. In either scenario, the park could benefit from improved opportunities for warm or cold weather recreation activities, potentially leading to more visits.

In the month of July, where visitation is projected to decline slightly, it may be influenced by excessively high temperatures, which could reach 37°C as soon as the 2050s under the larger climate change scenario used in the study. Temperatures this high could be hazardous to the personal health of visitors, particularly those planning to participate in intensive recreation activities such as hiking or climbing. Warmer temperatures would also be detrimental to wildflower growth, possibly deterring visitors from taking scenic drives or hiking into the higher elevations of the park to view them.

6.3.3 Channel Islands National Park

Made up of five individual islands off the southwestern coast of California, Channel Islands National Park contains sea caves, beaches, a wide diversity of sea life, and many species of terrestrial plants and animals, approximately 145 of which are endemic (NPS 2006c). Kelp forests growing in the sheltered areas between the islands are home to many species of young fish and smaller sea creatures such as sea urchins, juvenile lobsters, and sea cucumbers (NPS 2006c). The mixing of cooler water currents from the north with warmer ones from the south creates habitat for both warm and cool water aquatic life (NPS 2006c). Seals and sea lions reside offshore, and blue and grey whales pass by the park on their annual migration routes up and down the west coast of North America, drawing visitors to partake in seasonal whale-watching tours (NPS 2006c). The Mediterranean climate of Channel Islands National Park experiences little annual variation in temperature, with mean monthly maximum baseline temperatures fluctuating between 18°C in December and January, and 25°C in August.

Overall visitation at Channel Islands National Park is projected to decline slightly in the future, with moderate increases in the months of January, February, and September through November being outweighed by decreases in March through June.

Future visitation for July, August, and December was not projected. Declining visitation throughout the spring season could be linked to a projected increase in red tide blooms along the coast of the Pacific Ocean as sea temperatures rise (Scott and Suffling 2000), which could limit recreational activity in the waters surrounding the islands. Also, if a warmer future climate changes ocean currents in and around Channel Islands National Park, the existing diverse array of aquatic life could suffer, potentially attracting fewer divers and snorkelers. Rising water levels could also threaten some of the existing aquatic environments surrounding the islands, and decrease the terrestrial area of the park (Saunders *et al.* 2006). Temperatures in the summer months may become uncomfortably hot for some activities, particularly hiking. Conversely, boaters and beachgoers may enjoy warmer temperatures, attracting more visitors wishing to participate in these activities.

6.4 Intermountain Region

6.4.1 Grand Teton National Park

Located in northwestern Wyoming, just south of Yellowstone, is Grand Teton National Park. Encompassing the Teton Mountain Range, which still contains glaciers, along with freshwater lakes and ponds, forests, and wetland areas, the terrain of this park is diverse (NPS 2006h). With mean monthly maximum baseline temperatures ranging from a low of 0°C in January to a high of 25°C in July, four distinct habitats exist in the park, including alpine, coniferous forest, sagebrush flats, and wetlands. These habitats are suitable for animals such as bald and golden eagles, black bears, bison, pronghorn antelope, and moose (NPS 2006h). The rivers and lakes of the park teem with various species of fish, including trout, which attract numerous anglers each year (NPS 2006h). Most of the trees growing in Grand Teton are coniferous, although there are pockets of deciduous species, including aspens, poplars, and willows (NPS 2006h). Wildflowers are abundant in the spring through summer months, with rapid changes in the species that bloom throughout the warm season (NPS 2006h).

Grand Teton National Park currently experiences approximately 60 frost-free days each year (NPS 2006h). Under a warmer climate, the number of frost-free days may increase, thereby lengthening the warm-weather recreation season in the park, and attracting more visitors in the late spring and early fall months. This possibility is reflected in the fact that visitation at the park is projected to increase slightly in the months of April, May, and October, for which projections were made. Future visitation was not projected for any other months of the year. The peaks of the mountains are projected to remain bare in future summer seasons with warmer temperatures and less snowfall (Saunders *et al.* 2006), detracting from the majestic beauty of this park. Increased wildfire activity (Saunders *et al.* 2006) could also result in fewer visits in the summer. Nevertheless, given the wide array of possible warm-weather recreation activities at this park, if climate change in any way threatens the ability of visitors to partake in one type of activity, the potential loss in visitation as a result may be compensated by increased participation in other activities. The winter season experiences the lowest visitation all year, and if it is shortened under a warmer climate so that winter recreation enthusiasts decline in numbers, increased visitation in the shoulder months with more warm-weather recreationists would likely compensate.

6.4.2 Rocky Mountain National Park

Similar to Grand Teton, Rocky Mountain National Park is situated in a mountainous environment, where freshwater lakes and streams abound, and forests and wetland areas provide habitat for a wide variety of plant and animal species (NPS 2006o). Mean monthly maximum baseline temperatures at Rocky Mountain are also similar to its neighbour to the north, although winters are a little warmer, with the low hitting

-1°C in January, and a high of 24°C in July (NPS 2006o). Wildlife species residing at Grand Teton include larger mammals such as cougars, black bears, moose, bighorn sheep, and elk (NPS 2006o). Grizzly bears, gray wolves, and bison were once native to the area, but have been extirpated, and the native lynx and wolverine are either very rare or also extinct from the region (NPS 2006o). White-tailed ptarmigans, pikas, and mountain yellow-legged frogs are now threatened with extinction from the park as temperatures rise and their natural habitats are lost (Saunders *et al.* 2006). Populations of elk, on the other hand, are expected to increase by 50-100% as winters become milder, which could create imbalances in the park's ecosystem structure (Wang *et al.* 2002). Fish residing in the many lakes and streams are dominated by various trout species, and suckers, sculpin, and dace (NPS 2006o). The many species of birds found in the park also make it popular with birdwatchers (NPS 2006o).

Increases in visitation are projected for every month of the year at Rocky Mountain as the climate warms, with the sole exception being May, for which projections were not made. The biggest increases could be seen in the warmest season, from June through to September, which is also the current peak time for visits year-round. Even under the largest climate change scenario, the hottest month is only projected to reach 32°C by the 2080s, which may become too warm for some visitors participating in more intensive activities like hiking and climbing, but may still be comfortable for other activities like boating and camping. Not accounted for in the projections is the risk to visitors from increased wildfire activity sparked by lightening (Saunders *et al.* 2006). The distinctive alpine tundra environment found in the higher elevations of the park could also be lost in future as warmer temperatures allow trees and other plants to invade (Saunders *et al.* 2006), possibly discouraging some people from taking scenic drives in the milder months. Warmer winter temperatures, on the other hand, would allow visitors to hike in areas with little or no snow cover, and take scenic drives on roads free of snow and ice, while areas of the park with sufficient snow cover could still be suitable for cross-country skiing and snowshoeing. Risk of avalanches is already often high in some areas of the park due to the steep slopes of the mountains and the high winds affecting them, which occasionally limits winter activities (NPS 2006o). As snow possibly ceases to remain on the mountain tops during future summer months (Saunders *et al.* 2006) and permafrost zones in the Colorado Front Range shrink, the slopes could become even less stable, increasing the risk of debris flows and rockslides during the warmer months as well as in winter (Janke 2005), which could also limit some recreation activities.

6.4.3 Mesa Verde National Park

In southwestern Colorado is Mesa Verde National Park, where the main attraction is the large number of preserved archaeological sites of past human settlements (NPS 2006k). Mean monthly maximum baseline temperatures at Mesa Verde remain above freezing year-round, with the low hitting 4°C in January, and the hottest month being July, at 31°C.

Overall visitation at Mesa Verde National Park is projected to decline by a small amount in the future as the climate warms. All of the decreases are projected to occur in July (although future visitation was not projected for the months of May, June, and August through October), when temperatures may become uncomfortably hot for visitors to participate in hikes (minimum temperatures are used in the analysis; thus, higher temperatures than those shown in Appendix F will actually be experienced). Countering this decline is a projected increase in the number of visits in the cooler months of November through to April, when warmer temperatures will be more conducive to warm-weather recreation activities. Ongoing drought conditions and high temperatures in the summer months caused the loss of approximately 90% of piñon pine trees in parts of Mesa Verde between 2002 and 2003 (Saunders *et al.* 2006). If these conditions continue, more species could be destroyed, and the park could lose some its scenic beauty, possibly resulting in fewer visits. The risk of wildfire at this park is increasing as fire-prone plant species invade, which further reduces the natural scenery (Saunders *et al.* 2006). It is also possible that as the climate warms, snowfalls may become less frequent at Mesa Verde, and eventually cease altogether. A total lack of snow would allow only warm-weather recreation activities to occur in the park, with visitors likely coming more often at times when the heat is not uncomfortable or hazardous to their health (*i.e.*, fall through spring).

6.4.4 Saguaro National Park

Saguaro National Park is located in southeastern Arizona, and is divided into two distinct districts on the east and west sides of the city of Tucson (NPS 2006p). The Tucson Mountain District to the west contains the Avra Valley and some scenic overlooks, in addition to ancient petroglyphs (NPS 2006p). To the east is the Rincon Mountain District, where there are trails that visitors can drive or bike along, and a backcountry wilderness area with an historic cabin (NPS 2006p). The climate is mild to hot year-round at Saguaro, with mean monthly minimum baseline temperatures of between 4°C in January and 24°C in July. The arid desert environment provides habitat for the enormous cactus plant for which the park is named, the Saguaro (NPS 2006p). Birds and insects, along with a wide variety of plants, can be spotted in the cactus forest (NPS 2006p). Other animals are more difficult to locate since they are mostly nocturnal and avoid the extreme heat of day, and include coyotes, desert tortoises, and javelinas (these animals resemble small pigs in appearance, but are actually in the peccary family) (NPS 2006p).

Overall, institutional seasonality (*i.e.*, higher visitation in the summer with school and work vacations) appears to be less influential than climate at Saguaro, since the lowest visitation actually occurs in the summer months at this park. Most people choose to visit Saguaro during the milder months of late fall to early spring, thereby avoiding the extreme high temperatures of the summer that can make participation in recreation activities uncomfortable or dangerous health-wise (NPS 2006p). Overall visitation at Saguaro is projected to decrease under climate change, with all of these decreases occurring between April and October (June and August are excluded from the projections). The cooler months of November to March were not included in the visitation projection analysis, and may in fact demonstrate an opposite trend in future that could help to balance the projected decreases in the warmer months. These months are already the slowest time of year in terms of the number of visits due to very high temperatures, and as temperatures continue to climb in the future, even fewer visits could occur during this period (minimum temperatures are used in the analysis; thus, higher temperatures than those shown in Appendix F will actually be experienced). Particularly in the summer months, increased risk of wildfire at Saguaro threatens the continued presence of the park's namesake cacti (Saunders *et al.* 2006), which is one of the main attractions for visitors.

6.5 Midwest Region

6.5.1 Hot Springs National Park

Located in Arkansas, Hot Springs National Park surrounds the north end of the city of Hot Springs (NPS 2006j). The forested mountains in the park help to maintain the hydrologic system that feeds the hot springs (NPS 2006j). Mean monthly maximum baseline temperatures at Hot Springs are mild to hot year-round, ranging from 10°C in January to 34°C in July. These conditions provide suitable habitat for a number of bird species, including herons, owls, eagles, and a large number of songbirds (NPS 2006j). Amphibious creatures are also abundant in the park, including various species of salamanders, toads, and frogs, such as the green tree frog (NPS 2006j). Resident mammals are mostly small in size, and there are no game fish in the small creeks running through the park (NPS 2006j). Additionally, no threatened or endangered species have been reported in the park (NPS 2006j). Oak, hickory, and pine trees are dominant in the forests, in addition to other species of both coniferous and deciduous trees, the latter of which change colour in the fall season, attracting many visitors (NPS 2006j). Wildflowers also grow in the spring and summer months (NPS 2006j).

Overall, a slight increase in visitation is projected for Hot Springs National Park for the months for which projections were made. February, and the warmer months of May to July were not included in the projections. Visits in August are projected to increase until the temperature hits approximately 37°C, after which they will likely begin to decrease by a small amount. The most strenuous common recreation activity that visitors can participate in at Hot Springs is a hike on one of the many marked trails, which is likely why higher temperatures under climate change may not deter most people from visiting this park. The coolest temperatures of the winter months will likely become warmer, which may be more comfortable for a number of potential visitors participating in outdoor recreation activities, thereby increasing visitation from the late fall to early spring. Warmer fall temperatures may also encourage an increasing number of visitors to walk through the forests to take in the changing colours of the leaves.

6.5.2 Cuyahoga Valley National Park

Cuyahoga Valley National Park is located south of Lake Erie in northern Ohio. The Cuyahoga River is the central natural feature in the park, running from north to south

(NPS 2006d). Though its water quality has improved from the highest levels of pollution it once contained, contaminants still enter the river in runoff from urban and agricultural sites nearby and existing within the park itself, continuing to threaten its quality and make it unsafe for human recreation (NPS 2006d). The park also contains wetland areas and multiple streams and rivers that run down the steep valley walls and feed the Cuyahoga River (NPS 2006d). Waterfalls are abundant in the park, with the highest being the 20 metre (65 foot) Brandywine Falls (NPS 2006d). Cuyahoga Valley National Park incorporates lands that were previously used for human settlement and development, including such activities as agriculture, mining, dumping, and industrial activities (NPS 2006d). Some of these activities continue inside the boundaries of the park today, and areas that are no longer used for these purposes are in the process of recovering their natural functions and processes, with the occasional help of park staff (NPS 2006d).

A wide range of mean monthly maximum baseline temperatures are experienced annually at Cuyahoga Valley National Park, from 0°C in January to 28°C in July. Residential areas, golf courses, ski areas, and low levels of agricultural activity all continue within the boundaries of the park (NPS 2006d). Mostly deciduous with some conifers, the mixed forests of Cuyahoga Valley are composed primarily of oak, hickory, beech, maple, sycamore, hemlock, pine, and spruce, and are spread throughout the park, in between patches of developed land (NPS 2006d). The leaves of these forests change colours in the fall months, creating wonderful displays for visitors. Wildlife present in the park include deer, beavers, painted turtles, coyotes, and many fish and bird species, including bald eagles, wild turkeys and great blue herons (NPS 2006d). Since the park is located in close proximity to the two major cities of Cleveland and Akron, it is readily accessible by road, and local residents can easily make day trips to Cuyahoga Valley. Interestingly, there is no charge to visitors entering or using the facilities at Cuyahoga Valley National Park, other than fees for attending special events such as concerts and other programs (NPS 2006d).

As a result of climate change, spring and fall visitation (March to June, and October to November) at Cuyahoga Valley is projected to increase up to 22% under the highest change scenario by the 2080s, reflecting a lengthening of the warm-weather recreation season. Future visitation for the winter and summer months was not projected. October currently experiences the second-highest monthly visitation year-round after that of June through August, and an increase in future visits during this month may be substantial enough to shift the peak visitation season at this park.

There are a few possible reasons why October is a popular month for visitation at Cuyahoga Valley. First, this is the prime time for visitors to enjoy the changing colours of the deciduous forests. Second, there may be abundant numbers of Monarch butterflies in the park at this time, where they stop over for a rest on their annual migration to Mexico (although this migration begins in September (NPS 2006d), it may linger into October). Additionally, November is the month when bald eagles can be seen in the skies acting out their annual courtship rituals (NPS 2006d). Some of this activity may begin earlier, which could be an attraction for visitors in October.

6.6 Northeast Region

6.6.1 Acadia National Park

Acadia National Park is located in the northeast corner of the US, on the coast of the Atlantic Ocean in Maine. A wide variety of natural landscapes and features exist within the boundaries of the park, including ocean coastline, where the beaches are mostly cobble, with the exception of one sandy beach; both northern boreal and eastern deciduous forests; wetlands and freshwater lakes; and islands, one of which has mountainous terrain (NPS 2006a). There is no single feature that the park was established to protect; rather, it was created to preserve the diversity of landscapes within its boundaries (NPS 2006a).

Mean monthly maximum baseline temperatures at Acadia range from a low of 0°C in January to a high of 26°C in July. The wide variety of climatic conditions experienced at this park cover four distinct seasons, and support peregrine falcons, osprey, bald eagles, and many species of sea and song birds, as well as freshwater fish species that are favourites of anglers, and amphibious creatures including salamanders and frogs (NPS 2006a). Plant life is very diverse at Acadia, with over 1,100 species of vascular plants growing between sea level and sub-alpine elevations where conditions are too harsh for most trees to survive (NPS 2006a).

Overall visitation to Acadia is projected to increase slightly to moderately under a warmer climate for the months of April, and June through August, and decrease in October and November. Future visitation for the winter months of December through February, and for the months of March, May, and September, was not projected. Warmer temperatures may draw more beach tourism to this coastal park in the summer months, where visitors can participate in ocean and lake activities such as swimming and boating. However, sea level rise, increased precipitation, flooding, and coastal storm activity, and lower water quality are possible future problems at Acadia, similar to those projected for the Chesapeake Bay region further down the coast (USEPA 2001a). Since extreme hot temperatures are not projected to occur at Acadia, even as far into the future as the 2080s (the hottest projected mean maximum temperature is 32.5°C in July under the highest change scenario), visitors could also continue to partake comfortably and safely in other warm-weather recreation activities such as hiking and climbing. It is unclear why visitation in the fall months of October and November may decline with warmer temperatures, since warm-weather recreation activities would benefit from such a change in climate, although two possible biophysical changes may have an influence. The timing of the leaves of the deciduous forests changing colours may be delayed, and warmer water temperatures later into the fall season may make fishing for certain species less productive, both of which may lead to fewer visits.

6.7 Southeast Region

6.7.1 Great Smoky Mountains National Park

Located amongst the Southern Appalachian Mountains, which form the divide between Tennessee and South Carolina, is Great Smoky Mountains National Park (NPS 2006i). The mountains create countless opportunities for panoramic views of the scenery below, while numerous waterfalls and creeks, and expansive forests are part of pristine environments for outdoor recreation (NPS 2006i). The climate is mild most of the year, with the summer season being the hottest. Mean monthly maximum baseline temperatures at Great Smoky Mountains range from 8°C in January to 29°C in July. With more than 10,000 identified species of plants and animals, this park has the highest diversity of species of any area in the temperate zone worldwide (NPS 2006i). Of the scores of animal species residing in the park, which include birds, fish, amphibians, and mammals, the black bear is the most popularly sought-after for sightings by visitors (NPS 2006i). In the cooler climate of the high elevations of the mountains, a number of species live well beyond their primary southern range, such as the northern flying squirrel and numerous bird species (NPS 2006i). The varied range of microclimates provides habitat for countless plant species, including temperate rain forests at higher elevations and extensive deciduous and mixed forests that attract large numbers of visitors in the fall as their leaves change colour, with October being the most popular month for this type of tourism (NPS 2006i). Improved air quality in the fall months may also be a factor attracting visitors during this time of year.

Great Smoky Mountains is by far the most heavily visited national park in the US, having drawn almost a quarter of all visits to all national parks combined in 2005. Visits to this park are projected to increase in number as the climate warms. With the exceptions of July, October, and December, for which visitation projections were not made, visits are projected to rise in every month of the year, with the largest increases occurring in January and February.

Although it is not reflected in the visitation projections for the park, temperatures may become too warm at Great Smoky Mountains in the summer months in the future for visitors to participate comfortably in more strenuous activities such as hiking up mountain trails. July may reach 36°C as early as the 2050s under the larger climate change scenario. Also not reflected in visitation projections is a potential decline in the number of hikers wishing to view some of the wildlife species currently living at the southernmost limit of their ranges if they are extirpated from the area under warmer conditions. Nevertheless, any loss in visitation through hiking may be made up for through more visitors partaking in other less strenuous activities. Additionally, the largest increases in visitation are projected to occur during what is now the annual low, likely due to temperatures becoming more conducive to warm-weather recreation.

6.7.2 Everglades National Park

Located on the west coast of the southern tip of Florida is Everglades National Park. Extensive wetlands cover much of the park, which was created to protect approximately one-fifth of the historic Everglades ecosystem (NPS 2006f). The climate is mild in the winter months, with mean monthly minimum baseline temperatures hitting 13°C as a low in January. June through October is the rainy season, when the highest mean minimum baseline temperature reaches 23°C in August.

The rainy season coincides with mosquito season at Everglades, as well as hurricane season, which stretches into November (NPS 2006f). The park is a sanctuary for a number of threatened and endangered species, such as various types of sea turtle, the West Indian manatee, and the Florida panther (NPS 2006f). The range of habitats created by the change in elevation from the sea to the inland areas of the park are home to many plants, including mangrove forests, fresh and salt-water grasses, cypress trees, and inland pine forests dependent on occasional lightning-induced wildfires (NPS 2006f).

Visitation at Everglades is projected to decline slightly under climate change from March through May, and October through December. Visitation projections were not made for the winter months of January and February, or for the warmer summer months of June through September. It is possible that it could become too hot and humid during the months for which projections were made for many visitors to comfortably participate in outdoor recreation pursuits, as appears to currently be the case for the summer months (minimum temperatures are used in the analysis; thus, higher temperatures than those shown in Appendix F will actually be experienced). A possibly extended and more intense hurricane season could also deter people from visiting the park at these times of year, particularly from October to December.

Another threat to the park is rising sea levels, which could submerge delicate ecosystems close to the shoreline in water with higher concentrations of salt, with dire consequences for the wildlife species that exist within and depend on them (USEPA 2001b). The effects of such a possibility on visitation to the park are not captured in the projections, and may lead to fewer overall visits.

6.8 Implications of Changes in National Park Visitation

As the national parks of the US continue to be affected by general warming and varied changes in precipitation brought about by climate change, both these direct climate changes and a wide variety of related biophysical changes have the potential to influence the number of people choosing to visit the parks, and at which times of the year. Ecological, economical, and social implications for park management resulting from visitation changes could be substantial, particularly for the parks where the most dramatic changes are projected to occur. Financially, national parks could benefit from increased visitation. Under the Recreational Fee Demonstration Program that the NPS has had in place since 1996 and made permanent in 2004, each park retains 80% of the user-fees it collects to be invested in improvements to infrastructure, and preservation and visitation services, with the remaining 20% being distributed by the NPS for special projects across the park system (NPS 2004b; United States Congress 2004). However, additional costs may also be associated with increased visitation. For instance, additional park patrols and visitor services, and increased maintenance for infrastructure such as trails, visitor centres, roadways, and campgrounds may all be necessary under heavier levels of use. Conversely, for those parks projected to attract fewer recreation visits in the future, financial resources could become more strained than they are currently, as less income would be collected from user-fees.

From a social perspective, increased volumes of visitors could lead to new or additional conflicts between groups participating in the same or different recreation activities, since many people seek peace and quiet in these protected places (Eagles 2003). This is of particular concern where the volume of visits is projected to increase at a park during the peak season, when resources are already at or close to their maximum capacity for use. Mountain parks are especially vulnerable, as the cooler temperatures experienced there could attract more visitors than to the hotter parks at lower elevations that not located along a coastline (Saunders *et al.* 2006). A new balance may have to be worked out in the future between the benefits gained in financial revenue from increased visits, and the additional burdens placed on recreational and ecological resources with higher volumes of use.

Some of the direct impacts on visitation to national parks that are brought about by climate change are inevitable, such as hazardous conditions created by tropical storms and extreme temperatures that disallow visitors from partaking in most or all outdoor recreation activities. Nonetheless, adaptation strategies can be implemented to reduce the effects of direct climate change and climate-induced biophysical changes on visitation in national parks. For instance, if one major feature of a park disappears in the future, such as the glaciers in one of the mountain parks, an interpretive program could be established to teach visitors about the landscape changes within the park in a relatively short time period, stressing the need to combat climate change (Scott 2006a). Although visitors would no longer be able to physically see the glaciers, they could still learn about them, and about the impacts of climate change. At the same time, other activities and programs could be promoted in order to draw the attention of visitors to the other natural features still present in the park. The combination of these efforts may help to buffer any decline in visitation resulting from the loss of glaciers from the park.

Thus, while climate change will continue to impact the biophysical resources present in national parks upon which outdoor recreation depends, adaptation strategies introduced by park managers may help to alleviate their impacts on the level and pattern of visitation to each park.

6.9 US National Parks as Analogues for Canada

Some of the results of this study may provide plausible analogues for national and provincial parks spread across the southern reaches of Canada. The climate change scenarios utilized were consistent between the Jones and Scott (2006a) studies of visitation changes for Canada's and Ontario's systems of national parks and this study for US national parks (*i.e.,* NCARPCM B21 and CCSRNIES A11), excluding Alaska. Results for US parks close to the Canada-US border demonstrate projected changes in visitation similar to those projected for Canadian national parks in two recent studies by Jones and Scott (2006a; 2006b). Projected changes in visitation to Canada's national parks are fairly consistent in terms of seasonality, with only increases expected, most of which will occur in the spring and fall months, although some parks will also likely host additional visits in the summer season (Jones and Scott 2006a, 2006b). For the 2020s, overall visitation increases for Canada's system of national parks of between 6% and 8% are projected, with higher projections of 9-29% for the 2050s, and 10-41% for the 2080s (Jones and Scott 2006a).

In the US, increases are also projected to occur, although they are more conservative than those in Canada. In the 2020s, system-wide visitation could increase a combined 2-5%, with higher projections of 3-12% for the 2050s, and 4-16% into the 2080s. When only the parks in the northern US are considered (*i.e.,* Olympic, Grand Teton, Cuyahoga Valley, and Acadia combined), which may be a more realistic comparison for Canada, these projections increase to 4-6% for the 2020s, 5-16% for the 2050s, and 7-23% for the 2080s. Although these projections are still slightly lower than the projections for Canada's parks, the range of impacts on visitation are consistent.

Northern parks across the US projected to experience changes in future visitation patterns similar to those in Canada include Olympic in the west, Cuyahoga Valley south of the Great Lakes, and Acadia in the east (an increase in the peak summer season is projected at this park). These parks may indicate near future changes in visits to Canada's national parks. As the climate continues to warm, weather systems and climate regions will likely continue to shift in a generally northward direction, which means that parks farther south, in the midlatitudes of the US, could serve as analogues for Canada's parks further into the future.

Visitation projections for Olympic and Channel Islands national parks could serve as analogues for coastal parks in British Columbia, including Gwaii Haanas, Pacific Rim, and Gulf Islands. Olympic National Park is projected to experience moderate to large increases in visitation in the spring season. Farther south, visitation may decline through the spring season at Channel Islands National Park under hotter temperatures, although the fall could experience a moderate increase in visits, which could indicate visitation patterns farther into the future in Canadian parks.

For the western mountain parks of Canada, Rocky Mountain national park in the US can serve as an analogue (Grand Teton does not serve well as an analogue due to the weak confidence level of its annual model). Visits to Rocky Mountain are projected to increase from the spring through the fall months. The cooler temperatures of this mountain park may make it an attractive alternative to hotter parks located at or close to ground level as annual temperatures continue to rise. A similar situation may occur in the future in the Rocky Mountains of Canada for parks such as Kootenay and Banff. Yosemite, which is located even farther south than Rocky Mountain, could serve as an analogue farther into the future. At this park there is a decline in visits projected during the hottest month of July as temperatures may become too hot for visitors to participate comfortably in outdoor recreation activities.

Cuyahoga Valley and Hot Springs national parks could serve as analogues for Canadian parks located in the interior of the country, such as Grasslands in Saskatchewan, Riding Mountain in Manitoba, and all five of the national parks in Ontario since they are all generally located in the southern parts of the province. Cuyahoga Valley may see a slight to moderate increase in visits in the spring season, and major increases in the fall, particularly in the month of October. The projected pattern is similar for Hot Springs to the south, although at this park August may become too hot, resulting in slightly fewer visits during this month, which could also eventually become the case in Canada.

Fundy National Park in New Brunswick and Cape Breton Highlands National Park in Nova Scotia could experience visitation changes similar to those projected for Acadia National Park in the US. At Acadia, visits are projected to increase during the peak summer months and decline negligibly in the fall season. Similar patterns could be observed along the east coast of Canada in the near future.

7 Conclusion

Continued climate changes may lead to changes in visitation volumes and patterns in national parks throughout the world. Using a method of single variable regression analysis of climate and visitation data, this study examined impacts of climate change on visitation in US national parks for the 2020s, the 2050s, and the 2080s under two different climate change scenarios (The Met Office Hadley Centre CM3 B21 (United Kingdom (UK)) and Commonwealth Scientific and Industrial Research Organisation MK2B A11 (Australia) climate models were used for the Alaskan parks, and the National Center for Atmospheric Research PCM B21 (United States) and Centre for Climate Systems Research NIES A11 (Japan) models were used for the contiguous states). Due to the diversity of climatic regimes across the US, the affects of climate change on visitation will not be uniform for each national park. Hence, fourteen parks were chosen to represent the major climatic regimes.

Projected changes in visitation vary greatly according the geographic location of each park, although similar patterns were observed across each park region. Parks in the northern parts of the US (*i.e.*, Olympic, Grand Teton, Cuyahoga Valley, and Acadia combined) are projected to experience increases in visitation of between 4% and 6% in the 2020s, 5% and 16% in the 2050s, and 7% and 23% in the 2080s. At parks located generally in the middle latitudes of the country, where overall visitation is projected to increase (*i.e.*, Yosemite, Rocky Mountain, Hot Springs, and Great Smoky Mountains combined), these increases are generally smaller than for their regional counterparts farther to the north (2-7% for the 2020s, 3-15% for the 2050s, and 5-19% for the 2080s), while the parks generally in the southern parts of the regions are projected to see decreases in visitation (*i.e.*, Channel Islands, Mesa Verde, Saguaro, and Everglades combined). Losses in visits to southern parks may be anywhere from 2-3% in the

2020s, 2-7% in the 2050s, and 3-9% in the 2080s. In Alaska, visitation may increase in the future during the low season of the winter months, as demonstrated by Denali, and decrease during the more heavily visited summer months, as demonstrated by Glacier Bay.

In parks where peak visitation corresponds to the warmest time of year, the warm-weather recreation season may be extended into the shoulder months of the spring and fall. In general, parks in the northern regions of the US are projected to experience higher visitation in the spring (April to June) and fall (September to November) months as temperatures become warmer in the future, and hence are more conducive to warm-weather outdoor recreation activities. If this pattern of higher visitation during the shoulder months is sustained over the long term, some parks may need to extend their operating season. Acadia National Park is the only park in the study where projected increases in visitation are expected to be highest in the summer months of July and August. Additional visits during the peak tourism season could place more strain on park resources that could already be near their maximum capacity. In general, the cold-weather recreation season dependent on snowfall could suffer in the years to come under warmer temperatures.

No consistent patterns are observed for the southern parks, where visitation is projected to decrease under climate change. Large variations in monthly and seasonal changes exist between these parks, whereby some may see increased visitation in the shoulder months while others may experience decreases, and visits may decline in the summer months at some of these parks, while at others future visitation during the summer is uncertain since it was not projected in this study. In locations where the summer season already experiences very high temperatures, even higher temperatures could lead to fewer visits. In Alaska, visitation may increase slightly during the winter months and decrease somewhat during the warmer summer season.

Significant challenges may be faced by national park and other protected areas managers in the US in the future if the visitation changes projected in this study become a reality. Perhaps the most fundamental challenge will be deciding upon a management ethos to guide decisions. The current ethos followed by the NPS is to protect the natural heritage and resources of the country as they exist currently (NPS 2006l). Such an ethos assumes a static natural environment that does and will continue to provide ideal habitat for the plant and animal species that reside in the parks, as well as for the physical resources that can be found there currently. The affects of climate change on the natural resources protected by parks are not accounted for by the NPS, which will lead to the need for managers to make decisions in the near future that may directly oppose the guiding mandates of the parks. For instance, as alien species become more common and indigenous ones decline in number, it may become unrealistic and undesirable to eliminate the newer species in an attempt to increase populations of the declining ones.

Studies such as the one presented in this paper can provide critical information that can aid decision makers in making necessary changes to the guiding policies of protected areas agencies worldwide to account for the potentially substantial effects of climate change. Jones and Scott (2006a) indicated that Parks Canada would need to account for potential changes in visitation in any climate change adaptation strategy. The results of this study indicate that the same consideration will be required of the NPS in the decades ahead.

7.1 Major Limitations to the Study

This study was limited by two major factors. The first factor is the temporal availability of national park visitation data (*i.e.*, monthly rather than daily), which resulted in a monthly analysis and the inability to create reliable climate-visitation models for a number of months or seasons for some of the parks in the study due to the influence of non-climate variables on visitation. Daily data would allow a more in-depth analysis, where daily and weekly fluctuations in visitation could be studied in relation to factors such as storm events and non-climate factors such as sporting events. The second major limitation was the presence of significant gaps in the climate records of the meteorological stations closest to each park. These gaps resulted in the elimination of a number of national parks from the study, some of which were the only ones located in certain climate regimes, which led to those climate regimes not being represented in the study.

7.2 Future Research Needs

More research similar to that found in this study is needed for all national parks across the globe. As it appears that Canada and the US are the only two countries for which such studies have been carried out (at least in the English language), there is much opportunity for similar research to be conducted for national parks and other types of protected areas in other parts of the world on both a system-wide and individual unit basis.

In Canada and the US, more intensive studies could be conducted for individual national parks, or on a climate region basis. For instance, for those months of the year where the climate-visitation model created in this exploratory study was weak (i.e., R-squared value of less than 0.2), other national parks could be analysed in future studies to determine if the climate-visitation relationship is stronger, and therefore worthy of further analysis. If no other suitable national parks exist in the same region, other types of protected areas could be studied instead, such as state or provincial parks. Alternatively, a larger data set could be used, such as daily data, that would isolate the influence of other factors on visitation (such as short-term storm events), thereby allowing a more reliable relationship to be established between climate and visitation. Finally, more sophisticated statistical techniques could be employed, such as in the study by Meyer and Dewar (1999), where daily precipitation data is used to determine a relationship with visitation to the Franz Josef Glacier visitor centre at Westlands National Park in New Zealand. In this study, both a transfer model and a dynamic linear model are used to describe the relationship between precipitation and visitation, in order to minimize the effects of other variables on visitation, such as holidays and business cycles.

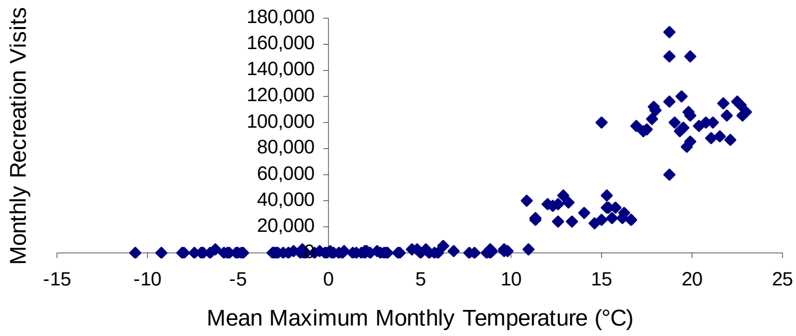
Another area of research that could be expanded upon is the affect of climate change on future tourism volumes and patterns in conjunction with other variables such as population growth, an aging and more ethnically diverse society, changing travel costs, changing energy supplies, and changing competition for travel destinations. For instance, Perry (2003) speculates that demographic changes may lead to increased winter and shoulder season tourism in the Mediterranean, but he calls for research on how these changes may interact with climate change to be able to make more informed projections of future tourism patterns. A study by Hamilton *et al.* (2005a) attempts to simulate the effects of climate change on international tourism in combination with the effects of changes in population volumes and per capita income. However, this study is limited in that it does not take into account the age or ethnicity of future populations, nor does it consider any of the other variables mentioned above, such as changing energy supplies.

Only two studies (Jones and Scott 2006a, 2006b) were located that addressed the affects of climate change in conjunction with other variables on future tourism specifically in national parks or other protected areas. The first of these studies (Jones and Scott 2006a) projects tourism volumes and patterns under climate change for Canada’s system of national parks and then attempts to incorporate demographic change projections made by the Canadian Tourism Commission (2003a) for common nature-based tourism activities. The second study (Jones and Scott 2006b) focuses on Ontario's provincial parks, and similarly incorporates demographic change projections made by the Canadian Tourism Commission (Canadian Tourism Commission 2003b) after first projecting tourism changes under climate change alone. Since climate change will not act alone to alter visitation patterns and volumes in protected areas in the future, it will become increasingly important to understand the concurrent influences of other factors.

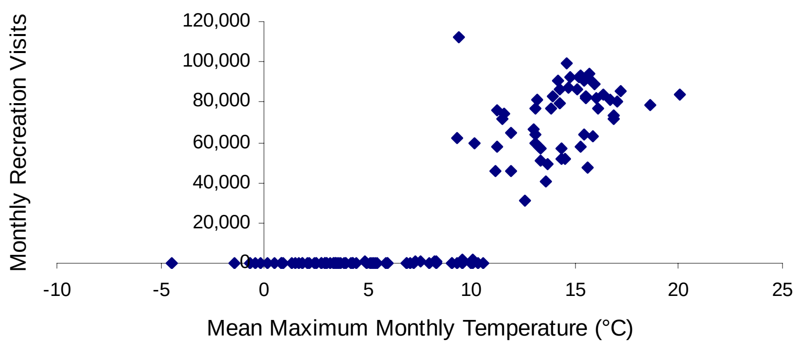
Appendix A – Correlation between Chosen Climate Variable and Monthly Recreation Visitation for 1995-2005

Figure 1 – Correlation between Chosen Climate Variable and Monthly Recreation Visitation for 1995-2005

A Denali[1]



B Glacier Bay



C Olympic

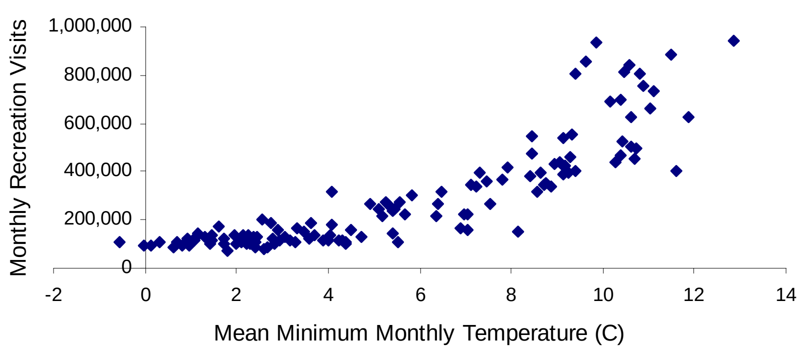
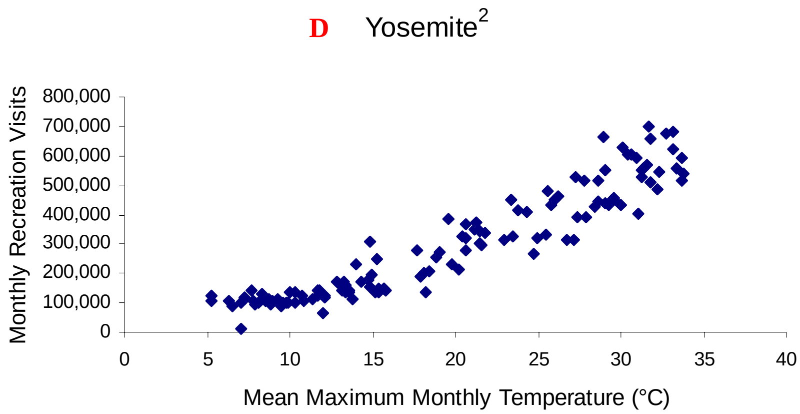
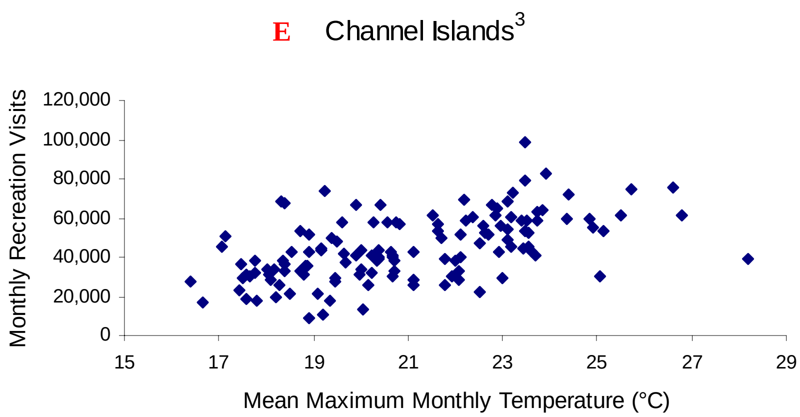


Figure 1 continued – Correlation between Chosen Climate Variable and Monthly Recreation Visitation for 1995-2005





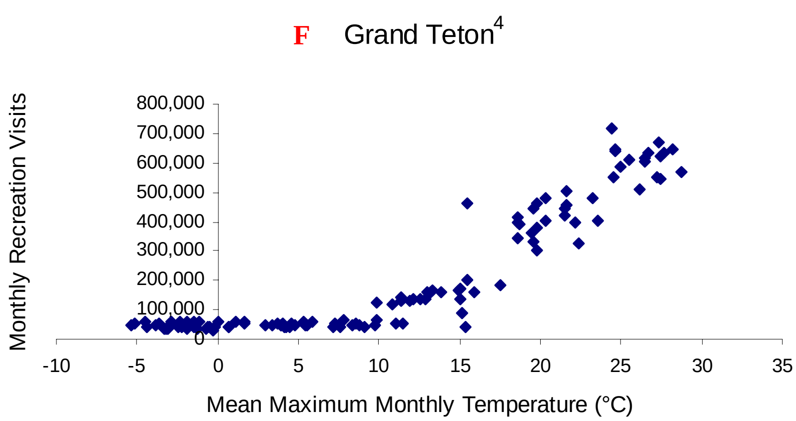
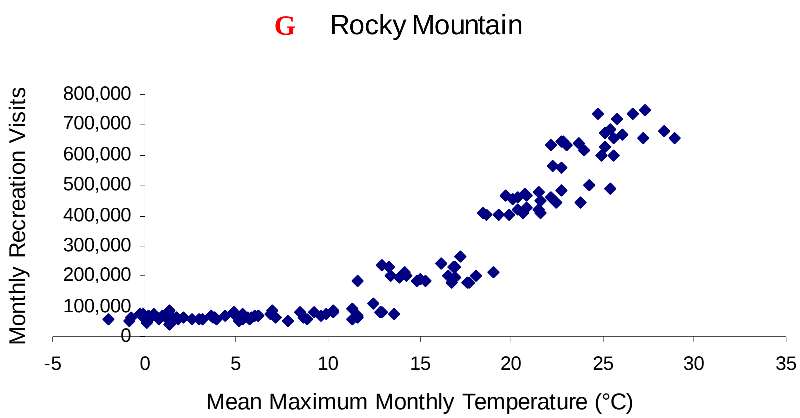
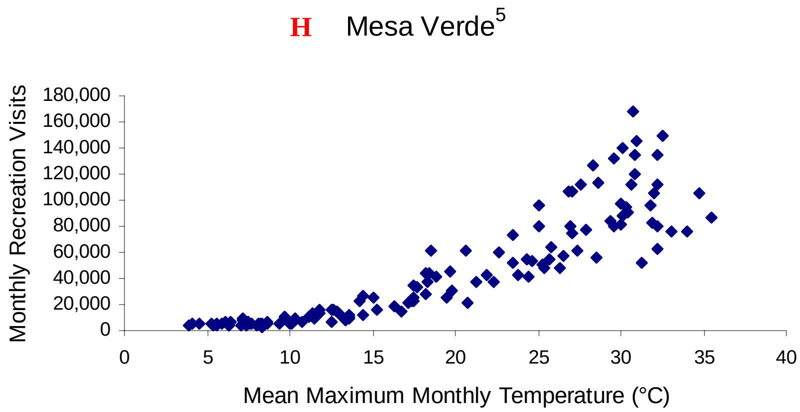


Figure 1 continued – Correlation between Chosen Climate Variable and Monthly Recreation Visitation for 1995-2005





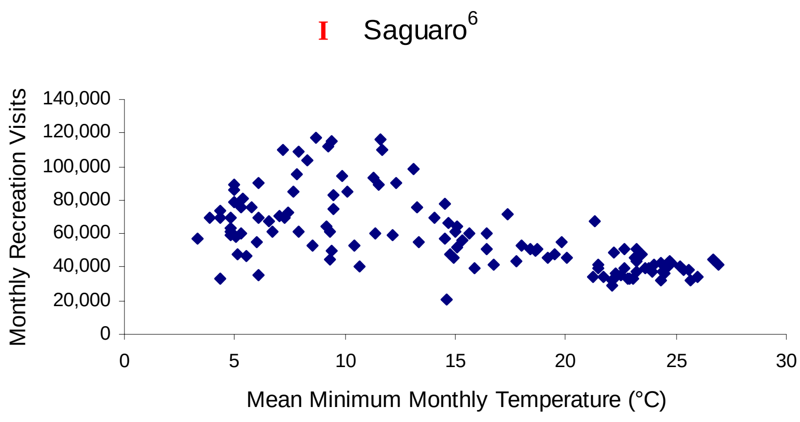
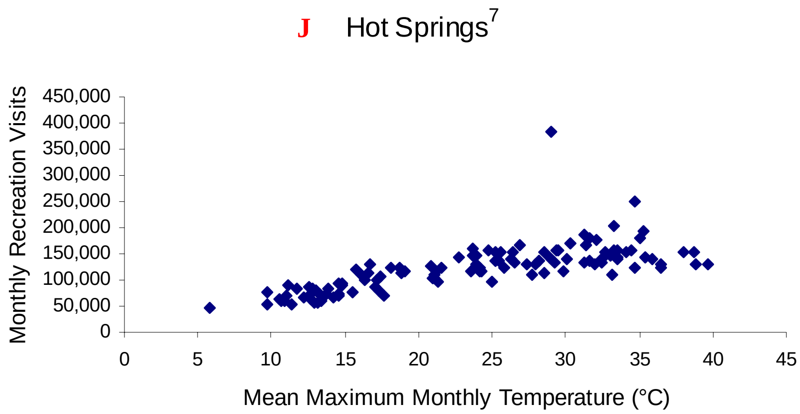
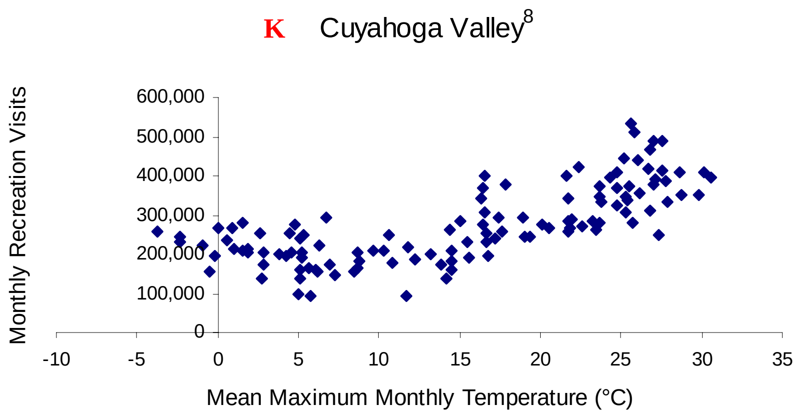


Figure 1 continued – Correlation between Chosen Climate Variable and Monthly Recreation Visitation for 1995-2005





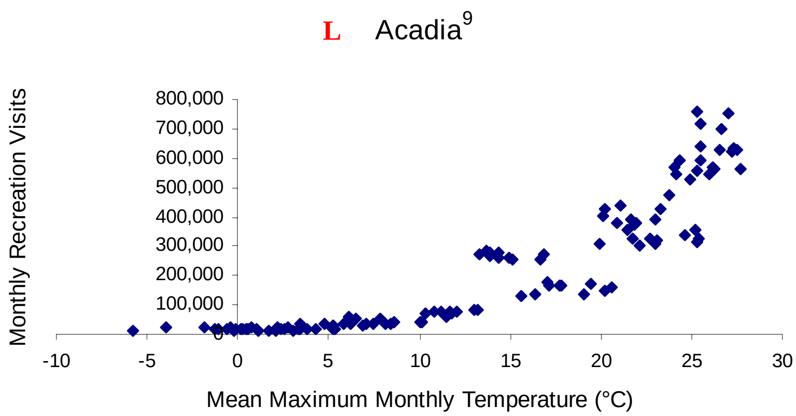
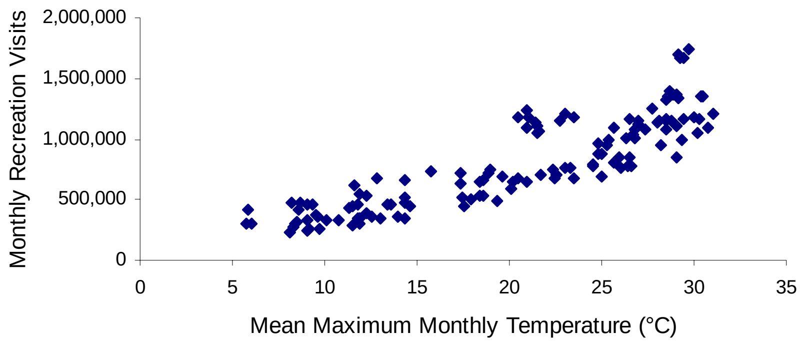
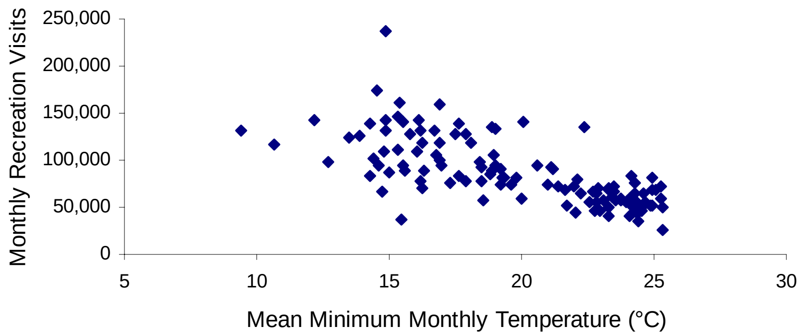


Figure 1 continued – Correlation between Chosen Climate Variable and Monthly Recreation Visitation for 1995-2005

M Great Smoky Mountains



N Everglades[10]



Notes:
1) Climate data missing for Oct 1995
2) Missing climate data for Mar/Jul 2004, Apr/May 2005
3) Missing visitation data for Dec 2005
4) Missing climate data for Jul/Dec 1999, Jul 2002, Nov/Dec 2005; missing visitation data for Jan-Dec 2005
5) Missing climate data for Apr/May 1997
6) Missing climate data for Apr/Sep/Nov/Dec 1997, Mar/Jun/Nov 2005
7) Missing climate data for Dec 2003, Jun 2004, Jan-Dec 2005
8) Missing climate data for Jan-Dec 2005
9) Missing climate data for Apr 1995; Jan-Dec 2005
10) Missing climate data for Mar/Jun/Sep 1995, Nov/Dec 2001, Jan/Feb 2002, Oct-Dec 2005

Appendix B – Modeled Monthly Baseline (1961-90) Visitation

Figure 1 – Modeled Monthly Baseline (1961-90) Visitation

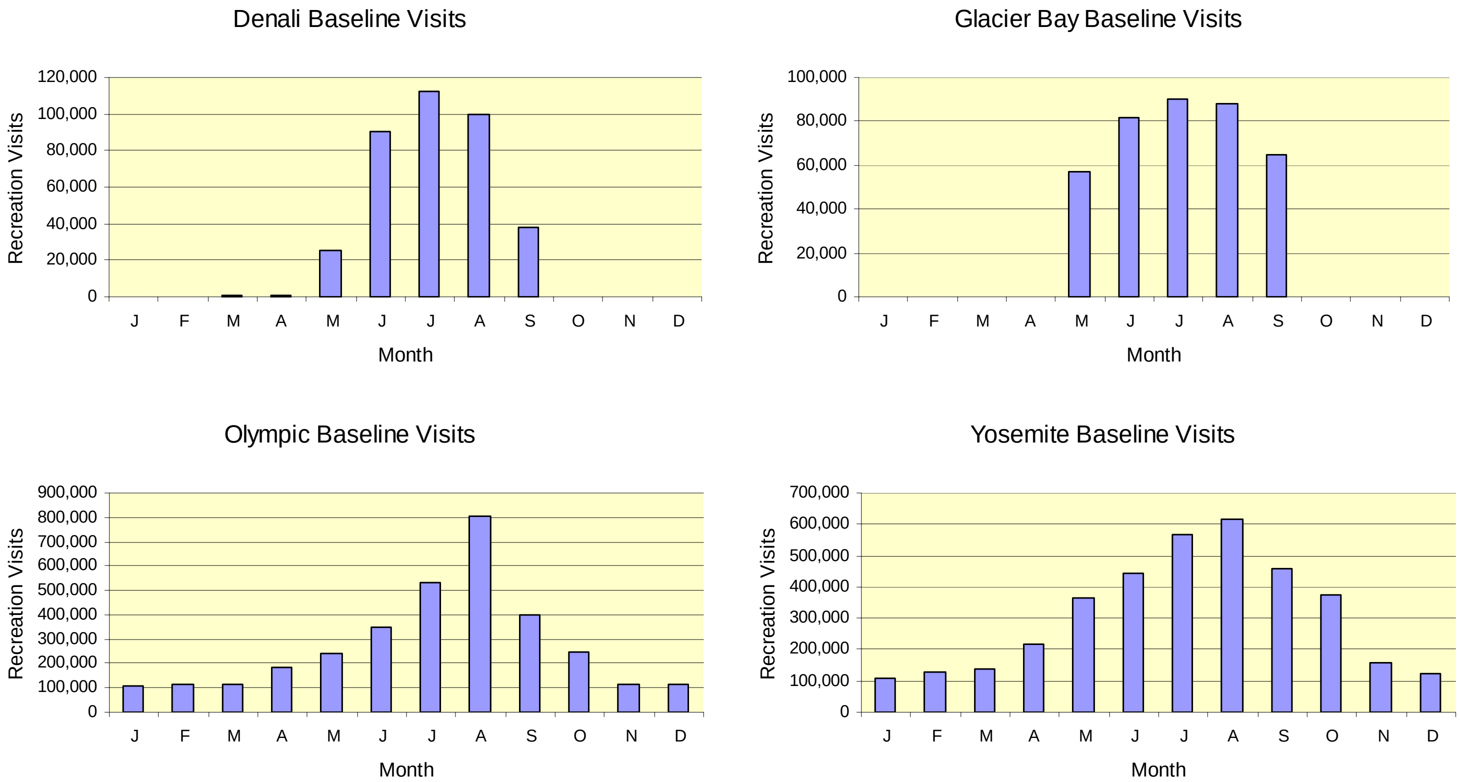
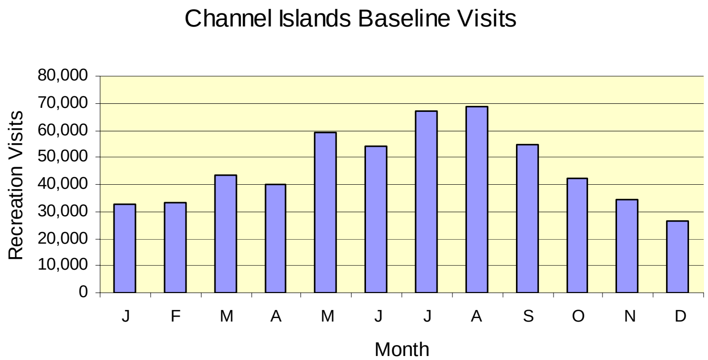
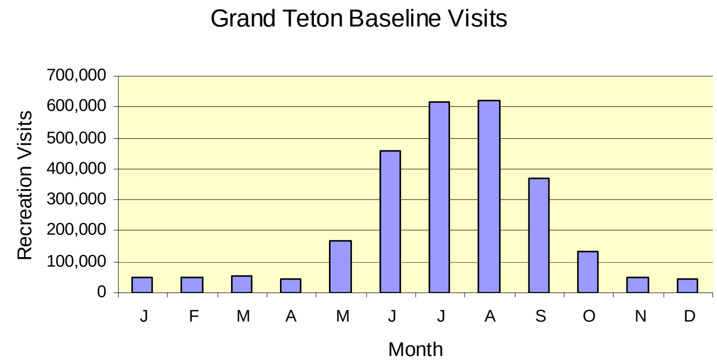
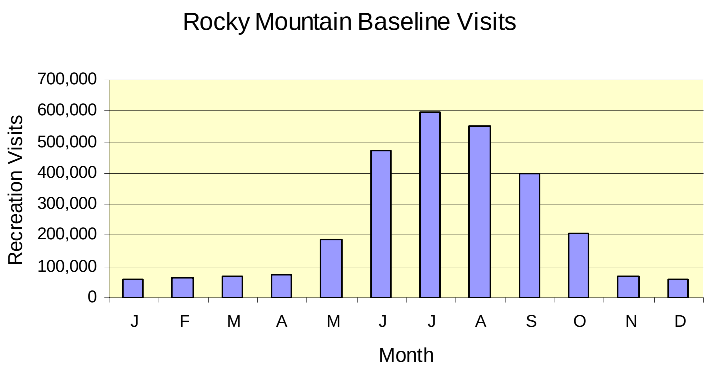


Figure 1 continued – Modeled Monthly Baseline (1961-90) Visitation







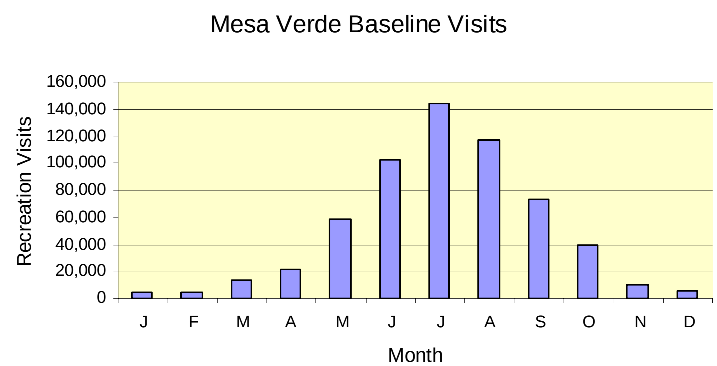


Figure 1 continued – Modeled Monthly Baseline (1961-90) Visitation

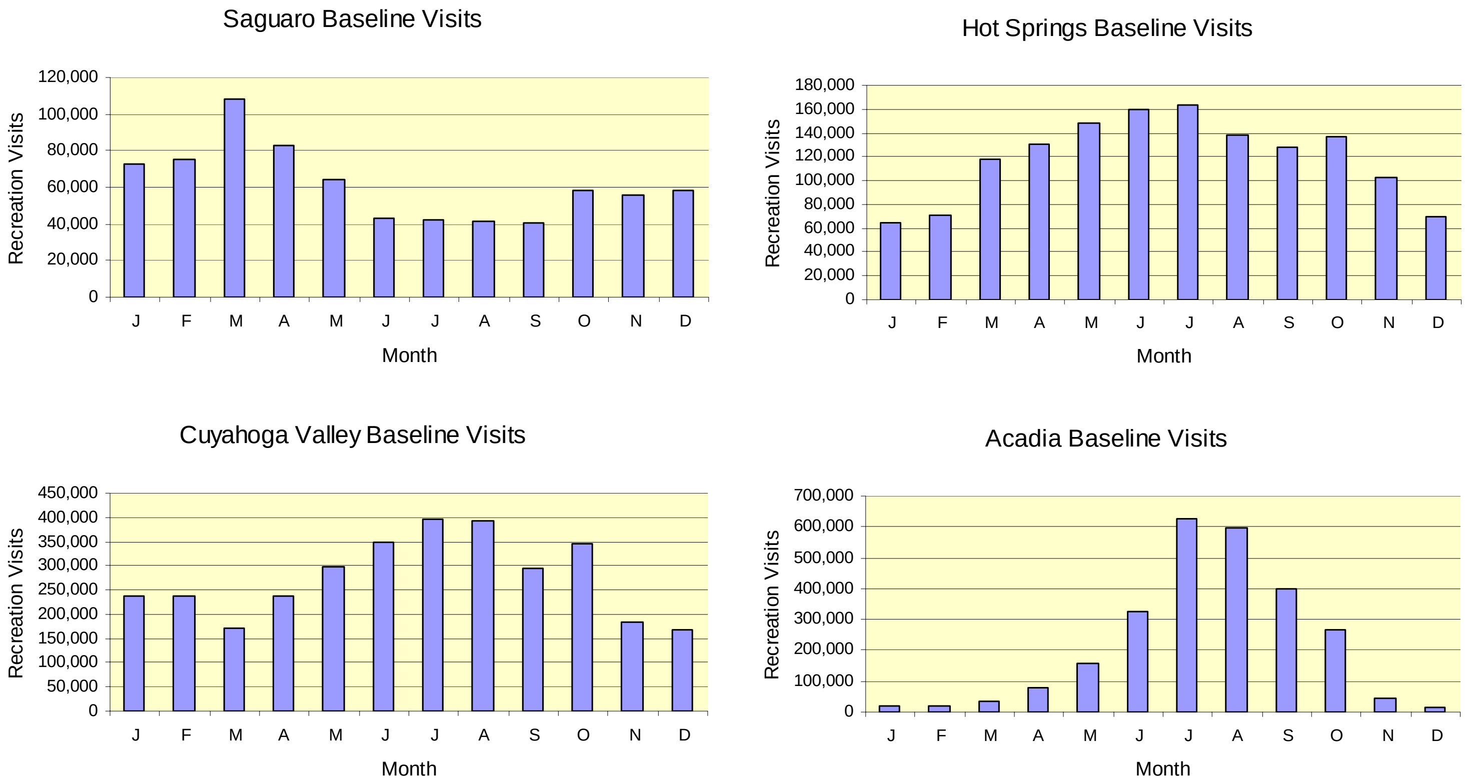
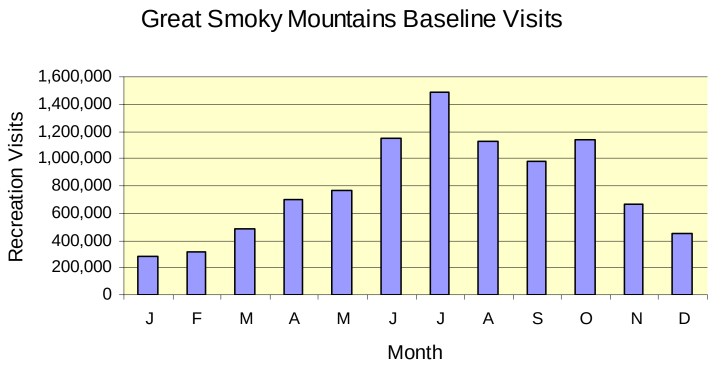
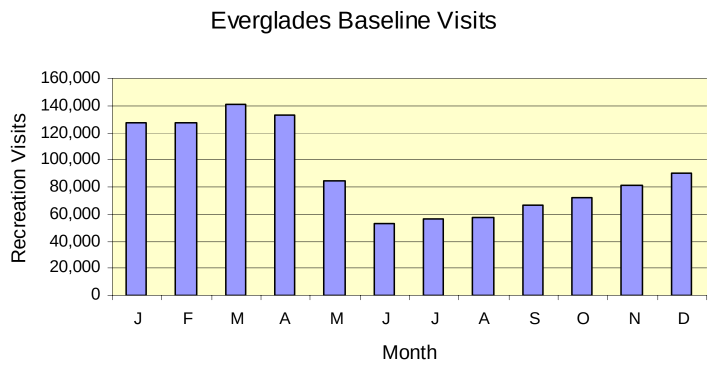


Figure 1 continued – Modeled Monthly Baseline (1961-90) Visitation





Appendix C – Regression Models of the Climate-Visitation Relationship

Table 1 - Regression Models of the Climate-Visitation Relationship

National Park	Models	Projector of Visits	Model Type[1]	R^2	Equation Used in Study (Visits =)
Denali (Alaska)	Jan/Nov/Dec	T-max	L	0.35	= 4.57x + 66.52
	Feb		L	0.47	= 21.28x + 191.71
	Mar		L	0.07	= 115.88x + 492.68
	Apr		L	0.64	= 522.24x - 3,105.40
	May		L	0.14	= 368.58x + 20,257.26
	Jun		L	0.01	= 587.77x + 79,821.27
	Jul		L	0.00	= 46.76x + 111,564.95
	Aug		L	0.22	= 1,053.38x + 80,600.06
	Sep		L	0.05	= -476.70x + 44,350.70
	Oct		L	0.53	= 23.66x + 54.84
Glacier Bay (Alaska)	Jan/Feb	T-max	L	0.04	= 3.72x + 79.54
	Mar		L	0.04	= 9.19x + 38.55
	Apr		L	0.01	= 7.22x + 208.90
	May		L	0.40	= -2,643.22x + 83,184.71
	Jun		L	0.10	= -1,053.95x + 95,235.48
	Jul		L	0.44	= -3,652.20x + 145,494.26
	Aug		L	0.31	= -1,933.70x + 117,772.85
	Sep		L	0.35	= -2841.76x + 101,459.54
	Oct		L	0.01	= -6.84x + 245.13
	Nov/Dec		L	0.14	= 10.32x + 49.25

Table 1 continued – Regression Models of the Climate-Visitation Relationship

Olympic (Washington)	Jan/Feb/Mar	T-min	L	0.12	= 3,475.91x + 106,143.24
	Apr/May/Jun		C	0.86	$= -118.00x^3 + 5{,}442.52x^2 - 14{,}461.09x + 174{,}194.48$
	Jul		L	0.12	= 32,946.43x + 234,419.23
	Aug		L	0.08	= 22,880.27x + 579,976.74
	Sep		L	0.35	= 26,411.00x + 183,782.81
	Oct		L	0.02	= 7,567.39x + 204,128.13
	Nov		L	0.06	= 3,377.87x + 106,291.84
	Dec		L	0.02	= 3,605.31x + 109,106.02
Yosemite (California)	Jan/Feb/Mar	T-max	L	0.65	= 4,889.05x + 64,358.70
	Apr		L	0.15	= 4,465.46x + 136,126.89
	May/Jun		L	0.62	= 16,745.56x - 21,961.23
	Jul		L	0.37	= -17,743.48x + 1,137,117.42
	Aug		L	0.01	= 5,579.55x + 436,987.56
	Sep/Oct		L	0.51	= 13,809.53x + 56,054.35
	Nov/Dec		L	0.68	= 6,292.40x + 67,004.72
Channel Islands (California)	Jan/Feb	T-max	L	0.32	= 1,897.26x - 2,678.57
	Mar/Apr		L	0.31	= -2,296.40x + 87,086.44
	May/Jun		L	0.57	= -4,249.22x + 147,781.59
	Jul/Aug		L	0.06	= 1,623.49x + 27,782.54
	Sep		L	0.26	= 2,058.08x + 4,484.95
	Oct/Nov		L	0.25	= 2,904.69x - 25,843.86
	Dec		L	0.01	= 328.98x + 20,647.03

Table 1 continued – Regression Models of the Climate-Visitation Relationship

Grand Teton (Wyoming)	Jan	T-max	L	0.01	= -591.03x + 48,278.42
	Feb		L	0.06	= -1,070.58x + 47,350.46
	Mar		L	0.00	= 139.15x + 51,728.93
	Apr		L	0.44	= 2,040.03x + 29,181.29
	May		L	0.22	= 4,187.70x + 107,740.61
	Jun		L	0.06	= 3,064.67x + 394,837.63
	Jul/Aug		L	0.03	= -6,169.59x + 771,891.92
	Sep		L	0.11	= 7,650.77x + 225,238.92
	Oct		L	0.49	= 3,598.53x + 89,201.25
	Nov		L	0.06	= 635.76x + 49,770.94
	Dec		L	0.19	= -1,545.37x + 38,880.88
Rocky Mountain (Colorado)	Jan/Feb/Mar/Apr/Nov/Dec	T-max	L	0.28	= 1,165.48x + 61,703.39
	May		L	0.08	= 3,938.34x + 127,272.29
	Jun/Jul/Aug/Sep		L	0.75	= 39,295.18x - 350,374.64
	Oct		L	0.49	= 9,514.56x + 81,588.43

Table 1 continued – Regression Models of the Climate-Visitation Relationship

Mesa Verde	Jan	T-max	L	0.47	= 193.72x + 3,621.97
(Colorado)	Feb		L	0.70	= 360.23x + 2,101.55
	Mar/Apr		L	0.73	= 1,660.42x - 5,465.59
	May		L	0.15	= -743.21x + 74,563.99
	Jun		L	0.18	= -2,114.28x + 162,020.31
	Jul		L	0.69	= -11,777.70x + 511,474.40
	Aug		L	0.19	= -7,132.66x + 328,202.39
	Sep		L	0.12	= -2,112.23x + 126,239.98
	Oct		L	0.03	= 433.12x + 31,248.58
	Nov		L	0.23	= 229.21x + 7,419.11
	Dec		L	0.34	= 343.86x + 4,027.15
Saguaro (Arizona)	Jan/Feb	T-min	L	0.14	= 1,635.07x + 66,159.90
	Mar		L	0.00	= -24.53x + 108,702.87
	Apr/May		L	0.66	= -4,261.25x + 130,312.32
	Jun		L	0.07	= -1,592.99x + 76,191.93
	Jul		L	0.29	= -2,141.62x + 93,072.76
	Aug		L	0.01	= -444.54x + 51,459.23
	Sep		L	0.26	= -3,698.44x + 116,230.70
	Oct		L	0.26	= -4,431.64x + 120,588.28
	Nov/Dec		L	0.12	= -880.39x + 62,828.58

Table 1 continued – Regression Models of the Climate-Visitation Relationship

Hot Springs (Arkansas)	Jan/Dec	T-max	L	0.39	= 3,617.49x + 26,985.20
	Feb		L	0.11	= 1,730.14x + 48,021.67
	Mar/Apr		L	0.34	= 2,476.27x + 71,724.93
	May/Jun/Jul		C	0.19	$= -86.12x^3 + 7,881.65^2 - 236,198.10x + 2,471,334.59$
	Aug/Sep		C	0.21	$= -5.21x^3 + 161.64x^2 + 8,260.29x - 122,976.33$
	Oct/Nov		L	0.64	= 4,523.70x + 25,579.51
Cuyahoga Valley (Ohio)	Jan/Feb	T-max	L	0.01	= 878.67x + 237,009.18
	Mar/Apr/May/Jun		L	0.73	= 10,231.64x + 84,292.25
	Jul/Aug		C	0.09	$= 436.79x^3 - 41532.98x^2 + 1,293,056.39x - 12,830,496.49$
	Sep		L	0.02	= 2,957.03x + 227,685.37
	Oct		L	0.50	= 33,540.91x - 215,525.30
	Nov		L	0.59	= 14,116.21x + 45,836.87
	Dec		L	0.00	= 185.62x + 165,796.61
Acadia (Maine)	Jan/Dec	T-max	L	0.16	= -441.64x + 17,533.66
	Feb		L	0.13	= -610.83x + 21,812.64
	Mar		L	0.02	= 315.65x + 30,760.48
	Apr		L	0.64	= 3,731.70x + 32,810.66
	May		L	0.04	= 2,023.86x + 118,736.49
	Jun		L	0.34	= 4,991.98x + 206,709.24
	Jul/Aug		L	0.46	= 37,335.10x - 364,243.77
	Sep		L	0.01	= -2,580.99x + 452,576.11
	Oct		L	0.22	= -4,153.06x + 329,972.83
	Nov		L	0.39	= -3,790.58x + 76,372.01

Table 1 continued – Regression Models of the Climate-Visitation Relationship

Great Smoky Mountains	Jan/Feb	T-max	L	0.48	= 18,003.91x + 127,386.46
(North Carolina)	Mar		L	0.38	= 10,846.25x + 309,448.69
	Apr/May		L	0.51	=18,546.1x + 309,879.31
	Jun		L	0.34	= 15,029.83x + 723,974.96
	Jul		L	0.01	= 26,389x + 708,080.44
	Aug		L	0.45	= 30,732.7x + 231,556.06
	Sep		L	0.40	= 20,654.88x + 437,899.37
	Oct		L	0.03	= 9,789.81x + 934,051.61
	Nov		L	0.44	= 16,400.91x + 406,083.47
	Dec		L	0.03	= 2,261.10x + 427,028.24
Everglades	Jan/Feb	T-min	L	0.01	= 647.38x + 119,080.22
(Florida)	Mar/Apr		L	0.42	= -8,640.97x + 272,014.09
	May		L	0.42	= -3,554.55x + 151,454.24
	Jun/Jul/Aug		L	0.03	= 2,846.37x - 9,299.99
	Sep		L	0.17	= -18,552.68x + 499,991.01
	Oct/Nov/Dec		L	0.41	= -2,587.04x + 127,072.38

1) Model type: C (cubic regression) and L (linear regression)

Appendix D – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

Table 1 – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

A Denali

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Jan/Nov/Dec	105	130	24.2
1996	Jan/Nov/Dec	48	106	120.9
1997	Jan/Nov/Dec	183	141	-22.8
1998	Jan/Nov/Dec	171	135	-20.9
1999	Jan/Nov/Dec	89	112	25.5
2000	Jan/Nov/Dec	73	161	120.7
2001	Jan/Nov/Dec	125	153	22.7
2002	Jan/Nov/Dec	219	208	-4.8
2003	Jan/Nov/Dec	1,799	173	-90.4
2004	Jan/Nov/Dec	1,865	153	-91.8
2005	Jan/Nov/Dec	5,826	141	-97.6
1995	Mar	400	308	-23.0
1996	Mar	52	840	1514.8
1997	Mar	271	582	114.8
1998	Mar	261	950	263.9
1999	Mar	207	642	210.2
2000	Mar	216	858	297.4
2001	Mar	464	719	55.0
2002	Mar	1,858	802	-56.8
2003	Mar	753	733	-2.6
2004	Mar	1,441	588	-59.2
2005	Mar	2,118	1,018	-51.9
1995	May	25,415	25,806	1.5
1996	May	24,676	26,394	7.0
1997	May	23,058	25,661	11.3
1998	May	26,131	24,451	-6.4
1999	May	23,686	25,211	6.4
2000	May	23,810	24,912	4.6
2001	May	25,020	24,439	-2.3
2002	May	25,525	26,388	3.4
2003	May	27,260	25,997	-4.6
2004	May	30,132	26,255	-12.9
2005	May	27,022	26,222	-3.0

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Feb	88	126	43.0
1996	Feb	7	69	885.6
1997	Feb	49	230	368.7
1998	Feb	75	224	199.0
1999	Feb	79	0	-100.0
2000	Feb	115	203	76.7
2001	Feb	252	176	-30.3
2002	Feb	90	194	115.8
2003	Feb	886	235	-73.5
2004	Feb	392	261	-33.5
2005	Feb	751	151	-79.9
1995	Apr	2,948	1,914	-35.1
1996	Apr	200	1,557	678.5
1997	Apr	779	1,586	103.6
1998	Apr	626	1,081	72.7
1999	Apr	458	37	-92.0
2000	Apr	500	919	83.7
2001	Apr	861	501	-41.8
2002	Apr	2,437	0	-100.0
2003	Apr	2,985	2,619	-12.3
2004	Apr	3,087	1,537	-50.2
2005	Apr	1,451	1,952	34.5
1995	Jun	150,886	90,858	-39.8
1996	Jun	80,725	91,391	13.2
1997	Jun	86,916	92,827	6.8
1998	Jun	92,670	90,032	-2.8
1999	Jun	95,652	91,283	-4.6
2000	Jun	92,862	91,208	-1.8
2001	Jun	89,229	92,468	3.6
2002	Jun	84,916	91,544	7.8
2003	Jun	88,471	92,187	4.2
2004	Jun	100,127	92,253	-7.9
2005	Jun	99,756	92,044	-7.7

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Jul	150,533	112,498	-25.3	1995	Aug	169,322	100,404	-40.7
1996	Jul	105,447	112,497	6.7	1996	Aug	94,342	99,046	5.0
1997	Jul	113,436	112,627	-0.7	1997	Aug	94,585	101,082	6.9
1998	Jul	115,478	112,443	-2.6	1998	Aug	100,141	96,401	-3.7
1999	Jul	120,134	112,473	-6.4	1999	Aug	102,573	99,327	-3.2
2000	Jul	111,929	112,402	0.4	2000	Aug	97,581	98,437	0.9
2001	Jul	109,881	112,405	2.3	2001	Aug	99,767	100,702	0.9
2002	Jul	105,422	112,590	6.8	2002	Aug	60,231	100,386	66.7
2003	Jul	104,686	112,629	7.6	2003	Aug	97,821	102,083	4.4
2004	Jul	116,601	112,618	-3.4	2004	Aug	108,097	104,763	-3.1
2005	Jul	114,308	112,581	-1.5	2005	Aug	108,451	101,516	-6.4
1995	Sep	43,502	37,049	-14.8	1995[a]	Oct			
1996	Sep	35,810	38,471	7.4	1996	Oct	78	72	-7.4
1997	Sep	34,824	36,837	5.8	1997	Oct	177	122	-30.9
1998	Sep	36,692	38,347	4.5	1998	Oct	274	192	-30.0
1999	Sep	43,848	38,172	-12.9	1999	Oct	141	144	2.0
2000	Sep	36,820	38,585	4.8	2000	Oct	77	174	125.4
2001	Sep	34,520	37,060	7.4	2001	Oct	72	109	51.0
2002	Sep	30,383	37,642	23.9	2002	Oct	254	261	2.6
2003	Sep	34,639	37,015	6.9	2003	Oct	889	288	-67.6
2004	Sep	39,969	39,133	-2.1	2004	Oct	2,525	181	-92.8
2005	Sep	38,121	38,074	-0.1	2005	Oct	5,716	203	-96.5

1) Missing climate data for: a - October 1995

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

B Glacier Bay

Year	Month(s)	Observed	Modeled	% Difference	Year	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb	125	166	33.1	1995	Mar	111	68	-38.7
1996	Jan/Feb	148	152	2.6	1996	Mar	53	86	62.5
1997	Jan/Feb	111	178	60.3	1997	Mar	48	69	43.8
1998	Jan/Feb	223	184	-17.3	1998	Mar	89	93	4.2
1999	Jan/Feb	101	161	59.2	1999	Mar	6	66	992.6
2000	Jan/Feb	171	168	-2.0	2000	Mar	149	78	-47.6
2001	Jan/Feb	171	188	9.7	2001	Mar	144	70	-51.4
2002	Jan/Feb	348	172	-50.7	2002	Mar	187	55	-70.5
2003	Jan/Feb	110	186	69.5	2003	Mar	43	77	79.3
2004	Jan/Feb	137	173	26.0	2004	Mar	28	72	157.1
2005	Jan/Feb	121	169	39.7	2005	Mar	101	94	-7.4
1995	Apr	283	281	-0.8	1995	May	30,767	49,983	62.5
1996	Apr	84	278	230.8	1996	May	40,694	47,237	16.1
1997	Apr	1,823	278	-84.8	1997	May	50,806	47,942	-5.6
1998	Apr	503	263	-47.6	1998	May	59,361	56,474	-4.9
1999	Apr	91	248	172.4	1999	May	111,916	58,456	-47.8
2000	Apr	324	260	-19.8	2000	May	57,993	53,434	-7.9
2001	Apr	123	258	110.0	2001	May	61,901	58,647	-5.3
2002	Apr	585	244	-58.3	2002	May	71,676	52,920	-26.2
2003	Apr	68	276	305.7	2003	May	46,093	53,772	16.7
2004	Apr	510	268	-47.4	2004	May	45,512	51,730	13.7
2005	Apr	224	285	27.3	2005	May	51,792	44,917	-13.3
1995	Jun	51,394	80,129	55.9	1995	Jul	57,857	89,737	55.1
1996	Jun	56,968	80,088	40.6	1996	Jul	73,655	83,833	13.8
1997	Jun	71,263	77,453	8.7	1997	Jul	80,263	83,387	3.9
1998	Jun	76,985	80,638	4.7	1998	Jul	99,354	92,213	-7.2
1999	Jun	79,181	80,205	1.3	1999	Jul	86,633	90,326	4.3
2000	Jun	83,305	80,539	-3.3	2000	Jul	86,887	92,030	5.9
2001	Jun	85,945	80,246	-6.6	2001	Jul	90,261	93,714	3.8
2002	Jun	81,396	81,317	-0.1	2002	Jul	93,032	89,737	-3.5
2003	Jun	76,891	81,435	5.9	2003	Jul	93,887	88,297	-6.0
2004	Jun	82,066	78,314	-4.6	2004	Jul	85,286	82,717	-3.0
2005	Jun	82,032	78,917	-3.8	2005	Jul	81,442	84,624	3.9

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Aug	63,941	87,940	37.5
1996	Aug	82,828	87,801	6.0
1997	Aug	78,913	81,763	3.6
1998	Aug	92,688	89,283	-3.7
1999	Aug	88,956	86,995	-2.2
2000	Aug	90,415	87,897	-2.8
2001	Aug	76,561	86,554	13.1
2002	Aug	92,793	88,348	-4.8
2003	Aug	90,500	87,274	-3.6
2004	Aug	83,350	79,067	-5.1
2005	Aug	84,146	86,168	2.4
1995	Oct	166	180	8.5
1996	Oct	305	198	-35.0
1997	Oct	231	183	-20.6
1998	Oct	191	177	-7.6
1999	Oct	96	196	104.1
2000	Oct	616	189	-69.4
2001	Oct	624	195	-68.7
2002	Oct	1,589	176	-88.9
2003	Oct	226	175	-22.8
2004	Oct	40	183	358.6
2005	Oct	226	189	-16.5

1995	Sep	47,410	57,207	20.7
1996	Sep	49,564	62,575	26.3
1997	Sep	63,434	56,465	-11.0
1998	Sep	73,993	68,669	-7.2
1999	Sep	75,568	69,616	-7.9
2000	Sep	64,779	67,516	4.2
2001	Sep	64,264	64,359	0.1
2002	Sep	66,191	64,469	-2.6
2003	Sep	58,244	63,775	9.5
2004	Sep	56,627	63,569	12.3
2005	Sep	59,586	64,248	7.8
1995	Nov/Dec	211	151	-28.3
1996	Nov/Dec	75	128	70.6
1997	Nov/Dec	154	192	24.5
1998	Nov/Dec	125	140	12.4
1999	Nov/Dec	59	146	147.2
2000	Nov/Dec	45	182	304.9
2001	Nov/Dec	120	139	15.4
2002	Nov/Dec	346	207	-40.3
2003	Nov/Dec	257	159	-38.3
2004	Nov/Dec	130	175	34.8
2005	Nov/Dec	159	177	11.3

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

C Olympic

Year	Month(s)	Observed	Modeled	% Difference	Year	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb/Mar	308,305	343,997	11.6	1995	Apr/May/Jun	813,584	837,284	2.9
1996	Jan/Feb/Mar	287,442	337,180	17.3	1996	Apr/May/Jun	777,945	787,888	1.3
1997	Jan/Feb/Mar	358,613	340,985	-4.9	1997	Apr/May/Jun	998,798	933,252	-6.6
1998	Jan/Feb/Mar	357,335	347,705	-2.7	1998	Apr/May/Jun	863,677	915,726	6.0
1999	Jan/Feb/Mar	315,766	335,114	6.1	1999	Apr/May/Jun	871,226	729,048	-16.3
2000	Jan/Feb/Mar	349,655	333,086	-4.7	2000	Apr/May/Jun	833,466	834,856	0.2
2001	Jan/Feb/Mar	367,689	331,271	-9.9	2001	Apr/May/Jun	785,846	715,986	-8.9
2002	Jan/Feb/Mar	343,388	332,256	-3.2	2002	Apr/May/Jun	858,466	792,942	-7.6
2003	Jan/Feb/Mar	346,985	348,072	0.3	2003	Apr/May/Jun	804,759	846,067	5.1
2004	Jan/Feb/Mar	330,568	344,557	4.2	2004	Apr/May/Jun	705,372	872,204	23.7
2005	Jan/Feb/Mar	302,589	340,270	12.5	2005	Apr/May/Jun	868,686	980,618	12.9
1995	Jul	664,530	597,562	-10.1	1995	Aug	932,892	805,475	-13.7
1996	Jul	469,384	576,330	22.8	1996	Aug	814,468	819,076	0.6
1997	Jul	629,238	584,017	-7.2	1997	Aug	884,173	843,227	-4.6
1998	Jul	624,743	625,200	0.1	1998	Aug	840,990	822,253	-2.2
1999	Jul	557,138	542,102	-2.7	1999	Aug	736,542	833,821	13.2
2000	Jul	496,673	587,495	18.3	2000	Aug	690,936	812,847	17.6
2001	Jul	538,036	534,964	-0.6	2001	Aug	752,472	828,863	10.2
2002	Jul	699,732	576,330	-17.6	2002	Aug	856,987	800,136	-6.6
2003	Jul	522,505	577,977	10.6	2003	Aug	805,921	794,797	-1.4
2004	Jul	399,944	616,415	54.1	2004	Aug	940,156	873,988	-7.0
2005	Jul	452,981	586,946	29.6	2005	Aug	806,537	827,592	2.6
1995	Sep	436,992	455,669	4.3	1995	Oct	318,603	253,106	-20.6
1996	Sep	548,851	406,809	-25.9	1996	Oct	238,398	245,202	2.9
1997	Sep	506,847	464,033	-8.4	1997	Oct	226,600	256,764	13.3
1998	Sep	472,706	407,249	-13.8	1998	Oct	218,287	252,391	15.6
1999	Sep	393,154	376,436	-4.3	1999	Oct	243,335	242,764	-0.2
2000	Sep	427,104	426,324	-0.2	2000	Oct	247,361	245,454	-0.8
2001	Sep	427,314	425,443	-0.4	2001	Oct	275,194	246,295	-10.5
2002	Sep	420,204	393,310	-6.4	2002	Oct	217,635	243,437	11.9
2003	Sep	388,750	425,443	9.4	2003	Oct	152,942	265,718	73.7
2004	Sep	341,704	418,107	22.4	2004	Oct	167,016	256,217	53.4
2005	Sep	348,835	371,594	6.5	2005	Oct	161,829	257,562	59.2

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Nov	107,672	124,926	16.0
1996	Nov	117,985	116,181	-1.5
1997	Nov	129,687	122,243	-5.7
1998	Nov	104,466	121,117	15.9
1999	Nov	113,231	119,803	5.8
2000	Nov	138,278	111,171	-19.6
2001	Nov	138,758	119,991	-13.5
2002	Nov	158,942	121,492	-23.6
2003	Nov	87,717	108,412	23.6
2004	Nov	99,965	121,061	21.1
2005	Nov	104,002	114,305	9.9

1995	Dec	76,037	118,420	55.7
1996	Dec	94,250	109,627	16.3
1997	Dec	112,753	116,737	3.5
1998	Dec	94,803	112,591	18.8
1999	Dec	133,874	116,857	-12.7
2000	Dec	144,249	113,312	-21.4
2001	Dec	130,760	113,813	-13.0
2002	Dec	135,956	117,238	-13.8
2003	Dec	115,748	114,414	-1.2
2004	Dec	88,997	118,800	33.5
2005	Dec	97,315	115,315	18.5

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

D Yosemite

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb/Mar	399,656	351,020	-12.2
1996	Jan/Feb/Mar	419,910	359,032	-14.5
1997	Jan/Feb/Mar	213,197	375,139	76.0
1998	Jan/Feb/Mar	380,563	332,224	-12.7
1999	Jan/Feb/Mar	339,997	353,220	3.9
2000	Jan/Feb/Mar	333,600	359,521	7.8
2001	Jan/Feb/Mar	346,493	348,684	0.6
2002	Jan/Feb/Mar	364,367	366,665	0.6
2003	Jan/Feb/Mar	366,040	381,739	4.3
2004[a]	Jan/Feb/Mar	206,278	203,384	-1.4
2005	Jan/Feb/Mar	338,329	344,800	1.9
1995	May/Jun	729,086	644,227	-11.6
1996	May/Jun	874,648	767,214	-12.3
1997	May/Jun	779,567	813,264	4.3
1998	May/Jun	653,247	564,034	-13.7
1999	May/Jun	783,934	755,771	-3.6
2000	May/Jun	771,647	835,406	8.3
2001	May/Jun	749,911	913,086	21.8
2002	May/Jun	732,373	803,496	9.7
2003	May/Jun	726,222	782,192	7.7
2004	May/Jun	775,583	842,011	8.6
2005[c]	May/Jun	413,124	376,118	-9.0
1995	Aug	656,064	614,386	-6.4
1996	Aug	679,862	621,764	-8.5
1997	Aug	697,060	613,983	-11.9
1998	Aug	672,966	619,687	-7.9
1999	Aug	625,405	604,870	-3.3
2000	Aug	546,981	617,362	12.9
2001	Aug	591,196	624,987	5.7
2002	Aug	570,914	613,270	7.4
2003	Aug	604,093	608,063	0.7
2004	Aug	508,094	614,262	20.9
2005	Aug	485,643	616,649	27.0

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Apr	250,592	204,275	-18.5
1996	Apr	253,532	220,301	-13.1
1997	Apr	200,212	216,753	8.3
1998	Apr	231,495	198,817	-14.1
1999	Apr	169,517	199,958	18.0
2000	Apr	216,087	226,255	4.7
2001	Apr	192,936	202,861	5.1
2002	Apr	186,682	216,083	15.7
2003	Apr	174,337	193,607	11.1
2004	Apr	228,212	224,692	-1.5
2005[b]	Apr			
1995	Jul	663,052	623,937	-5.9
1996	Jul	622,855	548,231	-12.0
1997	Jul	595,059	588,252	-1.1
1998	Jul	603,790	597,223	-1.1
1999	Jul	558,114	580,958	4.1
2000	Jul	548,440	583,225	6.3
2001	Jul	528,849	581,944	10.0
2002	Jul	513,789	539,359	5.0
2003	Jul	536,683	537,388	0.1
2004[d]	Jul			
2005	Jul	554,567	544,682	-1.8
1995	Sep/Oct	961,205	848,694	-11.7
1996	Sep/Oct	883,247	780,797	-11.6
1997	Sep/Oct	888,738	801,434	-9.8
1998	Sep/Oct	865,369	736,990	-14.8
1999	Sep/Oct	763,512	867,797	13.7
2000	Sep/Oct	713,191	771,207	8.1
2001	Sep/Oct	712,984	862,810	21.0
2002	Sep/Oct	727,603	801,358	10.1
2003	Sep/Oct	721,971	909,225	25.9
2004	Sep/Oct	665,637	760,083	14.2
2005	Sep/Oct	748,642	754,022	0.7

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Nov/Dec	298,751	309,428	3.6
1996	Nov/Dec	312,153	265,591	-14.9
1997	Nov/Dec	296,137	267,863	-9.5
1998	Nov/Dec	249,702	257,760	3.2
1999	Nov/Dec	253,128	297,227	17.4
2000	Nov/Dec	270,957	274,854	1.4
2001	Nov/Dec	246,362	252,691	2.6
2002	Nov/Dec	266,139	278,630	4.7
2003	Nov/Dec	249,318	242,728	-2.6
2004	Nov/Dec	218,367	260,102	19.1
2005	Nov/Dec	263,902	285,377	8.1

1) Missing climate data for: a - March 2004; b - April 2005; c - May 2005; d - July 2004

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

E Channel Islands

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb	48,656	64,135	31.8
1996	Jan/Feb	64,738	64,441	-0.5
1997	Jan/Feb	84,566	65,126	-23.0
1998	Jan/Feb	46,933	62,301	32.7
1999	Jan/Feb	69,345	64,863	-6.5
2000	Jan/Feb	48,428	62,365	28.8
2001	Jan/Feb	59,980	59,508	-0.8
2002	Jan/Feb	76,225	66,981	-12.1
2003	Jan/Feb	72,561	71,461	-1.5
2004	Jan/Feb	68,615	61,816	-9.9
2005	Jan/Feb	41,147	65,400	58.9
1995	May/Jun	77,552	130,953	68.9
1996	May/Jun	108,555	108,999	0.4
1997	May/Jun	87,943	99,674	13.3
1998	May/Jun	124,806	123,611	-1.0
1999	May/Jun	117,291	134,966	15.1
2000	May/Jun	105,105	107,087	1.9
2001	May/Jun	110,074	113,295	2.9
2002	May/Jun	130,319	125,406	-3.8
2003	May/Jun	124,405	125,382	0.8
2004	May/Jun	119,343	110,415	-7.5
2005	May/Jun	100,179	111,525	11.3
1995	Sep	53,242	52,770	-0.9
1996	Sep	44,349	52,701	18.8
1997	Sep	39,266	62,534	59.3
1998	Sep	58,488	53,341	-8.8
1999	Sep	51,389	49,991	-2.7
2000	Sep	55,317	55,788	0.9
2001	Sep	45,530	52,964	16.3
2002	Sep	54,380	52,015	-4.3
2003	Sep	55,783	50,940	-8.7
2004	Sep	61,629	59,596	-3.3
2005	Sep	42,447	53,113	25.1

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Mar/Apr	73,396	83,376	13.6
1996	Mar/Apr	74,304	77,405	4.2
1997	Mar/Apr	81,316	76,321	-6.1
1998	Mar/Apr	90,384	85,978	-4.9
1999	Mar/Apr	97,209	91,541	-5.8
2000	Mar/Apr	76,578	86,195	12.6
2001	Mar/Apr	75,349	88,594	17.6
2002	Mar/Apr	122,034	89,104	-27.0
2003	Mar/Apr	82,635	83,440	1.0
2004	Mar/Apr	97,515	78,030	-20.0
2005	Mar/Apr	82,112	81,577	-0.7
1995	Jul/Aug	171,404	131,355	-23.4
1996	Jul/Aug	118,611	133,889	12.9
1997	Jul/Aug	117,153	134,259	14.6
1998	Jul/Aug	139,942	137,434	-1.8
1999	Jul/Aug	151,632	131,905	-13.0
2000	Jul/Aug	118,286	133,276	12.7
2001	Jul/Aug	127,350	128,884	1.2
2002	Jul/Aug	129,594	129,235	-0.3
2003	Jul/Aug	146,227	136,938	-6.4
2004	Jul/Aug	142,298	132,203	-7.1
2005	Jul/Aug	117,318	130,922	11.6
1995	Oct/Nov	90,622	72,972	-19.5
1996	Oct/Nov	62,456	68,583	9.8
1997	Oct/Nov	60,407	84,833	40.4
1998	Oct/Nov	92,433	73,601	-20.4
1999	Oct/Nov	91,496	80,363	-12.2
2000	Oct/Nov	51,319	68,260	33.0
2001	Oct/Nov	72,539	66,162	-8.8
2002	Oct/Nov	70,328	69,583	-1.1
2003	Oct/Nov	72,878	75,973	4.2
2004	Oct/Nov	39,133	69,809	78.4
2005	Oct/Nov	50,904	77,797	52.8

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Dec	11,010	26,962	144.9
1996	Dec	17,702	26,501	49.7
1997	Dec	18,106	27,009	49.2
1998	Dec	21,284	26,737	25.6
1999	Dec	28,695	27,598	-3.8
2000	Dec	27,538	27,044	-1.8
2001	Dec	29,606	26,408	-10.8
2002	Dec	31,055	26,432	-14.9
2003	Dec	31,430	26,591	-15.4
2004	Dec	9,183	26,861	192.5
2005[a]	Dec			

1) Missing visitation data for: a - December 2005

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

F Grand Teton

Year[1,2]	Month(s)	Observed	Modeled	% Difference	Year[1,2]	Month(s)	Observed	Modeled	% Difference
1995	Jan	35,760	50,078	40.0	1995	Feb	43,571	42,955	-1.4
1996	Jan	35,023	50,206	43.4	1996	Feb	42,816	46,631	8.9
1997	Jan	37,291	50,163	34.5	1997	Feb	40,998	47,921	16.9
1998	Jan	37,773	48,735	29.0	1998	Feb	44,298	46,631	5.3
1999	Jan	42,914	49,178	14.6	1999	Feb	39,694	47,541	19.8
2000	Jan	56,329	49,667	-11.8	2000	Feb	55,986	45,566	-18.6
2001	Jan	55,717	50,396	-9.5	2001	Feb	55,052	49,028	-10.9
2002	Jan	56,314	50,938	-9.5	2002	Feb	56,764	48,962	-13.7
2003	Jan	61,043	48,288	-20.9	2003	Feb	57,583	49,367	-14.3
2004	Jan	51,294	51,309	0.0	2004	Feb	36,582	48,742	33.2
1995	Mar	39,922	52,313	31.0	1995	Apr	48,571	46,182	-4.9
1996	Mar	58,360	52,547	-10.0	1996	Apr	43,897	47,802	8.9
1997	Mar	47,657	52,490	10.1	1997	Apr	41,501	43,881	5.7
1998	Mar	45,149	52,278	15.8	1998	Apr	47,384	49,015	3.4
1999	Mar	49,885	52,502	5.2	1999	Apr	42,384	44,674	5.4
2000	Mar	49,764	52,392	5.3	2000	Apr	51,355	52,528	2.3
2001	Mar	59,457	52,470	-11.8	2001	Apr	53,784	46,635	-13.3
2002	Mar	57,923	51,956	-10.3	2002	Apr	47,955	47,088	-1.8
2003	Mar	48,717	52,275	7.3	2003	Apr	64,112	49,242	-23.2
2004	Mar	54,733	52,736	-3.6	2004	Apr	52,743	51,769	-1.8
1995	May	168,819	163,344	-3.2	1995	Jun	445,606	454,939	2.1
1996	May	161,679	162,832	0.7	1996	Jun	481,622	466,057	-3.2
1997	May	157,661	174,465	10.7	1997	Jun	441,755	460,779	4.3
1998	May	199,320	172,348	-13.5	1998	Jun	460,412	442,340	-3.9
1999	May	159,492	161,925	1.5	1999	Jun	416,156	451,823	8.6
2000	May	170,039	170,789	0.4	2000	Jun	501,849	460,949	-8.1
2001	May	181,257	181,072	-0.1	2001	Jun	421,604	460,898	9.3
2002	May	164,065	170,417	3.9	2002	Jun	458,491	461,120	0.6
2003	May	90,174	171,091	89.7	2003	Jun	480,739	457,272	-4.9
2004	May	160,692	165,833	3.2	2004	Jun	463,445	455,501	-1.7

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Jul/Aug	1,333,851	1,229,340	-7.8	1995	Sep	400,346	381,102	-4.8
1996	Jul/Aug	1,289,745	1,205,656	-6.5	1996	Sep	398,302	367,628	-7.7
1997	Jul/Aug	1,283,014	1,239,726	-3.4	1997	Sep	382,007	376,852	-1.3
1998	Jul/Aug	1,285,600	1,205,348	-6.2	1998	Sep	398,202	394,959	-0.8
1999[a]	Jul/Aug	610,687	614,773	0.7	1999	Sep	392,841	368,351	-6.2
2000	Jul/Aug	1,142,900	1,211,517	6.0	2000	Sep	329,923	375,152	13.7
2001	Jul/Aug	1,149,456	1,210,866	5.3	2001	Sep	323,038	396,404	22.7
2002[b]	Jul/Aug	549,234	620,737	13.0	2002	Sep	360,557	373,876	3.7
2003	Jul/Aug	1,121,303	1,198,698	6.9	2003	Sep	300,997	376,554	25.1
2004	Jul/Aug	994,203	1,244,250	25.2	2004	Sep	342,945	367,203	7.1
1995	Oct	139,670	130,284	-6.7	1995	Nov	43,978	52,621	19.7
1996	Oct	133,597	132,863	-0.5	1996	Nov	51,717	52,339	1.2
1997	Oct	131,589	132,084	0.4	1997	Nov	45,908	51,901	13.1
1998	Oct	137,766	135,382	-1.7	1998	Nov	53,282	52,137	-2.1
1999	Oct	139,183	143,239	2.9	1999	Nov	63,873	54,751	-14.3
2000	Oct	132,501	130,085	-1.8	2000	Nov	58,504	49,054	-16.2
2001	Oct	136,043	134,283	-1.3	2001	Nov	52,701	52,667	-0.1
2002	Oct	122,602	124,487	1.5	2002	Nov	58,652	50,477	-13.9
2003	Oct	44,268	144,539	226.5	2003	Nov	42,495	49,372	16.2
2004	Oct	117,902	128,145	8.7	2004	Nov	45,877	51,668	12.6
1995	Dec	30,921	39,353	27.3					
1996	Dec	36,681	41,791	13.9					
1997	Dec	49,381	44,779	-9.3					
1998	Dec	47,874	42,264	-11.7					
1999[c]	Dec								
2000	Dec	41,474	45,586	9.9					
2001	Dec	46,999	47,131	0.3					
2002	Dec	60,621	43,285	-28.6					
2003	Dec	44,262	42,676	-3.6					
2004	Dec	39,957	42,401	6.1					

1) Missing climate data for: a - July 1999; b - July 2002; c - December 1999

2) Missing visitation data for January to December 2005

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

G Rocky Mountain

Year	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb/Mar/Apr/Nov/Dec	365,558	404,142	10.6
1996	Jan/Feb/Mar/Apr/Nov/Dec	375,352	398,399	6.1
1997	Jan/Feb/Mar/Apr/Nov/Dec	377,688	397,939	5.4
1998	Jan/Feb/Mar/Apr/Nov/Dec	389,937	401,099	2.9
1999	Jan/Feb/Mar/Apr/Nov/Dec	449,139	413,706	-7.9
2000	Jan/Feb/Mar/Apr/Nov/Dec	466,241	402,174	-13.7
2001	Jan/Feb/Mar/Apr/Nov/Dec	426,853	410,462	-3.8
2002	Jan/Feb/Mar/Apr/Nov/Dec	404,631	398,315	-1.6
2003	Jan/Feb/Mar/Apr/Nov/Dec	377,425	401,507	6.4
2004	Jan/Feb/Mar/Apr/Nov/Dec	376,591	405,690	7.7
2005	Jan/Feb/Mar/Apr/Nov/Dec	380,647	400,950	5.3
1995	Jun/Jul/Aug/Sep	2,167,781	2,054,513	-5.2
1996	Jun/Jul/Aug/Sep	2,176,219	2,247,277	3.3
1997	Jun/Jul/Aug/Sep	2,193,777	2,115,857	-3.6
1998	Jun/Jul/Aug/Sep	2,219,399	2,253,390	1.5
1999	Jun/Jul/Aug/Sep	2,321,290	2,097,519	-9.6
2000	Jun/Jul/Aug/Sep	2,265,121	2,372,367	4.7
2001	Jun/Jul/Aug/Sep	2,329,419	2,435,239	4.5
2002	Jun/Jul/Aug/Sep	2,171,908	2,557,054	17.7
2003	Jun/Jul/Aug/Sep	2,228,361	2,273,911	2.0
2004	Jun/Jul/Aug/Sep	2,025,241	1,904,754	-5.9
2005	Jun/Jul/Aug/Sep	2,039,374	2,253,826	10.5

Year	Month(s)	Observed	Modeled	% Difference
1995	May	107,774	176,545	63.8
1996	May	177,831	197,156	10.9
1997	May	182,301	187,770	3.0
1998	May	198,448	194,115	-2.2
1999	May	187,697	186,697	-0.5
2000	May	211,790	202,363	-4.5
2001	May	198,797	198,556	-0.1
2002	May	228,491	193,830	-15.2
2003	May	198,771	192,408	-3.2
2004	May	179,887	196,521	9.2
2005	May	178,599	193,196	8.2
1995	Oct	237,056	204,696	-13.7
1996	Oct	194,353	213,735	10.0
1997	Oct	211,588	216,484	2.3
1998	Oct	227,638	208,608	-8.4
1999	Oct	228,197	243,072	6.5
2000	Oct	242,240	235,883	-2.6
2001	Oct	184,616	223,091	20.8
2002	Oct	183,445	191,904	4.6
2003	Oct	262,699	245,292	-6.6
2004	Oct	200,180	209,665	4.7
2005	Oct	199,748	217,805	9.0

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

H Mesa Verde

Year[1]	Month(s)	Observed	Modeled	% Difference	Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Jan	4,683	4,503	-3.8	1995	Feb	6,375	6,596	3.5
1996	Jan	4,222	4,843	14.7	1996	Feb	5,373	5,746	6.9
1997	Jan	4,176	4,369	4.6	1997	Feb	4,411	4,739	7.4
1998	Jan	4,647	4,979	7.1	1998	Feb	4,246	4,367	2.8
1999	Jan	5,659	5,295	-6.4	1999	Feb	6,060	5,962	-1.6
2000	Jan	5,476	5,101	-6.9	2000	Feb	5,424	5,484	1.1
2001	Jan	5,953	4,647	-21.9	2001	Feb	5,890	5,003	-15.1
2002	Jan	5,411	4,837	-10.6	2002	Feb	6,075	5,204	-14.3
2003	Jan	5,240	5,566	6.2	2003	Feb	4,533	4,989	10.1
2004	Jan	3,718	4,670	25.6	2004	Feb	3,859	4,109	6.5
2005	Jan	5,188	5,208	0.4	2005	Feb	5,035	5,081	0.9
1995	Mar/Apr	42,848	34,085	-20.5	1995	May	61,234	60,794	-0.7
1996	Mar/Apr	44,764	40,201	-10.2	1996	May	64,551	55,397	-14.2
1997[a]	Mar/Apr	16,079	19,828	23.3	1997[b]	May			
1998	Mar/Apr	37,782	35,579	-5.8	1998	May	59,334	57,743	-2.7
1999	Mar/Apr	41,963	39,638	-5.5	1999	May	60,979	59,246	-2.8
2000	Mar/Apr	38,342	40,311	5.1	2000	May	54,544	55,476	1.7
2001	Mar/Apr	39,588	39,343	-0.6	2001	May	50,627	55,786	10.2
2002	Mar/Apr	34,383	43,115	25.4	2002	May	54,699	56,516	3.3
2003	Mar/Apr	33,353	37,037	11.0	2003	May	41,268	56,421	36.7
2004	Mar/Apr	36,087	45,329	25.6	2004	May	42,616	56,904	33.5
2005	Mar/Apr	39,471	37,590	-4.8	2005	May	52,117	57,127	9.6
1995	Jun	106,569	104,817	-1.6	1995	Jul	168,285	149,899	-10.9
1996	Jun	111,471	97,182	-12.8	1996	Jul	149,493	127,979	-14.4
1997	Jun	113,185	101,446	-10.4	1997	Jul	145,272	147,347	1.4
1998	Jun	106,280	105,322	-0.9	1998	Jul	134,922	131,578	-2.5
1999	Jun	112,029	103,643	-7.5	1999	Jul	140,050	156,638	11.8
2000	Jun	94,990	98,005	3.2	2000	Jul	75,939	122,287	61.0
2001	Jun	91,085	97,770	7.3	2001	Jul	112,374	132,167	17.6
2002	Jun	80,180	94,011	17.2	2002	Jul	75,745	111,491	47.2
2003	Jun	83,797	99,966	19.3	2003	Jul	86,887	94,217	8.4
2004	Jun	80,600	99,532	23.5	2004	Jul	96,448	137,009	42.1
2005	Jun	95,570	109,163	14.2	2005	Jul	105,330	102,788	-2.4

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Aug	135,332	108,081	-20.1	1995	Sep	80,150	69,327	-13.5
1996	Aug	104,854	100,155	-4.5	1996	Sep	72,755	76,720	5.4
1997	Aug	131,793	116,917	-11.3	1997	Sep	74,904	69,010	-7.9
1998	Aug	120,282	108,081	-10.1	1998	Sep	77,771	67,250	-13.5
1999	Aug	127,159	126,507	-0.5	1999	Sep	79,689	73,399	-7.9
2000	Aug	62,877	98,372	56.5	2000	Sep	61,826	68,541	10.9
2001	Aug	97,236	114,104	17.3	2001	Sep	56,142	66,077	17.7
2002	Aug	51,962	105,267	102.6	2002	Sep	48,431	72,765	50.2
2003	Aug	82,861	100,433	21.2	2003	Sep	47,380	70,700	49.2
2004	Aug	81,771	114,341	39.8	2004	Sep	52,791	74,220	40.6
2005	Aug	88,348	113,589	28.6	2005	Sep	57,200	70,113	22.6
1995	Oct	45,786	39,779	-13.1	1995	Nov	9,817	10,522	7.2
1996	Oct	43,592	39,235	-10.0	1996	Nov	10,444	9,979	-4.5
1997	Oct	40,824	39,430	-3.4	1997	Nov	8,937	10,449	16.9
1998	Oct	44,159	39,151	-11.3	1998	Nov	8,074	10,475	29.7
1999	Oct	43,272	40,719	-5.9	1999	Nov	11,626	10,724	-7.8
2000	Oct	36,896	39,165	6.1	2000	Nov	9,227	9,053	-1.9
2001	Oct	37,384	40,462	8.2	2001	Nov	11,533	10,539	-8.6
2002	Oct	34,395	38,833	12.9	2002	Nov	9,067	10,059	10.9
2003	Oct	36,768	40,898	11.2	2003	Nov	10,814	9,648	-10.8
2004	Oct	33,497	38,903	16.1	2004	Nov	8,771	9,779	11.5
2005	Oct	31,087	39,810	28.1	2005	Nov	11,057	10,543	-4.7
1995	Dec	2,715	6,887	153.7					
1996	Dec	5,841	5,431	-7.0					
1997	Dec	5,366	6,054	12.8					
1998	Dec	7,059	6,602	-6.5					
1999	Dec	7,250	6,597	-9.0					
2000	Dec	6,746	6,591	-2.3					
2001	Dec	5,597	5,962	6.5					
2002	Dec	6,037	6,129	1.5					
2003	Dec	5,689	6,627	16.5					
2004	Dec	6,653	6,245	-6.1					
2005	Dec	7,930	6,474	-18.4					

1) Missing climate data for: a - April 1997; b - May 1997

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

I Saguaro

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb	178,190	163,223	-8.4
1996	Jan/Feb	122,926	156,237	27.1
1997	Jan/Feb	159,768	152,268	-4.7
1998	Jan/Feb	148,517	148,244	-0.2
1999	Jan/Feb	149,131	148,852	-0.2
2000	Jan/Feb	185,556	152,795	-17.7
2001	Jan/Feb	158,670	147,644	-6.9
2002	Jan/Feb	130,684	150,978	15.5
2003	Jan/Feb	143,121	155,910	8.9
2004	Jan/Feb	146,671	151,359	3.2
2005	Jan/Feb	153,001	159,662	4.4
1995	Apr/May	160,822	137,475	-14.5
1996	Apr/May	117,727	117,636	-0.1
1997[b]	Apr/May	67,192	39,358	-41.4
1998	Apr/May	154,375	151,963	-1.6
1999	Apr/May	124,979	151,418	21.2
2000	Apr/May	123,814	116,831	-5.6
2001	Apr/May	140,860	128,502	-8.8
2002	Apr/May	103,117	125,448	21.7
2003	Apr/May	111,096	132,361	19.1
2004	Apr/May	104,512	124,383	19.0
2005	Apr/May	126,215	125,543	-0.5
1995	Jul	32,069	38,188	19.1
1996	Jul	33,883	37,426	10.5
1997	Jul	41,088	35,392	-13.9
1998	Jul	39,013	40,448	3.7
1999	Jul	45,681	43,601	-4.6
2000	Jul	42,136	39,949	-5.2
2001	Jul	43,414	40,222	-7.4
2002	Jul	37,835	40,877	8.0
2003	Jul	38,741	38,806	0.2
2004	Jul	42,098	40,996	-2.6
2005	Jul	38,220	38,271	0.1

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Mar	109,434	108,415	-0.9
1996	Mar	85,078	108,454	27.5
1997	Mar	116,029	108,418	-6.6
1998	Mar	95,458	108,510	13.7
1999	Mar	117,488	108,490	-7.7
2000	Mar	103,194	108,499	5.1
2001	Mar	114,921	108,473	-5.6
2002	Mar	109,323	108,509	-0.7
2003	Mar	111,760	108,476	-2.9
2004	Mar	98,564	108,381	10.0
2005[a]	Mar			
1995	Jun	34,025	41,562	22.2
1996	Jun	36,174	37,226	2.9
1997	Jun	46,766	39,199	-16.2
1998	Jun	45,231	44,270	-2.1
1999	Jun	49,021	40,881	-16.6
2000	Jun	50,792	40,146	-21.0
2001	Jun	39,500	40,111	1.5
2002	Jun	33,564	39,465	17.6
2003	Jun	33,228	39,881	20.0
2004	Jun	34,763	40,323	16.0
2005[c]	Jun			
1995	Aug	40,165	40,249	0.2
1996	Aug	31,636	40,664	28.5
1997	Aug	44,289	39,612	-10.6
1998	Aug	41,516	40,783	-1.8
1999	Aug	43,119	41,151	-4.6
2000	Aug	37,172	41,126	10.6
2001	Aug	39,233	40,887	4.2
2002	Aug	39,101	40,968	4.8
2003	Aug	42,007	40,514	-3.6
2004	Aug	37,625	40,840	8.5
2005	Aug	47,620	41,040	-13.8

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Sep	50,443	30,345	-39.8
1996	Sep	55,344	43,084	-22.2
1997[d]	Sep			
1998	Sep	39,808	36,858	-7.4
1999	Sep	41,091	36,714	-10.7
2000	Sep	36,249	33,899	-6.5
2001	Sep	32,738	31,434	-4.0
2002	Sep	32,300	34,516	6.9
2003	Sep	28,814	34,392	19.4
2004	Sep	34,178	37,742	10.4
2005	Sep	34,215	33,838	-1.1
1995	Nov/Dec	75,394	110,901	47.1
1996	Nov/Dec	122,702	113,244	-7.7
1997[e]	Nov/Dec			
1998	Nov/Dec	94,995	114,848	20.9
1999	Nov/Dec	122,956	113,087	-8.0
2000	Nov/Dec	139,088	116,682	-16.1
2001	Nov/Dec	117,123	112,759	-3.7
2002	Nov/Dec	108,139	112,906	4.4
2003	Nov/Dec	91,183	112,549	23.4
2004	Nov/Dec	107,574	112,906	5.0
2005[f]	Nov/Dec	60,360	58,172	-3.6

1995	Oct	52,271	53,646	2.6
1996	Oct	66,173	55,468	-16.2
1997	Oct	64,254	53,867	-16.2
1998	Oct	57,247	56,256	-1.7
1999	Oct	55,548	52,760	-5.0
2000	Oct	47,194	55,295	17.2
2001	Oct	39,415	50,371	27.8
2002	Oct	20,982	55,862	166.2
2003	Oct	43,747	41,877	-4.3
2004	Oct	45,479	54,434	19.7
2005	Oct	50,482	47,836	-5.2

1) Missing climate data for: a - March 2005; b - April 1997; c - June 2005; d - September 1997; e - November and December 1997; f - November 2005

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

J Hot Springs

Year[1,2]	Month(s)	Observed	Modeled	% Difference
1995	Jan/Dec	133,559	132,155	-1.1
1996	Jan/Dec	132,108	141,944	7.4
1997	Jan/Dec	134,589	128,849	-4.3
1998	Jan/Dec	158,618	145,121	-8.5
1999	Jan/Dec	121,242	147,908	22.0
2000	Jan/Dec	101,660	122,560	20.6
2001	Jan/Dec	119,566	140,583	17.6
2002	Jan/Dec	136,142	146,547	7.6
2003[a]	Jan/Dec	58,698	65,753	12.0
2004	Jan/Dec	169,060	142,657	-15.6
1995	Mar/Apr	247,834	249,873	0.8
1996	Mar/Apr	236,721	241,058	1.8
1997	Mar/Apr	227,640	246,882	8.5
1998	Mar/Apr	256,974	243,968	-5.1
1999	Mar/Apr	230,038	246,517	7.2
2000	Mar/Apr	240,845	252,568	4.9
2001	Mar/Apr	231,240	249,591	7.9
2002	Mar/Apr	249,684	247,327	-0.9
2003	Mar/Apr	278,864	252,236	-9.5
2004	Mar/Apr	109,638	123,957	13.1
1995	Aug/Sep	305,349	260,357	-14.7
1996	Aug/Sep	320,307	261,204	-18.5
1997	Aug/Sep	290,699	276,712	-4.8
1998	Aug/Sep	281,641	280,083	-0.6
1999	Aug/Sep	266,781	271,737	1.9
2000	Aug/Sep	240,566	272,610	13.3
2001	Aug/Sep	247,983	269,499	8.7
2002	Aug/Sep	291,910	279,425	-4.3
2003	Aug/Sep	237,628	263,671	11.0
2004	Aug/Sep	261,976	270,175	3.1

Year[1,2]	Month(s)	Observed	Modeled	% Difference
1995	Feb	89,003	73,733	-17.2
1996	Feb	76,328	74,836	-2.0
1997	Feb	74,464	71,880	-3.5
1998	Feb	72,144	73,253	1.5
1999	Feb	80,142	77,922	-2.8
2000	Feb	70,500	78,614	11.5
2001	Feb	69,789	73,287	5.0
2002	Feb	74,832	70,884	-5.3
2003	Feb	57,610	70,404	22.2
2004	Feb	90,441	67,378	-25.5
1995	May/Jun/Jul	590,242	470,388	-20.3
1996	May/Jun/Jul	540,055	476,857	-11.7
1997	May/Jun/Jul	529,160	465,985	-11.9
1998	May/Jun/Jul	448,728	471,950	5.2
1999	May/Jun/Jul	447,453	472,637	5.6
2000	May/Jun/Jul	466,232	463,712	-0.5
2001	May/Jun/Jul	395,546	476,800	20.5
2002	May/Jun/Jul	452,960	477,193	5.4
2003	May/Jun/Jul	635,969	461,504	-27.4
2004[b]	May/Jun/Jul	283,312	310,385	9.6
1995	Oct/Nov	251,090	244,754	-2.5
1996	Oct/Nov	232,586	222,054	-4.5
1997	Oct/Nov	253,044	225,184	-11.0
1998	Oct/Nov	277,888	244,881	-11.9
1999	Oct/Nov	238,813	260,636	9.1
2000	Oct/Nov	218,353	233,909	7.1
2001	Oct/Nov	232,662	256,925	10.4
2002	Oct/Nov	234,699	221,157	-5.8
2003	Oct/Nov	211,005	249,529	18.3
2004	Oct/Nov	203,905	237,760	16.6

1) Missing climate data for: a - December 2003; b - June 2004
2) Missing climate data for January to December 2005

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

K Cuyahoga Valley

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb	478,596	476,407	-0.5
1996	Jan/Feb	478,948	475,241	-0.8
1997	Jan/Feb	490,724	479,070	-2.4
1998	Jan/Feb	499,238	483,914	-3.1
1999	Jan/Feb	410,270	480,254	17.1
2000	Jan/Feb	472,375	479,002	1.4
2001	Jan/Feb	466,961	477,432	2.2
2002	Jan/Feb	501,283	482,646	-3.7
2003	Jan/Feb	480,835	469,908	-2.3
2004	Jan/Feb	498,920	474,275	-4.9
1995	Jul/Aug	757,192	775,164	2.4
1996	Jul/Aug	931,822	792,857	-14.9
1997	Jul/Aug	858,606	757,647	-11.8
1998	Jul/Aug	879,584	803,914	-8.6
1999	Jul/Aug	741,274	735,430	-0.8
2000	Jul/Aug	644,522	747,367	16.0
2001	Jul/Aug	716,340	804,828	12.4
2002	Jul/Aug	758,202	767,262	1.2
2003	Jul/Aug	558,737	803,062	43.7
2004	Jul/Aug	765,652	744,840	-2.7
1995	Oct	291,811	368,135	26.2
1996	Oct	277,322	334,473	20.6
1997	Oct	398,734	339,282	-14.9
1998	Oct	307,877	341,005	10.8
1999	Oct	342,141	331,468	-3.1
2000	Oct	376,690	383,763	1.9
2001	Oct	253,652	344,692	35.9
2002	Oct	262,022	265,348	1.3
2003	Oct	286,433	288,189	0.6
2004	Oct	366,784	334,473	-8.8

Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Mar/Apr/May/Jun	999,800	1,069,728	7.0
1996	Mar/Apr/May/Jun	1,128,059	997,183	-11.6
1997	Mar/Apr/May/Jun	1,143,774	998,540	-12.7
1998	Mar/Apr/May/Jun	1,116,291	1,071,115	-4.0
1999	Mar/Apr/May/Jun	1,115,714	1,081,408	-3.1
2000	Mar/Apr/May/Jun	1,158,257	1,086,096	-6.2
2001	Mar/Apr/May/Jun	1,059,150	1,041,587	-1.7
2002	Mar/Apr/May/Jun	1,061,961	1,050,658	-1.1
2003	Mar/Apr/May/Jun	997,775	1,046,923	4.9
2004	Mar/Apr/May/Jun	976,192	1,057,357	8.3
1995	Sep	421,389	293,835	-30.3
1996	Sep	401,641	291,645	-27.4
1997	Sep	340,423	291,919	-14.2
1998	Sep	322,829	300,790	-6.8
1999	Sep	332,420	298,106	-10.3
2000	Sep	265,275	292,138	10.1
2001	Sep	290,214	292,521	0.8
2002	Sep	279,230	303,856	8.8
2003	Sep	259,371	291,809	12.5
2004	Sep	279,209	297,833	6.7
1995	Nov	92,361	126,352	36.8
1996	Nov	98,305	115,895	17.9
1997	Nov	156,051	133,671	-14.3
1998	Nov	179,090	197,978	10.5
1999	Nov	185,112	218,630	18.1
2000	Nov	174,997	143,866	-17.8
2001	Nov	172,580	240,850	39.6
2002	Nov	147,299	149,094	1.2
2003	Nov	94,103	210,787	124.0
2004	Nov	247,374	195,103	-21.1

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Dec	154,058	165,693	7.6
1996	Dec	139,781	166,738	19.3
1997	Dec	139,525	166,312	19.2
1998	Dec	162,198	166,934	2.9
1999	Dec	197,353	166,582	-15.6
2000	Dec	232,802	165,361	-29.0
2001	Dec	164,456	166,848	1.5
2002	Dec	207,938	166,076	-20.1
2003	Dec	202,337	166,316	-17.8
2004	Dec	172,044	166,329	-3.3

1) Missing climate data for January to December 2005

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

L Acadia

Year[1,2]	Month(s)	Observed	Modeled	% Difference
1995	Jan/Dec	29,704	34,933	17.6
1996	Jan/Dec	37,119	33,674	-9.3
1997	Jan/Dec	36,002	34,086	-5.3
1998	Jan/Dec	33,498	32,630	-2.6
1999	Jan/Dec	32,641	32,899	0.8
2000	Jan/Dec	37,461	35,051	-6.4
2001	Jan/Dec	33,580	33,302	-0.8
2002	Jan/Dec	29,514	33,374	13.1
2003	Jan/Dec	35,885	35,455	-1.2
2004	Jan/Dec	24,082	37,117	54.1
1995	Mar	32,120	32,407	0.9
1996	Mar	32,452	32,407	-0.1
1997	Mar	27,035	31,881	17.9
1998	Mar	27,500	32,933	19.8
1999	Mar	33,688	32,729	-2.8
2000	Mar	35,423	33,414	-5.7
2001	Mar	35,473	31,830	-10.3
2002	Mar	34,498	32,605	-5.5
2003	Mar	34,274	32,260	-5.9
2004	Mar	20,952	32,384	54.6
1995	May	175,550	153,338	-12.7
1996	May	166,290	154,716	-7.0
1997	May	132,194	150,255	13.7
1998	May	148,052	159,685	7.9
1999	May	174,610	158,017	-9.5
2000	May	166,456	153,447	-7.8
2001	May	157,353	160,483	2.0
2002	May	163,145	154,607	-5.2
2003	May	135,443	151,851	12.1
2004	May	134,597	157,291	16.9

Year[1,2]	Month(s)	Observed	Modeled	% Difference
1995	Feb	20,510	22,164	8.1
1996	Feb	15,576	21,625	38.8
1997	Feb	17,230	20,237	17.5
1998	Feb	17,028	19,777	16.1
1999	Feb	17,162	19,692	14.7
2000	Feb	23,848	20,479	-14.1
2001	Feb	23,926	21,364	-10.7
2002	Feb	25,071	20,116	-19.8
2003	Feb	21,993	22,940	4.3
2004	Feb	14,266	20,549	44.0
1995[a]	Apr			
1996	Apr	76,597	74,550	-2.7
1997	Apr	77,005	73,237	-4.9
1998	Apr	81,896	82,221	0.4
1999	Apr	82,993	81,461	-1.8
2000	Apr	78,555	76,416	-2.7
2001	Apr	76,007	77,867	2.4
2002	Apr	72,528	76,900	6.0
2003	Apr	68,444	71,372	4.3
2004	Apr	60,180	75,794	25.9
1995	Jun	355,270	332,526	-6.4
1996	Jun	327,723	319,861	-2.4
1997	Jun	340,064	329,752	-3.0
1998	Jun	307,208	306,272	-0.3
1999	Jun	315,980	333,080	5.4
2000	Jun	319,208	321,802	0.8
2001	Jun	325,242	333,358	2.5
2002	Jun	325,441	315,146	-3.2
2003	Jun	309,230	321,525	4.0
2004	Jun	305,134	317,180	3.9

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Jul/Aug	1,380,746	1,272,085	-7.9	1995	Sep	439,553	398,232	-9.4
1996	Jul/Aug	1,285,107	1,122,209	-12.7	1996	Sep	426,562	400,287	-6.2
1997	Jul/Aug	1,380,987	1,231,271	-10.8	1997	Sep	404,808	400,717	-1.0
1998	Jul/Aug	1,266,574	1,245,322	-1.7	1998	Sep	391,378	396,750	1.4
1999	Jul/Aug	1,202,069	1,257,365	4.6	1999	Sep	426,024	392,496	-7.9
2000	Jul/Aug	1,142,833	1,082,733	-5.3	2000	Sep	378,135	398,710	5.4
2001	Jul/Aug	1,188,881	1,241,307	4.4	2001	Sep	377,456	395,842	4.9
2002	Jul/Aug	1,207,943	1,268,740	5.0	2002	Sep	392,531	393,261	0.2
2003	Jul/Aug	1,143,027	1,190,456	4.1	2003	Sep	376,060	396,129	5.3
2004	Jul/Aug	996,081	1,088,086	9.2	2004	Sep	357,146	397,228	11.2
1995	Oct	271,606	260,085	-4.2	1995	Nov	54,121	51,593	-4.7
1996	Oct	280,577	272,143	-3.0	1996	Nov	56,828	53,207	-6.4
1997	Oct	287,171	272,961	-4.9	1997	Nov	57,810	53,067	-8.2
1998	Oct	266,138	272,366	2.3	1998	Nov	55,225	46,820	-15.2
1999	Oct	277,644	270,431	-2.6	1999	Nov	39,416	37,975	-3.7
2000	Oct	253,626	267,156	5.3	2000	Nov	33,693	48,013	42.5
2001	Oct	257,280	260,830	1.4	2001	Nov	41,353	38,256	-7.5
2002	Oct	271,312	274,748	1.3	2002	Nov	36,589	49,698	35.8
2003	Oct	262,412	270,282	3.0	2003	Nov	44,294	43,591	-1.6
2004	Oct	261,284	268,049	2.6	2004	Nov	34,125	45,556	33.5

1) Missing climate data for: a - April 1995

2) Missing climate data for January to December 2005

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

M Great Smoky Mountains

Year	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb	541,701	567,641	4.8
1996	Jan/Feb	610,851	572,342	-6.3
1997	Jan/Feb	577,489	651,359	12.8
1998	Jan/Feb	588,289	623,553	6.0
1999	Jan/Feb	655,379	694,868	6.0
2000	Jan/Feb	754,952	670,963	-11.1
2001	Jan/Feb	660,211	609,850	-7.6
2002	Jan/Feb	637,743	676,865	6.1
2003	Jan/Feb	637,653	545,336	-14.5
2004	Jan/Feb	643,229	569,841	-11.4
2005	Jan/Feb	692,153	681,266	-1.6
1995	Apr/May	1,370,002	1,499,977	9.5
1996	Apr/May	1,425,560	1,482,977	4.0
1997	Apr/May	1,416,750	1,392,204	-1.7
1998	Apr/May	1,543,755	1,464,843	-5.1
1999	Apr/May	1,623,434	1,494,001	-8.0
2000	Apr/May	1,572,877	1,461,958	-7.1
2001	Apr/May	1,464,966	1,520,996	3.8
2002	Apr/May	1,464,352	1,509,662	3.1
2003	Apr/May	1,481,446	1,478,031	-0.2
2004	Apr/May	1,449,399	1,491,219	2.9
2005	Apr/May	1,419,321	1,435,993	1.2
1995	Jul	1,351,579	1,512,505	11.9
1996	Jul	1,394,781	1,463,832	5.0
1997	Jul	1,743,996	1,491,687	-14.5
1998	Jul	1,672,297	1,478,932	-11.6
1999	Jul	1,674,267	1,483,624	-11.4
2000	Jul	1,703,605	1,477,027	-13.3
2001	Jul	1,373,170	1,475,561	7.5
2002	Jul	1,359,477	1,508,693	11.0
2003	Jul	1,326,666	1,459,581	10.0
2004	Jul	1,355,683	1,461,926	7.8
2005	Jul	1,333,994	1,476,147	10.7

Year	Month(s)	Observed	Modeled	% Difference
1995	Mar	445,804	499,740	12.1
1996	Mar	387,653	442,797	14.2
1997	Mar	483,391	518,781	7.3
1998	Mar	472,838	464,550	-1.8
1999	Mar	454,227	456,777	0.6
2000	Mar	525,438	508,899	-3.1
2001	Mar	467,539	454,427	-2.8
2002	Mar	522,266	499,138	-4.4
2003	Mar	533,896	511,008	-4.3
2004	Mar	506,804	503,657	-0.6
2005	Mar	524,650	464,731	-11.4
1995	Jun	1,165,049	1,122,850	-3.6
1996	Jun	1,137,719	1,145,395	0.7
1997	Jun	1,091,996	1,109,991	1.6
1998	Jun	1,145,571	1,151,490	0.5
1999	Jun	1,250,890	1,140,886	-8.8
2000	Jun	1,167,097	1,151,490	-1.3
2001	Jun	1,085,811	1,127,025	3.8
2002	Jun	1,159,339	1,166,520	0.6
2003	Jun	1,156,774	1,129,530	-2.4
2004	Jun	1,076,888	1,134,790	5.4
2005	Jun	1,124,130	1,129,196	0.5
1995	Aug	1,171,837	1,161,220	-0.9
1996	Aug	1,156,114	1,096,340	-5.2
1997	Aug	1,362,372	1,118,365	-17.9
1998	Aug	1,184,421	1,153,537	-2.6
1999	Aug	1,206,176	1,185,465	-1.7
2000	Aug	1,147,933	1,117,170	-2.7
2001	Aug	1,121,119	1,121,609	0.0
2002	Aug	1,090,431	1,175,562	7.8
2003	Aug	1,109,676	1,123,317	1.2
2004	Aug	1,002,046	1,055,534	5.3
2005	Aug	997,352	1,132,536	13.6

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

1995	Sep	953,804	960,009	0.7	1995	Oct	1,070,437	1,146,001	7.1
1996	Sep	970,447	950,829	-2.0	1996	Oct	1,182,349	1,140,181	-3.6
1997	Sep	1,029,761	989,844	-3.9	1997	Oct	1,181,685	1,134,036	-4.0
1998	Sep	1,047,938	1,062,136	1.4	1998	Oct	1,179,433	1,164,221	-1.3
1999	Sep	1,081,556	1,026,908	-5.1	1999	Oct	1,136,547	1,143,336	0.6
2000	Sep	1,009,287	981,467	-2.8	2000	Oct	1,208,590	1,159,489	-4.1
2001	Sep	989,884	961,960	-2.8	2001	Oct	1,095,602	1,138,822	3.9
2002	Sep	947,207	1,020,023	7.7	2002	Oct	1,104,852	1,144,587	3.6
2003	Sep	807,827	967,697	19.8	2003	Oct	1,239,051	1,139,311	-8.0
2004	Sep	876,758	953,468	8.7	2004	Oct	1,158,267	1,156,715	-0.1
2005	Sep	854,342	1,037,235	21.4	2005	Oct	1,054,311	1,144,424	8.5
1995	Nov	532,510	607,177	14.0	1995	Dec	477,697	445,582	-6.7
1996	Nov	552,780	601,072	8.7	1996	Dec	447,413	453,119	1.3
1997	Nov	624,029	596,243	-4.5	1997	Dec	453,606	447,491	-1.3
1998	Nov	729,487	665,127	-8.8	1998	Dec	425,366	452,641	6.4
1999	Nov	741,325	717,063	-3.3	1999	Dec	459,797	453,646	-1.3
2000	Nov	668,947	640,525	-4.2	2000	Dec	417,086	440,193	5.5
2001	Nov	595,586	735,286	23.5	2001	Dec	343,809	459,525	33.7
2002	Nov	676,504	616,288	-8.9	2002	Dec	354,249	448,785	26.7
2003	Nov	658,929	710,685	7.9	2003	Dec	414,927	446,398	7.6
2004	Nov	630,539	691,004	9.6	2004	Dec	467,433	448,056	-4.1
2005	Nov	721,684	691,550	-4.2	2005	Dec	470,540	446,737	-5.1

Table 1 continued – Difference between Monthly or Seasonal Observed and Modeled Recreation Visits for 1995-2005

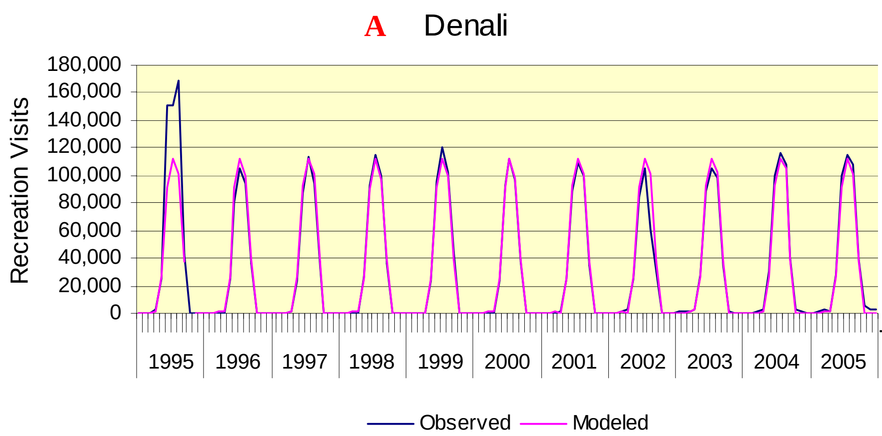
N Everglades

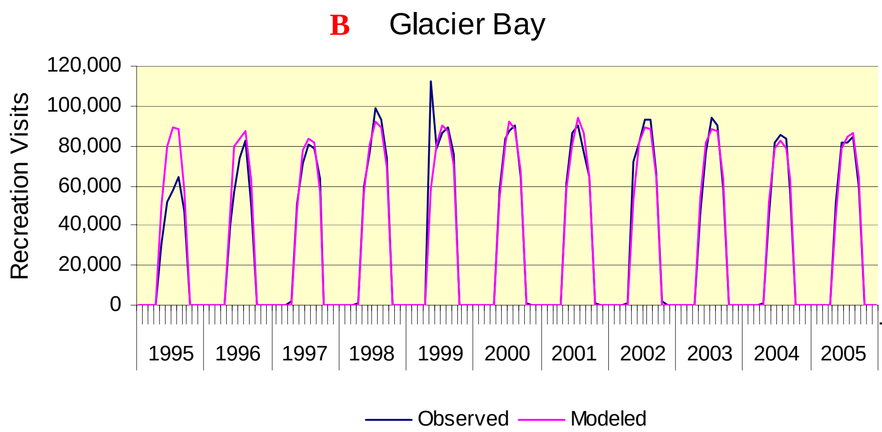
Year[1]	Month(s)	Observed	Modeled	% Difference	Year[1]	Month(s)	Observed	Modeled	% Difference
1995	Jan/Feb	204,007	258,610	26.8	1995[b]	Mar/Apr	91,298	88,778	-2.8
1996	Jan/Feb	190,240	256,417	34.8	1996	Mar/Apr	207,944	252,395	21.4
1997	Jan/Feb	230,723	259,060	12.3	1997	Mar/Apr	220,911	216,343	-2.1
1998	Jan/Feb	246,514	259,330	5.2	1998	Mar/Apr	236,425	235,882	-0.2
1999	Jan/Feb	258,276	258,740	0.2	1999	Mar/Apr	263,846	255,132	-3.3
2000	Jan/Feb	240,790	257,362	6.9	2000	Mar/Apr	227,946	246,635	8.2
2001	Jan/Feb	290,537	255,205	-12.2	2001	Mar/Apr	247,730	270,685	9.3
2002[a]	Jan/Feb				2002	Mar/Apr	228,990	225,608	-1.5
2003	Jan/Feb	247,334	255,532	3.3	2003	Mar/Apr	229,730	233,865	1.8
2004	Jan/Feb	302,886	255,989	-15.5	2004	Mar/Apr	213,205	264,445	24.0
2005	Jan/Feb	263,430	256,413	-2.7	2005	Mar/Apr	411,938	289,648	-29.7
1995	May	67,638	68,712	1.6	1995[c]	Jun/Jul/Aug	102,967	122,691	19.2
1996	May	71,766	73,412	2.3	1996	Jun/Jul/Aug	153,872	176,454	14.7
1997	May	72,557	75,387	3.9	1997	Jun/Jul/Aug	165,028	180,518	9.4
1998	May	94,166	78,191	-17.0	1998	Jun/Jul/Aug	225,143	179,063	-20.5
1999	May	82,388	82,851	0.6	1999	Jun/Jul/Aug	202,342	179,268	-11.4
2000	May	81,748	82,792	1.3	2000	Jun/Jul/Aug	141,996	168,721	18.8
2001	May	78,059	87,808	12.5	2001	Jun/Jul/Aug	178,271	172,990	-3.0
2002	May	59,925	80,363	34.1	2002	Jun/Jul/Aug	150,555	176,754	17.4
2003	May	68,448	74,538	8.9	2003	Jun/Jul/Aug	188,207	178,351	-5.2
2004	May	139,849	80,166	-42.7	2004	Jun/Jul/Aug	251,483	167,677	-33.3
2005	May	92,696	85,774	-7.5	2005	Jun/Jul/Aug	169,260	181,324	7.1
1995[d]	Sep				1995	Oct/Nov/Dec	146,865	230,752	57.1
1996	Sep	51,386	47,821	-6.9	1996	Oct/Nov/Dec	214,959	235,207	9.4
1997	Sep	45,536	45,141	-0.9	1997	Oct/Nov/Dec	254,777	233,181	-8.5
1998	Sep	56,280	48,542	-13.7	1998	Oct/Nov/Dec	259,687	216,610	-16.6
1999	Sep	58,989	53,490	-9.3	1999	Oct/Nov/Dec	208,141	228,884	10.0
2000	Sep	58,225	55,036	-5.5	2000	Oct/Nov/Dec	244,685	242,509	-0.9
2001	Sep	40,968	53,078	29.6	2001[e]	Oct/Nov/Dec	54,878	68,045	24.0
2002	Sep	46,264	46,481	0.5	2002	Oct/Nov/Dec	242,709	237,076	-2.3
2003	Sep	55,460	48,130	-13.2	2003	Oct/Nov/Dec	251,469	236,817	-5.8
2004	Sep	35,407	47,512	34.2	2004	Oct/Nov/Dec	238,525	236,889	-0.7
2005	Sep	44,948	48,233	7.3	2005[f]	Oct/Nov/Dec			

1) Missing climate data for: a - January and February 2002; b - March 1995; c - June 1995; d - September 1995; e - November and December 2001; f - October to December 2005

Appendix E – 1995-2005 Observed versus Modeled Recreation Visits

Figure 1 – 1995-2005 Observed versus Modeled Recreation Visits





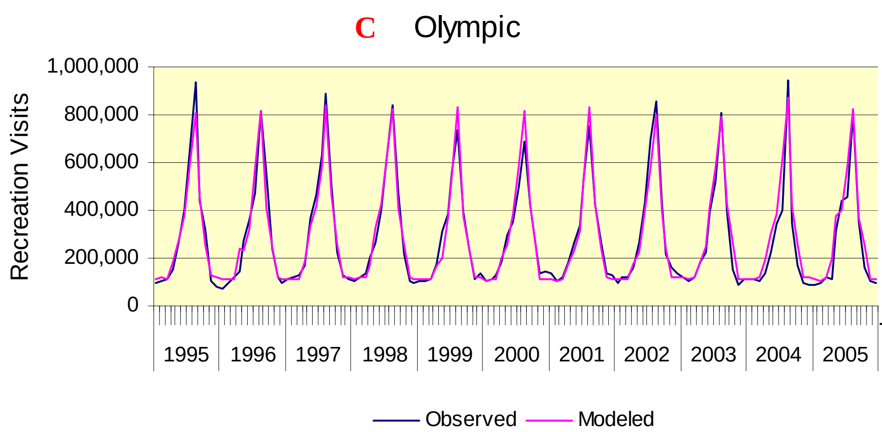
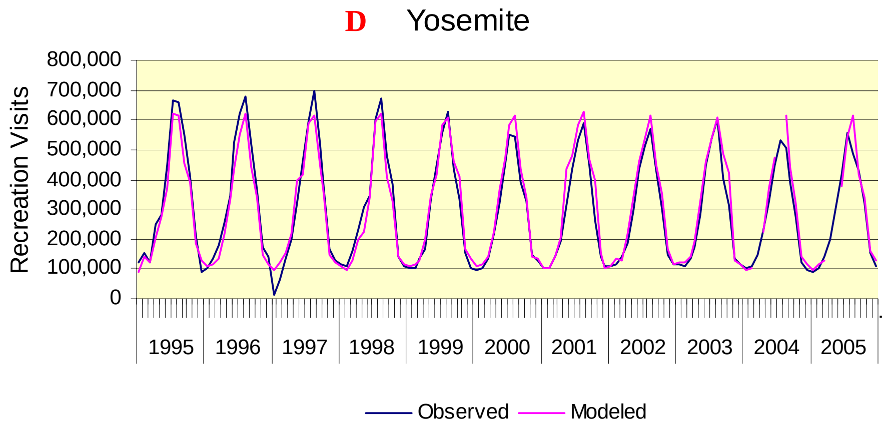
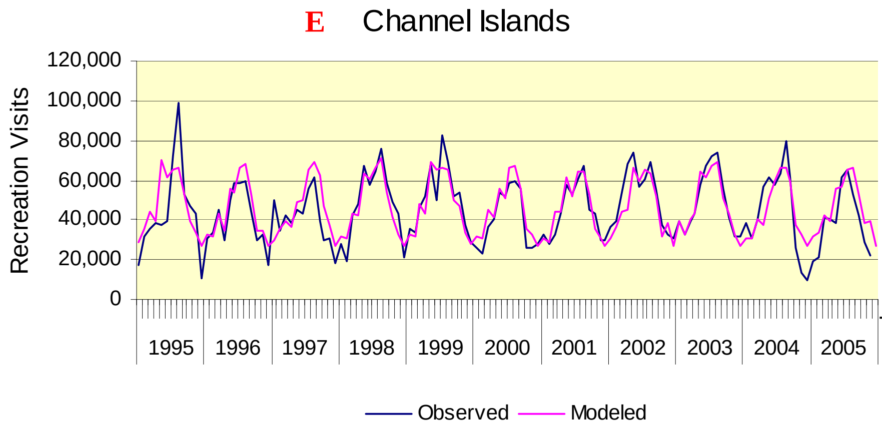


Figure 1 continued –1995-2005 Observed versus Modeled Recreation Visits





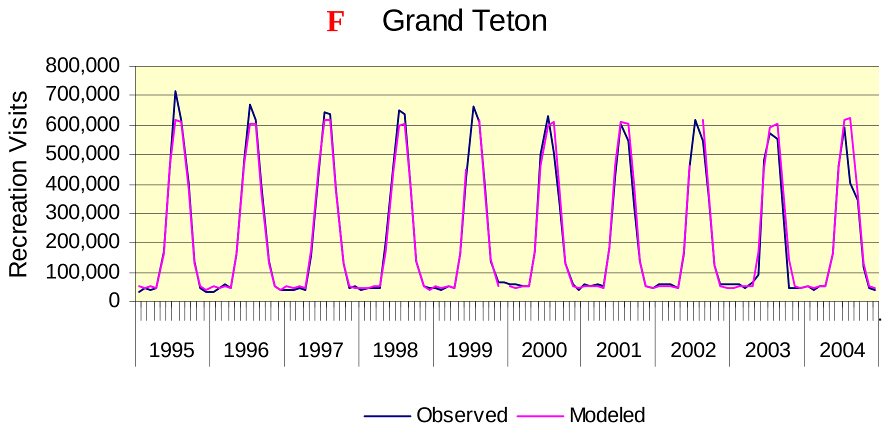
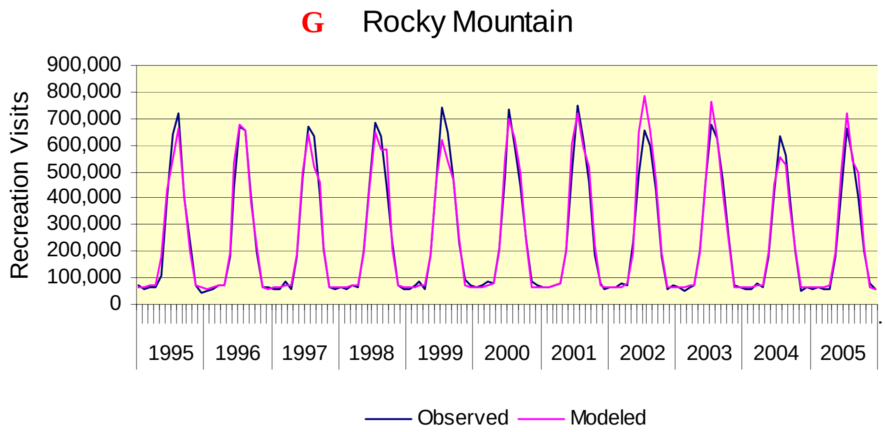
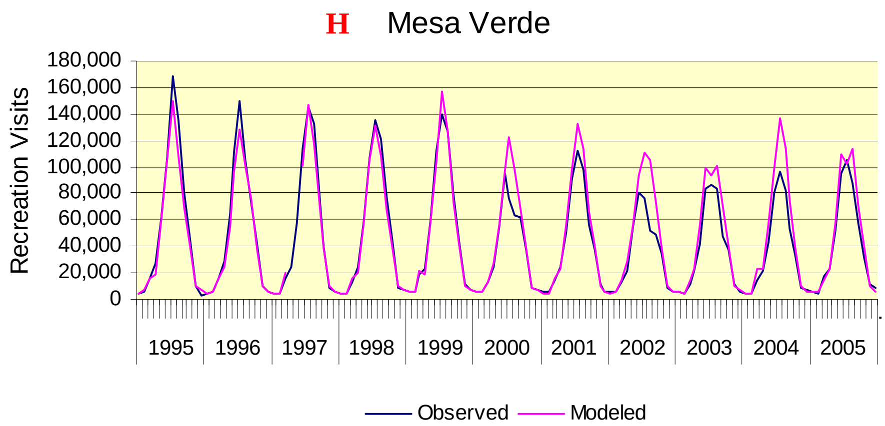


Figure 1 continued – 1995-2005 Observed versus Modeled Recreation Visits





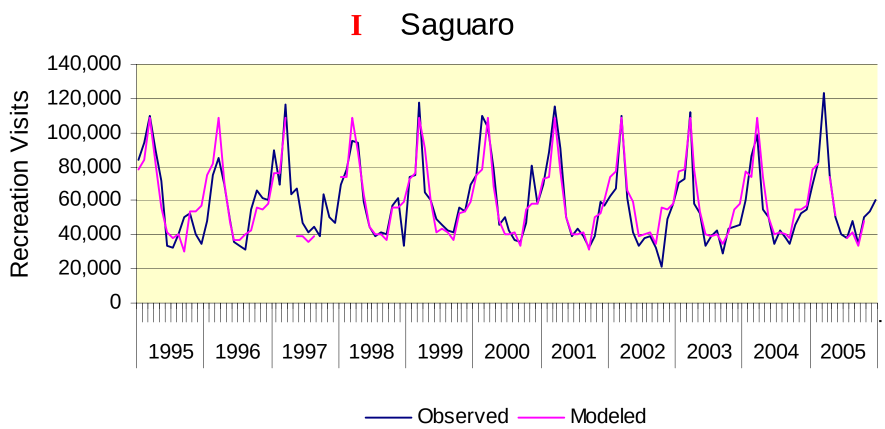
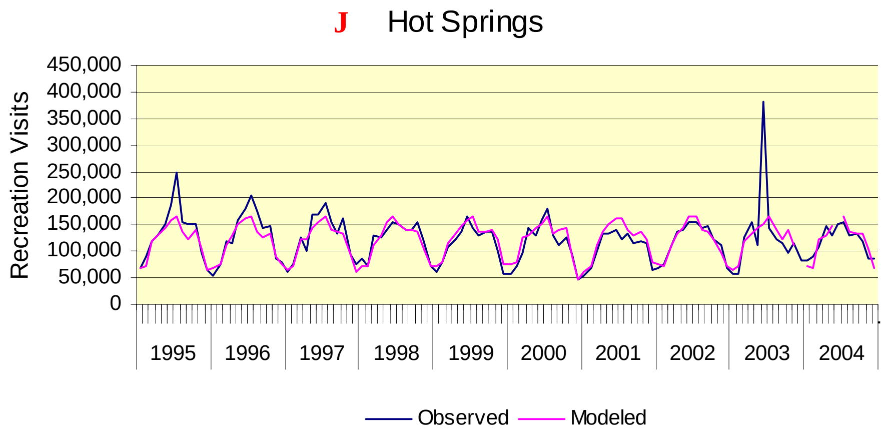
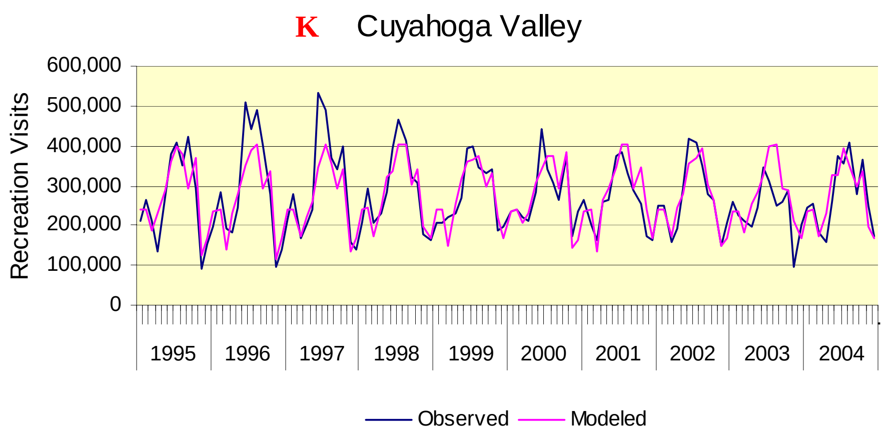


Figure 1 continued – 1995-2005 Observed versus Modeled Recreation Visits





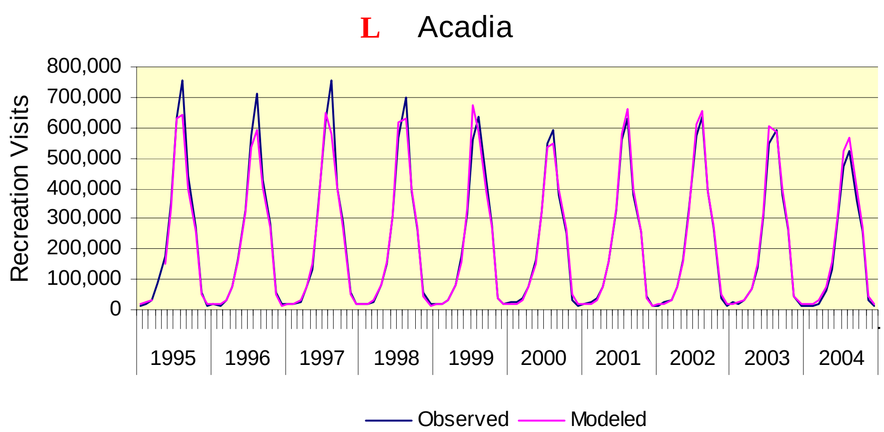
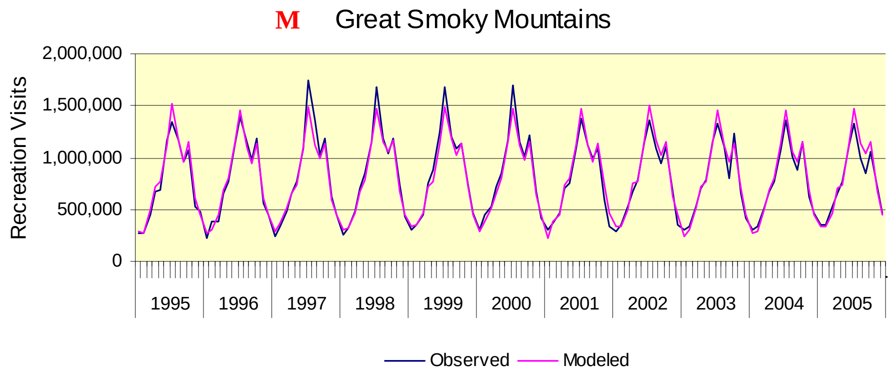
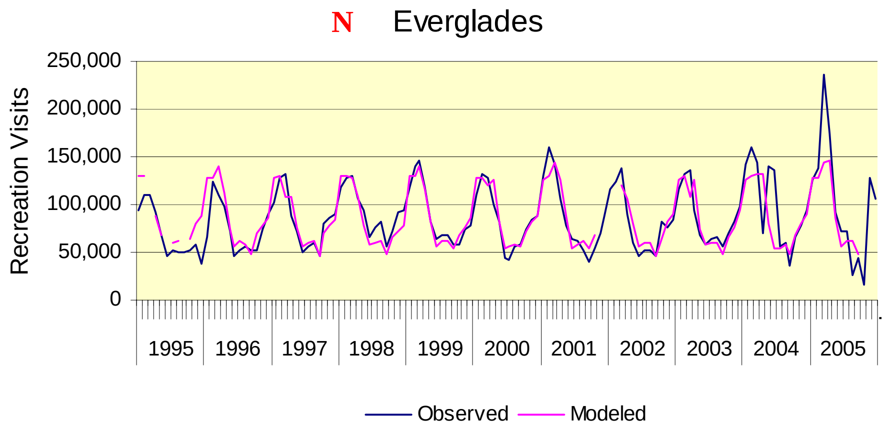


Figure 1 continued –1995-2005 Observed versus Modeled Recreation Visits





Appendix F – Projected Range of Temperature (°C) Changes under Climate Change

Table 1 – Projected Range of Temperature (°C) Changes under Climate Change

A Denali

Month	1961-90 Baseline	Least Change (HADCM3 B21) 2020s	2050s	2080s	Most Change (CSIROMK2B A11) 2020s	2050s	2080s
J	-7.1	-6.2	-5.8	-4.3	-4.9	-3.0	-1.1
F	-3.7	-2.8	-2.4	-0.9	-1.5	0.4	2.3
M	0.8	1.7	2.1	3.6	3.0	4.9	6.8
A	6.3	7.2	7.6	9.1	8.5	10.4	12.3
M	13.4	14.3	14.7	16.2	15.6	17.5	19.4
J	18.0	18.9	19.3	20.8	20.2	22.1	24.0
J	19.8	20.7	21.1	22.6	22.0	23.9	25.8
A	18.0	18.9	19.3	20.8	20.2	22.1	24.0
S	13.1	14.0	14.4	15.9	15.3	17.2	19.1
O	4.0	4.9	5.3	6.8	6.2	8.1	10.0
N	-3.9	-3.0	-2.6	-1.1	-1.7	0.2	2.1
D	-6.8	-5.9	-5.5	-4.0	-4.6	-2.7	-0.8

B Glacier Bay

Month	1961-90 Baseline	Least Change (HADCM3 B21) 2020s	2050s	2080s	Most Change (CSIROMK2B A11) 2020s	2050s	2080s
J	-0.4	-0.1	-0.2	0.9	2.0	3.7	4.8
F	1.7	2.0	1.9	3.0	4.1	5.8	6.9
M	3.5	3.8	3.7	4.8	5.9	7.6	8.7
A	6.4	6.7	6.6	7.7	8.8	10.5	11.6
M	10.0	10.3	10.2	11.3	12.4	14.1	15.2
J	13.1	13.4	13.3	14.4	15.5	17.2	18.3
J	15.1	15.4	15.3	16.4	17.5	19.2	20.3
A	15.4	15.7	15.6	16.7	17.8	19.5	20.6
S	13.0	13.3	13.2	14.3	15.4	17.1	18.2
O	8.4	8.7	8.6	9.7	10.8	12.5	13.6
N	3.0	3.3	3.2	4.3	5.4	7.1	8.2
D	0.5	0.8	0.7	1.8	2.9	4.6	5.7

Table 1 continued – Projected Range of Temperature (°C) Changes under Climate Change

C Olympic

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	0.8	1.9	2.3	2.7	1.9	4.5	6.4
F	1.6	2.7	3.1	3.5	2.7	5.3	7.2
M	1.7	2.8	3.2	3.6	2.8	5.4	7.3
A	3.0	4.1	4.5	4.9	4.1	6.7	8.6
M	5.4	6.5	6.9	7.3	6.5	9.1	11.0
J	8.0	9.1	9.5	9.9	9.1	11.7	13.6
J	9.5	10.6	11.0	11.4	10.6	13.2	15.1
A	9.9	11.0	11.4	11.8	11.0	13.6	15.5
S	8.2	9.3	9.7	10.1	9.3	11.9	13.8
O	5.5	6.6	7.0	7.4	6.6	9.2	11.1
N	2.8	3.9	4.3	4.7	3.9	6.5	8.4
D	1.2	2.3	2.7	3.1	2.3	4.9	6.8

D Yosemite

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	9.4	10.4	10.8	11.2	11.5	14.0	15.7
F	12.8	13.8	14.2	14.6	14.9	17.4	19.1
M	14.8	15.8	16.2	16.6	16.9	19.4	21.1
A	18.6	19.6	20.0	20.4	20.7	23.2	24.9
M	23.2	24.2	24.6	25.0	25.3	27.8	29.5
J	27.7	28.7	29.1	29.5	29.8	32.3	34.0
J	32.2	33.2	33.6	34.0	34.3	36.8	38.5
A	32.3	33.3	33.7	34.1	34.4	36.9	38.6
S	29.2	30.2	30.6	31.0	31.3	33.8	35.5
O	23.2	24.2	24.6	25.0	25.3	27.8	29.5
N	14.4	15.4	15.8	16.2	16.5	19.0	20.7
D	8.9	9.9	10.3	10.7	11.0	13.5	15.2

Table 1 continued – Projected Range of Temperature (°C) Changes under Climate Change

E Channel Islands

	1961-90	Least Change (NCARPCM B21)			Most Change (CCSRNIES A11)		
Month	**Baseline**	**2020s**	**2050s**	**2080s**	**2020s**	**2050s**	**2080s**
J	18.5	19.5	19.9	20.2	20.6	23.1	24.8
F	18.8	19.8	20.2	20.5	20.9	23.4	25.1
M	19.1	20.1	20.5	20.8	21.2	23.7	25.4
A	20.5	21.5	21.9	22.2	22.6	25.1	26.8
M	20.8	21.8	22.2	22.5	22.9	25.4	27.1
J	22.1	23.1	23.5	23.8	24.2	26.7	28.4
J	24.2	25.2	25.6	25.9	26.3	28.8	30.5
A	25.1	26.1	26.5	26.8	27.2	29.7	31.4
S	24.4	25.4	25.8	26.1	26.5	29.0	30.7
O	23.5	24.5	24.9	25.2	25.6	28.1	29.8
N	20.7	21.7	22.1	22.4	22.8	25.3	27.0
D	18.5	19.5	19.9	20.2	20.6	23.1	24.8

F Grand Teton

	1961-90	Least Change (NCARPCM B21)			Most Change (CCSRNIES A11)		
Month	**Baseline**	**2020s**	**2050s**	**2080s**	**2020s**	**2050s**	**2080s**
J	-4.0	-2.8	-2.5	-1.9	-1.7	1.4	3.3
F	-0.4	0.8	1.1	1.7	1.9	5.0	6.9
M	3.4	4.6	4.9	5.5	5.7	8.8	10.7
A	8.3	9.5	9.8	10.4	10.6	13.7	15.6
M	14.2	15.4	15.7	16.3	16.5	19.6	21.5
J	20.2	21.4	21.7	22.3	22.5	25.6	27.5
J	25.4	26.6	26.9	27.5	27.7	30.8	32.7
A	24.5	25.7	26.0	26.6	26.8	29.9	31.8
S	18.7	19.9	20.2	20.8	21.0	24.1	26.0
O	12.0	13.2	13.5	14.1	14.3	17.4	19.3
N	2.4	3.6	3.9	4.5	4.7	7.8	9.7
D	-3.4	-2.2	-1.9	-1.3	-1.1	2.0	3.9

Table 1 continued – Projected Range of Temperature (°C) Changes under Climate Change

G Rocky Mountain

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	-0.8	0.1	0.4	0.9	1.8	5.1	6.8
F	1.4	2.3	2.6	3.1	4.0	7.3	9.0
M	4.5	5.4	5.7	6.2	7.1	10.4	12.1
A	9.3	10.2	10.5	11.0	11.9	15.2	16.9
M	15.0	15.9	16.2	16.7	17.6	20.9	22.6
J	21.0	21.9	22.2	22.7	23.6	26.9	28.6
J	24.1	25.0	25.3	25.8	26.7	30.0	31.7
A	22.9	23.8	24.1	24.6	25.5	28.8	30.5
S	19.1	20.0	20.3	20.8	21.7	25.0	26.7
O	13.3	14.2	14.5	15.0	15.9	19.2	20.9
N	4.6	5.5	5.8	6.3	7.2	10.5	12.2
D	-0.3	0.6	0.9	1.4	2.3	5.6	7.3

H Mesa Verde

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	4.2	5.2	5.5	6.0	7.1	10.0	11.7
F	7.2	8.2	8.5	9.0	10.1	13.0	14.7
M	11.2	12.2	12.5	13.0	14.1	17.0	18.7
A	16.5	17.5	17.8	18.3	19.4	22.3	24.0
M	22.1	23.1	23.4	23.9	25.0	27.9	29.6
J	28.1	29.1	29.4	29.9	31.0	33.9	35.6
J	31.1	32.1	32.4	32.9	34.0	36.9	38.6
A	29.6	30.6	30.9	31.4	32.5	35.4	37.1
S	25.3	26.3	26.6	27.1	28.2	31.1	32.8
O	19.1	20.1	20.4	20.9	22.0	24.9	26.6
N	11.1	12.1	12.4	12.9	14.0	16.9	18.6
D	5.3	6.3	6.6	7.1	8.2	11.1	12.8

Table 1 continued – Projected Range of Temperature (°C) Changes under Climate Change

I Saguaro

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	4.2	5.3	5.8	6.2	6.5	8.9	10.4
F	5.7	6.8	7.3	7.7	8.0	10.4	11.9
M	7.8	8.9	9.4	9.8	10.1	12.5	14.0
A	11.2	12.3	12.8	13.2	13.5	15.9	17.4
M	15.5	16.6	17.1	17.5	17.8	20.2	21.7
J	20.6	21.7	22.2	22.6	22.9	25.3	26.8
J	23.8	24.9	25.4	25.8	26.1	28.5	30.0
A	23.0	24.1	24.6	25.0	25.3	27.7	29.2
S	20.4	21.5	22.0	22.4	22.7	25.1	26.6
O	14.1	15.2	15.7	16.1	16.4	18.8	20.3
N	8.1	9.2	9.7	10.1	10.4	12.8	14.3
D	4.7	5.8	6.3	6.7	7.0	9.4	10.9

J Hot Springs

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	10.4	11.3	11.9	12.4	12.4	15.7	16.4
F	13.4	14.3	14.9	15.4	15.4	18.7	19.4
M	18.5	19.4	20.0	20.5	20.5	23.8	24.5
A	23.9	24.8	25.4	25.9	25.9	29.2	29.9
M	27.6	28.5	29.1	29.6	29.6	32.9	33.6
J	31.6	32.5	33.1	33.6	33.6	36.9	37.6
J	34.2	35.1	35.7	36.2	36.2	39.5	40.2
A	33.8	34.7	35.3	35.8	35.8	39.1	39.8
S	29.9	30.8	31.4	31.9	31.9	35.2	35.9
O	24.6	25.5	26.1	26.6	26.6	29.9	30.6
N	17.7	18.6	19.2	19.7	19.7	23.0	23.7
D	11.9	12.8	13.4	13.9	13.9	17.2	17.9

Table 1 continued – Projected Range of Temperature (°C) Changes under Climate Change

K Cuyahoga Valley

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	0.3	1.3	1.8	2.6	3.4	6.6	8.7
F	2.1	3.1	3.6	4.4	5.2	8.4	10.5
M	8.5	9.5	10.0	10.8	11.6	14.8	16.9
A	15.1	16.1	16.6	17.4	18.2	21.4	23.5
M	21.0	22.0	22.5	23.3	24.1	27.3	29.4
J	25.9	26.9	27.4	28.2	29.0	32.2	34.3
J	28.0	29.0	29.5	30.3	31.1	34.3	36.4
A	27.0	28.0	28.5	29.3	30.1	33.3	35.4
S	23.2	24.2	24.7	25.5	26.3	29.5	31.6
O	16.7	17.7	18.2	19.0	19.8	23.0	25.1
N	9.9	10.9	11.4	12.2	13.0	16.2	18.3
D	3.1	4.1	4.6	5.4	6.2	9.4	11.5

L Acadia

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	-0.1	1.2	1.9	2.4	2.1	4.5	5.9
F	1.4	2.7	3.4	3.9	3.6	6.0	7.4
M	6.2	7.5	8.2	8.7	8.4	10.8	12.2
A	12.0	13.3	14.0	14.5	14.2	16.6	18.0
M	18.5	19.8	20.5	21.0	20.7	23.1	24.5
J	23.7	25.0	25.7	26.2	25.9	28.3	29.7
J	26.5	27.8	28.5	29.0	28.7	31.1	32.5
A	25.7	27.0	27.7	28.2	27.9	30.3	31.7
S	21.3	22.6	23.3	23.8	23.5	25.9	27.3
O	15.4	16.7	17.4	17.9	17.6	20.0	21.4
N	8.5	9.8	10.5	11.0	10.7	13.1	14.5
D	1.9	3.2	3.9	4.4	4.1	6.5	7.9

Table 1 continued – Projected Range of Temperature (°C) Changes under Climate Change

M Great Smoky Mountains

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	8.5	9.4	9.9	10.4	11.4	14.9	16.9
F	10.6	11.5	12.0	12.5	13.5	17.0	19.0
M	16.3	17.2	17.7	18.2	19.2	22.7	24.7
A	21.2	22.1	22.6	23.1	24.1	27.6	29.6
M	24.9	25.8	26.3	26.8	27.8	31.3	33.3
J	28.2	29.1	29.6	30.1	31.1	34.6	36.6
J	29.4	30.3	30.8	31.3	32.3	35.8	37.8
A	29.0	29.9	30.4	30.9	31.9	35.4	37.4
S	26.0	26.9	27.4	27.9	28.9	32.4	34.4
O	21.0	21.9	22.4	22.9	23.9	27.4	29.4
N	16.0	16.9	17.4	17.9	18.9	22.4	24.4
D	10.6	11.5	12.0	12.5	13.5	17.0	19.0

N Everglades

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	2050s	2080s	Most Change (CCSRNIES A11) 2020s	2050s	2080s
J	13.3	14.0	14.4	14.7	14.4	15.6	16.4
F	13.4	14.1	14.5	14.8	14.5	15.7	16.5
M	15.2	15.9	16.3	16.6	16.3	17.5	18.3
A	16.1	16.8	17.2	17.5	17.2	18.4	19.2
M	18.7	19.4	19.8	20.1	19.8	21.0	21.8
J	21.7	22.4	22.8	23.1	22.8	24.0	24.8
J	22.9	23.6	24.0	24.3	24.0	25.2	26.0
A	23.5	24.2	24.6	24.9	24.6	25.8	26.6
S	23.4	24.1	24.5	24.8	24.5	25.7	26.5
O	21.1	21.8	22.2	22.5	22.2	23.4	24.2
N	17.7	18.4	18.8	19.1	18.8	20.0	20.8
D	14.2	14.9	15.3	15.6	15.3	16.5	17.3

Appendix G – Projected Changes in Recreation Visits

Table 1 – Projected Change in Recreation Visits

A Denali

	1961-90	Least Change (HADCM3 B21)						Most Change (CSIROMK2B A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	34	38	11.8	40	17.2	47	37.3	44	29.2	53	54.7	61	80.2
F	116	133	14.6	141	21.9	173	49.4	161	38.4	201	73.3	241	108.1
M	585	585	0.0	585	0.0	585	0.0	585	0.0	585	0.0	585	0.0
A	518	661	27.4	870	67.7	1,653	218.8	1,340	158.4	2,332	349.7	3,324	541.1
M	25,182	25,182	0.0	25,182	0.0	25,182	0.0	25,182	0.0	25,182	0.0	25,182	0.0
J	90,416	90,416	0.0	90,416	0.0	90,416	0.0	90,416	0.0	90,416	0.0	90,416	0.0
J	112,492	112,492	0.0	112,492	0.0	112,492	0.0	112,492	0.0	112,492	0.0	112,492	0.0
A	99,598	100,546	1.0	100,968	1.4	100,968	1.4	101,916	2.3	103,917	4.3	105,919	6.3
S	38,112	38,112	0.0	38,112	0.0	38,112	0.0	38,112	0.0	38,112	0.0	38,112	0.0
O	151	172	14.1	181	20.4	217	44.0	203	34.6	248	64.4	293	94.3
N	49	53	8.4	55	12.2	62	26.2	59	20.6	68	38.4	76	56.2
D	36	40	11.1	41	16.3	48	35.6	45	27.9	54	52.3	63	76.7
Annual	**367,288**	**368,429**	**0.3**	**369,082**	**0.5**	**369,954**	**0.7**	**370,553**	**0.9**	**373,658**	**1.7**	**376,764**	**2.6**

Table 1 continued – Projected Change in Recreation Visits

B Glacier Bay

	1961-90	Least Change (HADCM3 B21)						Most Change (CSIROMK2B A11)					
Month	Baseline	2020s	%	2050s	%	2080s	%	2020s	%	2050s	%	2080s	%
J	78	78	0.0	78	0.0	78	0.0	78	0.0	78	0.0	78	0.0
F	86	86	0.0	86	0.0	86	0.0	86	0.0	86	0.0	86	0.0
M	70	70	0.0	70	0.0	70	0.0	70	0.0	70	0.0	70	0.0
A	255	255	0.0	255	0.0	255	0.0	255	0.0	255	0.0	255	0.0
M	56,728	55,935	-1.4	56,199	-0.9	53,291	-6.1	50,384	-11.2	45,890	-19.1	42,983	-24.2
J	81,447	81,447	0.0	81,447	0.0	81,447	0.0	81,447	0.0	81,447	0.0	81,447	0.0
J	90,203	89,108	-1.2	89,473	-0.8	85,455	-5.3	81,438	-9.7	75,229	-16.6	71,212	-21.1
A	87,985	87,404	-0.7	87,598	-0.4	85,471	-2.9	83,344	-5.3	80,056	-9.0	77,929	-11.4
S	64,623	63,770	-1.3	64,055	-0.9	60,929	-5.7	57,803	-10.6	52,972	-18.0	49,846	-22.9
O	188	188	0.0	188	0.0	188	0.0	188	0.0	188	0.0	188	0.0
N	80	80	0.0	80	0.0	80	0.0	80	0.0	80	0.0	80	0.0
D	55	55	0.0	55	0.0	55	0.0	55	0.0	55	0.0	55	0.0
Annual	**381,797**	**378,476**	**-0.9**	**379,583**	**-0.6**	**367,405**	**-3.8**	**355,227**	**-7.0**	**336,406**	**-11.9**	**324,229**	**-15.1**

Table 1 continued – Projected Change in Recreation Visits

C Olympic

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	Baseline	2020s	%	2050s	%	2080s	%	2020s	%	2050s	%	2080s	%
J	108,889	108,889	0.0	108,889	0.0	108,889	0.0	108,889	0.0	108,889	0.0	108,889	0.0
F	111,713	111,713	0.0	111,713	0.0	111,713	0.0	111,713	0.0	111,713	0.0	111,713	0.0
M	112,068	112,068	0.0	112,068	0.0	112,068	0.0	112,068	0.0	112,068	0.0	112,068	0.0
A	182,210	198,485	8.9	208,831	14.6	220,409	21.0	198,485	8.9	286,524	57.2	377,794	107.3
M	239,655	278,159	16.1	295,214	23.2	313,227	30.7	278,159	16.1	404,936	69.0	517,246	115.8
J	347,422	402,808	15.9	425,218	22.4	448,297	29.0	402,808	15.9	559,211	61.0	685,419	97.3
J	534,929	534,929	0.0	534,929	0.0	534,929	0.0	534,929	0.0	534,929	0.0	534,929	0.0
A	805,725	805,725	0.0	805,725	0.0	805,725	0.0	805,725	0.0	805,725	0.0	805,725	0.0
S	400,128	429,180	7.3	439,745	9.9	450,309	12.5	429,180	7.3	497,849	24.4	548,030	37.0
O	245,540	245,540	0.0	245,540	0.0	245,540	0.0	245,540	0.0	245,540	0.0	245,540	0.0
N	115,848	115,848	0.0	115,848	0.0	115,848	0.0	115,848	0.0	115,848	0.0	115,848	0.0
D	112,608	112,608	0.0	112,608	0.0	112,608	0.0	112,608	0.0	112,608	0.0	112,608	0.0
Annual	**3,316,735**	**3,455,952**	**4.2**	**3,516,328**	**6.0**	**3,579,561**	**7.9**	**3,455,952**	**4.2**	**3,895,840**	**17.5**	**4,275,808**	**28.9**

Table 1 continued – Projected Change in Recreation Visits

D Yosemite

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	110,074	114,963	4.4	116,919	6.2	118,874	8.0	120,341	9.3	132,564	20.4	140,875	28.0
F	126,794	131,683	3.9	133,639	5.4	135,595	6.9	137,061	8.1	149,284	17.7	157,595	24.3
M	136,867	141,756	3.6	143,712	5.0	145,667	6.4	147,134	7.5	159,357	16.4	167,668	22.5
A	218,997	218,997	0.0	218,997	0.0	218,997	0.0	218,997	0.0	218,997	0.0	218,997	0.0
M	366,908	383,653	4.6	390,352	6.4	397,050	8.2	402,074	9.6	443,937	21.0	472,405	28.8
J	442,408	459,153	3.8	465,851	5.3	472,550	6.8	477,573	7.9	519,437	17.4	547,905	23.8
J	566,335	548,591	-3.1	541,494	-4.4	534,397	-5.6	529,074	-6.6	484,715	-14.4	454,551	-19.7
A	617,151	617,151	0.0	617,151	0.0	617,151	0.0	617,151	0.0	617,151	0.0	617,151	0.0
S	458,673	472,483	3.0	478,007	4.2	483,531	5.4	487,673	6.3	522,197	13.8	545,673	19.0
O	376,498	390,307	3.7	395,831	5.1	401,355	6.6	405,498	7.7	440,022	16.9	463,498	23.1
N	157,387	163,679	4.0	166,196	5.6	168,713	7.2	170,601	8.4	186,332	18.4	197,029	25.2
D	122,958	129,250	5.1	131,767	7.2	134,284	9.2	136,172	10.7	151,903	23.5	162,600	32.2
Annual	**3,701,050**	**3,771,668**	**1.9**	**3,799,916**	**2.7**	**3,828,163**	**3.4**	**3,849,349**	**4.0**	**4,025,895**	**8.8**	**4,145,947**	**12.0**

Table 1 continued – Projected Change in Recreation Visits

E Channel Islands

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	32,398	34,295	5.9	35,054	8.2	35,623	10.0	36,382	12.3	41,125	26.9	44,351	36.9
F	33,064	34,961	5.7	35,720	8.0	36,289	9.8	37,048	12.1	41,791	26.4	45,017	36.2
M	43,140	40,843	-5.3	39,925	-7.5	39,236	-9.0	38,317	-11.2	32,576	-24.5	28,672	-33.5
A	40,115	37,819	-5.7	36,900	-8.0	36,211	-9.7	35,293	-12.0	29,552	-26.3	25,648	-36.1
M	59,189	54,940	-7.2	53,240	-10.1	51,966	-12.2	50,266	-15.1	39,643	-33.0	32,419	-45.2
J	54,047	49,798	-7.9	48,098	-11.0	46,824	-13.4	45,124	-16.5	34,501	-36.2	27,277	-49.5
J	67,093	67,093	0.0	67,093	0.0	67,093	0.0	67,093	0.0	67,093	0.0	67,093	0.0
A	68,464	68,464	0.0	68,464	0.0	68,464	0.0	68,464	0.0	68,464	0.0	68,464	0.0
S	54,785	56,843	3.8	57,666	5.3	58,283	6.4	59,106	7.9	64,252	17.3	67,750	23.7
O	42,443	45,347	6.8	46,509	9.6	47,380	11.6	48,542	14.4	55,804	31.5	60,742	43.1
N	34,398	37,303	8.4	38,464	11.8	39,336	14.4	40,498	17.7	47,759	38.8	52,697	53.2
D	26,745	26,745	0.0	26,745	0.0	26,745	0.0	26,745	0.0	26,745	0.0	26,745	0.0
Annual	**555,881**	**554,451**	**-0.3**	**553,880**	**-0.4**	**553,451**	**-0.4**	**552,879**	**-0.5**	**549,306**	**-1.2**	**546,877**	**-1.6**

Table 1 continued – Projected Change in Recreation Visits

F Grand Teton

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	50,623	50,623	0.0	50,623	0.0	50,623	0.0	50,623	0.0	50,623	0.0	50,623	0.0
F	47,831	47,831	0.0	47,831	0.0	47,831	0.0	47,831	0.0	47,831	0.0	47,831	0.0
M	52,202	52,202	0.0	52,202	0.0	52,202	0.0	52,202	0.0	52,202	0.0	52,202	0.0
A	46,178	48,627	5.3	49,239	6.6	50,463	9.3	50,871	10.2	57,195	23.9	61,071	32.2
M	167,355	172,380	3.0	173,636	3.8	176,149	5.3	176,987	5.8	189,968	13.5	197,925	18.3
J	456,600	456,600	0.0	456,600	0.0	456,600	0.0	456,600	0.0	456,600	0.0	456,600	0.0
J	615,019	615,019	0.0	615,019	0.0	615,019	0.0	615,019	0.0	615,019	0.0	615,019	0.0
A	620,708	620,708	0.0	620,708	0.0	620,708	0.0	620,708	0.0	620,708	0.0	620,708	0.0
S	368,446	368,446	0.0	368,446	0.0	368,446	0.0	368,446	0.0	368,446	0.0	368,446	0.0
O	132,508	136,826	3.3	137,905	4.1	140,064	5.7	140,784	6.2	151,940	14.7	158,777	19.8
N	51,325	51,325	0.0	51,325	0.0	51,325	0.0	51,325	0.0	51,325	0.0	51,325	0.0
D	44,207	44,207	0.0	44,207	0.0	44,207	0.0	44,207	0.0	44,207	0.0	44,207	0.0
Annual	**2,653,002**	**2,664,793**	**0.4**	**2,667,741**	**0.6**	**2,673,637**	**0.8**	**2,675,602**	**0.9**	**2,706,064**	**2.0**	**2,724,733**	**2.7**

Table 1 continued – Projected Change in Recreation Visits

G Rocky Mountain

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	60,751	61,800	1.7	62,150	2.3	62,732	3.3	63,781	5.0	67,627	11.3	69,609	14.6
F	63,327	64,376	1.7	64,725	2.2	65,308	3.1	66,357	4.8	70,203	10.9	72,184	14.0
M	66,905	67,954	1.6	68,304	2.1	68,886	3.0	69,935	4.5	73,781	10.3	75,763	13.2
A	72,528	73,577	1.4	73,927	1.9	74,509	2.7	75,558	4.2	79,404	9.5	81,386	12.2
M	186,182	186,182	0.0	186,182	0.0	186,182	0.0	186,182	0.0	186,182	0.0	186,182	0.0
J	474,730	510,095	7.4	521,884	9.9	541,531	14.1	576,897	21.5	706,571	48.8	773,373	62.9
J	596,181	631,546	5.9	643,335	7.9	662,983	11.2	698,348	17.1	828,022	38.9	894,824	50.1
A	550,271	585,637	6.4	597,425	8.6	617,073	12.1	652,438	18.6	782,112	42.1	848,914	54.3
S	399,559	434,925	8.9	446,714	11.8	466,361	16.7	501,727	25.6	631,401	58.0	698,203	74.7
O	208,250	216,813	4.1	219,668	5.5	224,425	7.8	232,988	11.9	264,386	27.0	280,561	34.7
N	67,006	68,055	1.6	68,405	2.1	68,988	3.0	70,037	4.5	73,883	10.3	75,864	13.2
D	61,377	62,426	1.7	62,775	2.3	63,358	3.2	64,407	4.9	68,253	11.2	70,234	14.4
Annual	**2,807,067**	**2,963,386**	**5.6**	**3,015,492**	**7.4**	**3,102,336**	**10.5**	**3,258,656**	**16.1**	**3,831,827**	**36.5**	**4,127,097**	**47.0**

Table 1 continued – Projected Change in Recreation Visits

H Mesa Verde

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	%	2050s	%	2080s	%	Most Change (CCSRNIES A11) 2020s	%	2050s	%	2080s	%
J	4,431	4,624	4.4	4,682	5.7	4,779	7.9	4,992	12.7	5,554	25.4	5,883	32.8
F	4,710	5,070	7.6	5,179	9.9	5,359	13.8	5,755	22.2	6,800	44.4	7,412	57.4
M	13,125	14,785	12.7	15,283	16.4	16,114	22.8	17,940	36.7	22,755	73.4	25,578	94.9
A	21,888	23,548	7.6	24,046	9.9	24,877	13.7	26,703	22.0	31,518	44.0	34,341	56.9
M	58,149	58,149	0.0	58,149	0.0	58,149	0.0	58,149	0.0	58,149	0.0	58,149	0.0
J	102,523	102,523	0.0	102,523	0.0	102,523	0.0	102,523	0.0	102,523	0.0	102,523	0.0
J	144,677	132,899	-8.1	129,366	-10.6	123,477	-14.7	110,522	-23.6	76,366	-47.2	56,344	-61.1
A	116,728	116,728	0.0	116,728	0.0	116,728	0.0	116,728	0.0	116,728	0.0	116,728	0.0
S	72,817	72,817	0.0	72,817	0.0	72,817	0.0	72,817	0.0	72,817	0.0	72,817	0.0
O	39,506	39,506	0.0	39,506	0.0	39,506	0.0	39,506	0.0	39,506	0.0	39,506	0.0
N	9,968	10,197	2.3	10,266	3.0	10,380	4.1	10,633	6.7	11,297	13.3	11,687	17.2
D	5,838	6,182	5.9	6,285	7.7	6,457	10.6	6,835	17.1	7,833	34.2	8,417	44.2
Annual	**594,360**	**587,030**	**-1.2**	**584,832**	**-1.6**	**581,167**	**-2.2**	**573,104**	**-3.6**	**551,847**	**-7.2**	**539,387**	**-9.2**

Table 1 continued – Projected Change in Recreation Visits

I Saguaro

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	73,093	73,093	0.0	73,093	0.0	73,093	0.0	73,093	0.0	73,093	0.0	73,093	0.0
F	75,509	75,509	0.0	75,509	0.0	75,509	0.0	75,509	0.0	75,509	0.0	75,509	0.0
M	108,511	108,511	0.0	108,511	0.0	108,511	0.0	108,511	0.0	108,511	0.0	108,511	0.0
A	82,590	77,903	-5.7	75,772	-8.3	74,068	-10.3	72,789	-11.9	62,562	-24.2	56,171	-32.0
M	64,385	59,698	-7.3	57,567	-10.6	55,863	-13.2	54,584	-15.2	44,357	-31.1	37,966	-41.0
J	43,332	43,332	0.0	43,332	0.0	43,332	0.0	43,332	0.0	43,332	0.0	43,332	0.0
J	42,007	39,651	-5.6	38,580	-8.2	37,724	-10.2	37,081	-11.7	31,941	-24.0	28,729	-31.6
A	41,220	41,220	0.0	41,220	0.0	41,220	0.0	41,220	0.0	41,220	0.0	41,220	0.0
S	40,632	36,564	-10.0	34,714	-14.6	33,235	-18.2	32,125	-20.9	23,249	-42.8	17,702	-56.4
O	58,276	53,401	-8.4	51,186	-12.2	49,413	-15.2	48,083	-17.5	37,447	-35.7	30,800	-47.1
N	55,736	55,736	0.0	55,736	0.0	55,736	0.0	55,736	0.0	55,736	0.0	55,736	0.0
D	58,664	58,664	0.0	58,664	0.0	58,664	0.0	58,664	0.0	58,664	0.0	58,664	0.0
Annual	**743,956**	**723,282**	**-2.8**	**713,885**	**-4.0**	**706,368**	**-5.1**	**700,729**	**-5.8**	**655,623**	**-11.9**	**627,432**	**-15.7**

Table 1 continued – Projected Change in Recreation Visits

J Hot Springs

Month	1961-90 Baseline	Least Change (NCARPCM B21) 2020s	%	2050s	%	2080s	%	Most Change (CCSRNIES A11) 2020s	%	2050s	%	2080s	%
J	64,493	67,749	5.0	69,920	8.4	71,728	11.2	71,728	11.2	83,666	29.7	86,198	33.7
F	71,129	71,129	0.0	71,129	0.0	71,129	0.0	71,129	0.0	71,129	0.0	71,129	0.0
M	117,616	119,844	1.9	121,330	3.2	122,568	4.2	122,568	4.2	130,740	11.2	132,473	12.6
A	130,892	133,121	1.7	134,607	2.8	135,845	3.8	135,845	3.8	144,017	10.0	145,750	11.4
M	147,783	147,783	0.0	147,783	0.0	147,783	0.0	147,783	0.0	147,783	0.0	147,783	0.0
J	159,900	159,900	0.0	159,900	0.0	159,900	0.0	159,900	0.0	159,900	0.0	159,900	0.0
J	163,134	163,134	0.0	163,134	0.0	163,134	0.0	163,134	0.0	163,134	0.0	163,134	0.0
A	138,330	140,583	1.6	140,852	1.8	140,862	1.8	140,862	1.8	135,763	-1.9	133,462	-3.5
S	128,197	132,575	3.4	134,491	4.9	135,906	6.0	135,906	6.0	140,836	9.9	140,832	9.9
O	136,767	140,838	3.0	143,552	5.0	145,814	6.6	145,814	6.6	160,742	17.5	163,909	19.8
N	102,951	109,690	6.5	112,404	9.2	114,666	11.4	114,666	11.4	129,594	25.9	132,761	29.0
D	70,157	73,413	4.6	75,584	7.7	77,392	10.3	77,392	10.3	89,330	27.3	91,862	30.9
Annual	**1,431,349**	**1,459,760**	**2.0**	**1,474,686**	**3.0**	**1,486,729**	**3.9**	**1,486,729**	**3.9**	**1,556,635**	**8.8**	**1,569,194**	**9.6**

Table 1 continued – Projected Change in Recreation Visits

K Cuyahoga Valley

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	237,262	237,262	0.0	237,262	0.0	237,262	0.0	237,262	0.0	237,262	0.0	237,262	0.0
F	238,867	238,867	0.0	238,867	0.0	238,867	0.0	238,867	0.0	238,867	0.0	238,867	0.0
M	171,249	181,481	6.0	186,596	9.0	194,782	13.7	202,967	18.5	235,708	37.6	257,195	50.2
A	238,385	248,616	4.3	253,732	6.4	261,917	9.9	270,103	13.3	302,844	27.0	324,330	36.1
M	299,291	309,523	3.4	314,639	5.1	322,824	7.9	331,009	10.6	363,750	21.5	385,237	28.7
J	348,982	359,214	2.9	364,330	4.4	372,515	6.7	380,700	9.1	413,442	18.5	434,928	24.6
J	394,810	394,810	0.0	394,810	0.0	394,810	0.0	394,810	0.0	394,810	0.0	394,810	0.0
A	394,332	394,332	0.0	394,332	0.0	394,332	0.0	394,332	0.0	394,332	0.0	394,332	0.0
S	296,208	296,208	0.0	296,208	0.0	296,208	0.0	296,208	0.0	296,208	0.0	296,208	0.0
O	345,413	378,954	9.7	395,725	14.6	422,557	22.3	449,390	30.1	556,721	61.2	627,157	81.6
N	184,882	198,998	7.6	206,056	11.5	217,349	17.6	228,642	23.7	273,814	48.1	303,458	64.1
D	166,379	166,379	0.0	166,379	0.0	166,379	0.0	166,379	0.0	166,379	0.0	166,379	0.0
Annual	**3,316,060**	**3,404,644**	**2.7**	**3,448,935**	**4.0**	**3,519,802**	**6.1**	**3,590,669**	**8.3**	**3,874,137**	**16.8**	**4,060,163**	**22.4**

Table 1 continued – Projected Change in Recreation Visits

L Acadia

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	17,565	17,565	0.0	17,565	0.0	17,565	0.0	17,565	0.0	17,565	0.0	17,565	0.0
F	20,980	20,980	0.0	20,980	0.0	20,980	0.0	20,980	0.0	20,980	0.0	20,980	0.0
M	32,703	32,703	0.0	32,703	0.0	32,703	0.0	32,703	0.0	32,703	0.0	32,703	0.0
A	77,766	82,617	6.2	85,230	9.6	87,095	12.0	85,976	10.6	94,932	22.1	100,156	28.8
M	156,107	156,107	0.0	156,107	0.0	156,107	0.0	156,107	0.0	156,107	0.0	156,107	0.0
J	324,880	331,370	2.0	334,864	3.1	337,360	3.8	335,863	3.4	347,844	7.1	354,832	9.2
J	626,764	675,300	7.7	701,435	11.9	720,102	14.9	708,902	13.1	798,506	27.4	850,775	35.7
A	596,503	645,039	8.1	671,173	12.5	689,841	15.6	678,640	13.8	768,244	28.8	820,514	37.6
S	397,580	397,580	0.0	397,580	0.0	397,580	0.0	397,580	0.0	397,580	0.0	397,580	0.0
O	266,064	260,665	-2.0	257,758	-3.1	255,682	-3.9	256,928	-3.4	246,960	-7.2	241,146	-9.4
N	44,188	39,260	-11.2	36,607	-17.2	34,712	-21.4	35,849	-18.9	26,751	-39.5	21,445	-51.5
D	16,682	16,682	0.0	16,682	0.0	16,682	0.0	16,682	0.0	16,682	0.0	16,682	0.0
Annual	**2,577,782**	**2,675,867**	**3.8**	**2,728,683**	**5.9**	**2,766,408**	**7.3**	**2,743,773**	**6.4**	**2,924,853**	**13.5**	**3,030,484**	**17.6**

Table 1 continued – Projected Change in Recreation Visits

M Great Smoky Mountains

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	279,706	295,909	5.8	304,911	9.0	313,913	12.2	331,917	18.7	394,931	41.2	430,939	54.1
F	318,831	335,035	5.1	344,037	7.9	353,039	10.7	371,043	16.4	434,056	36.1	470,064	47.4
M	486,749	496,510	2.0	501,933	3.1	507,357	4.2	518,203	6.5	556,165	14.3	577,857	18.7
A	702,638	719,329	2.4	728,602	3.7	737,875	5.0	756,421	7.7	821,333	16.9	858,425	22.2
M	771,396	788,087	2.2	797,360	3.4	806,633	4.6	825,179	7.0	890,091	15.4	927,183	20.2
J	1,147,151	1,160,678	1.2	1,168,193	1.8	1,175,708	2.5	1,190,737	3.8	1,243,342	8.4	1,273,402	11.0
J	1,483,805	1,483,805	0.0	1,483,805	0.0	1,483,805	0.0	1,483,805	0.0	1,483,805	0.0	1,483,805	0.0
A	1,123,214	1,150,874	2.5	1,166,240	3.8	1,181,606	5.2	1,212,339	7.9	1,319,903	17.5	1,381,369	23.0
S	975,347	993,936	1.9	1,004,264	3.0	1,014,591	4.0	1,035,246	6.1	1,107,538	13.6	1,148,848	17.8
O	1,139,728	1,139,728	0.0	1,139,728	0.0	1,139,728	0.0	1,139,728	0.0	1,139,728	0.0	1,139,728	0.0
N	667,784	682,545	2.2	690,746	3.4	698,946	4.7	715,347	7.1	772,750	15.7	805,552	20.6
D	451,072	451,072	0.0	451,072	0.0	451,072	0.0	451,072	0.0	451,072	0.0	451,072	0.0
Annual	**9,547,420**	**9,697,509**	**1.6**	**9,780,891**	**2.4**	**9,864,273**	**3.3**	**10,031,038**	**5.1**	**10,614,714**	**11.2**	**10,948,243**	**14.7**

Table 1 continued – Projected Change in Recreation Visits

N Everglades

	1961-90	Least Change (NCARPCM B21)						Most Change (CCSRNIES A11)					
Month	**Baseline**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**	**2020s**	**%**	**2050s**	**%**	**2080s**	**%**
J	127,695	127,695	0.0	127,695	0.0	127,695	0.0	127,695	0.0	127,695	0.0	127,695	0.0
F	127,740	127,740	0.0	127,740	0.0	127,740	0.0	127,740	0.0	127,740	0.0	127,740	0.0
M	140,898	134,849	-4.3	131,393	-6.7	128,801	-8.6	131,393	-6.7	121,024	-14.1	114,111	-19.0
A	132,996	126,947	-4.5	123,491	-7.1	120,898	-9.1	123,491	-7.1	113,121	-14.9	106,209	-20.1
M	84,971	82,483	-2.9	81,061	-4.6	79,995	-5.9	81,061	-4.6	76,796	-9.6	73,952	-13.0
J	52,468	52,468	0.0	52,468	0.0	52,468	0.0	52,468	0.0	52,468	0.0	52,468	0.0
J	55,925	55,925	0.0	55,925	0.0	55,925	0.0	55,925	0.0	55,925	0.0	55,925	0.0
A	57,520	57,520	0.0	57,520	0.0	57,520	0.0	57,520	0.0	57,520	0.0	57,520	0.0
S	66,710	66,710	0.0	66,710	0.0	66,710	0.0	66,710	0.0	66,710	0.0	66,710	0.0
O	72,488	70,677	-2.5	69,642	-3.9	68,866	-5.0	69,642	-3.9	66,538	-8.2	64,468	-11.1
N	81,406	79,595	-2.2	78,560	-3.5	77,784	-4.4	78,560	-3.5	75,455	-7.3	73,386	-9.9
D	90,251	88,440	-2.0	87,405	-3.2	86,629	-4.0	87,405	-3.2	84,301	-6.6	82,231	-8.9
Annual	**1,091,067**	**1,071,048**	**-1.8**	**1,059,609**	**-2.9**	**1,051,030**	**-3.7**	**1,059,609**	**-2.9**	**1,025,292**	**-6.0**	**1,002,414**	**-8.1**

Appendix H – Projected Changes in Recreation Visits for the 2020s, 2050s, and 2080s

Figure 1 – Projected Changes in Recreation Visits to Denali for the 2020s, 2050s, and 2080s

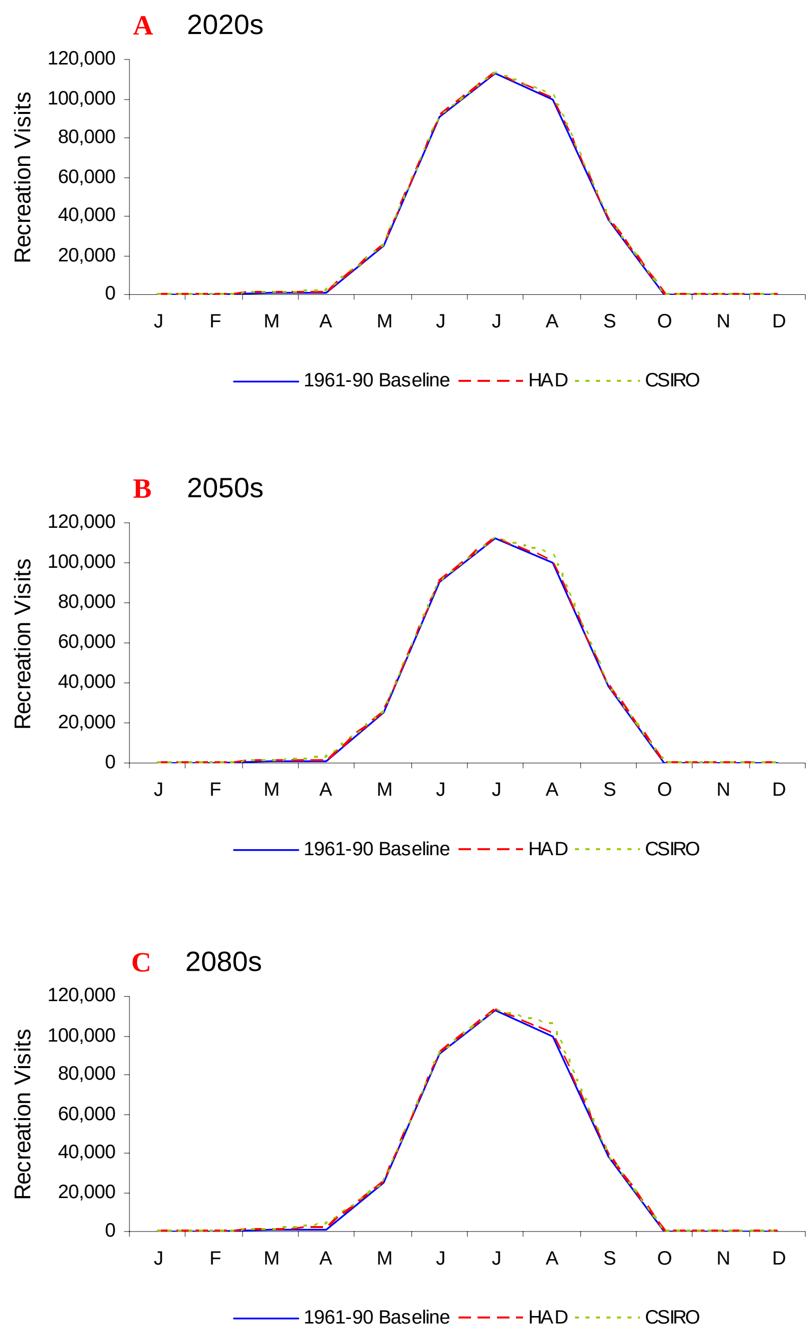


Figure 2 – Projected Changes in Recreation Visits to Glacier Bay for the 2020s, 2050s, and 2080s

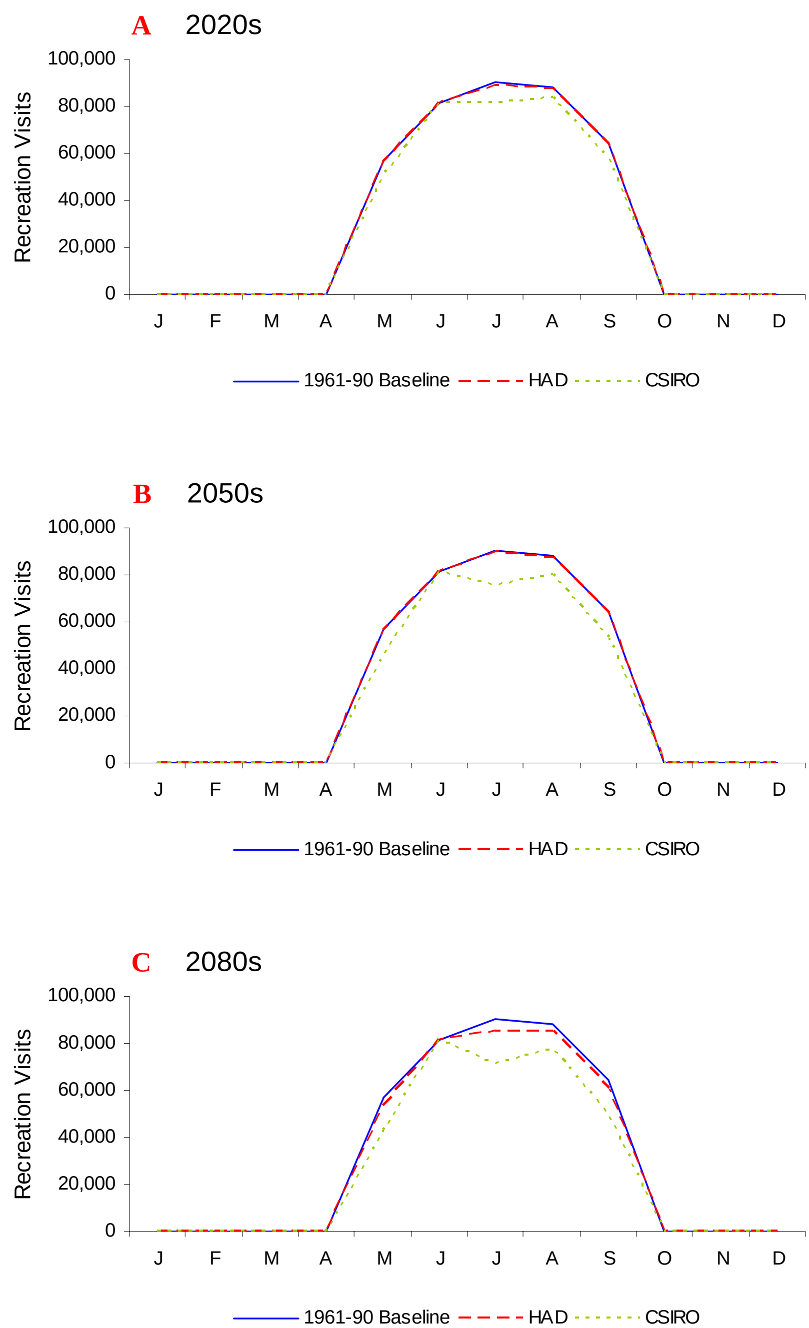


Figure 3 – Projected Changes in Recreation Visits to Olympic for the 2020s, 2050s, and 2080s

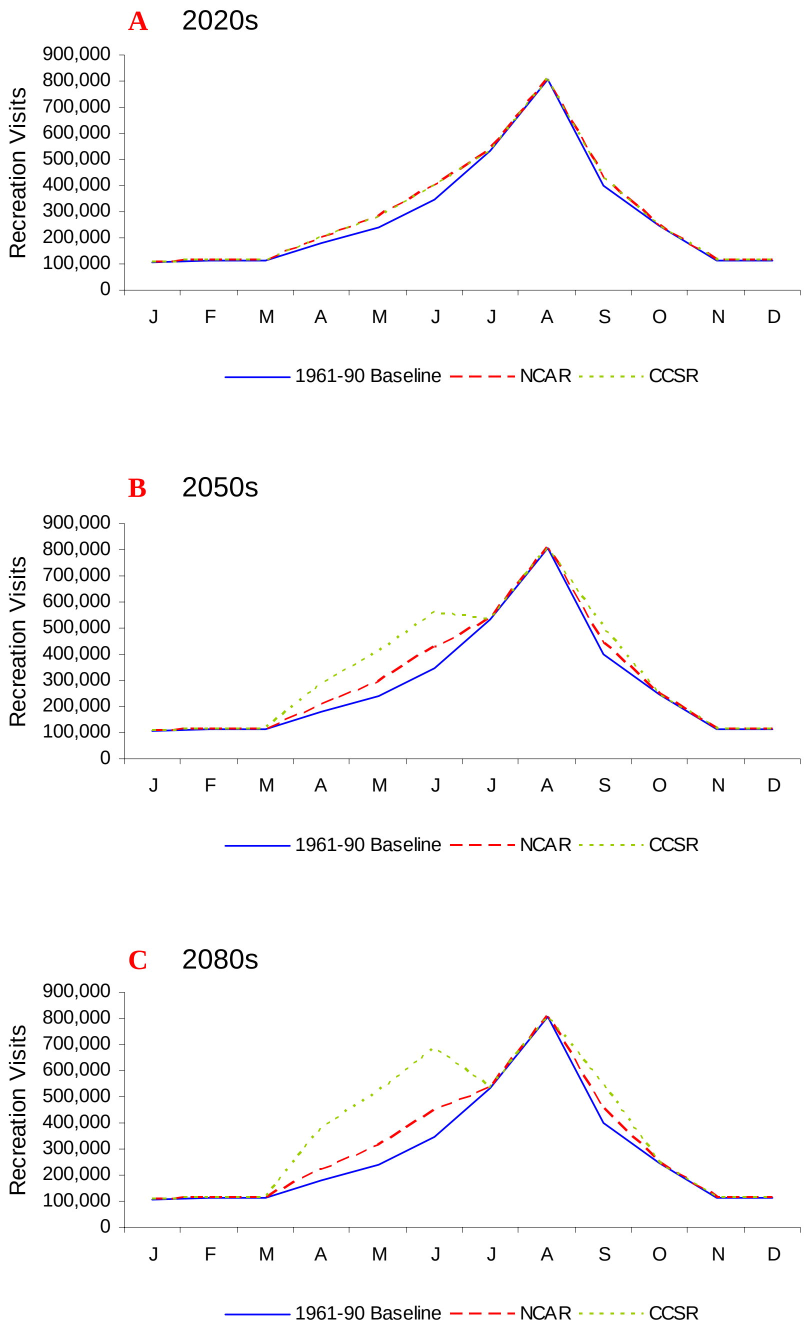


Figure 4 – Projected Changes in Recreation Visits to Yosemite for the 2020s, 2050s, and 2080s

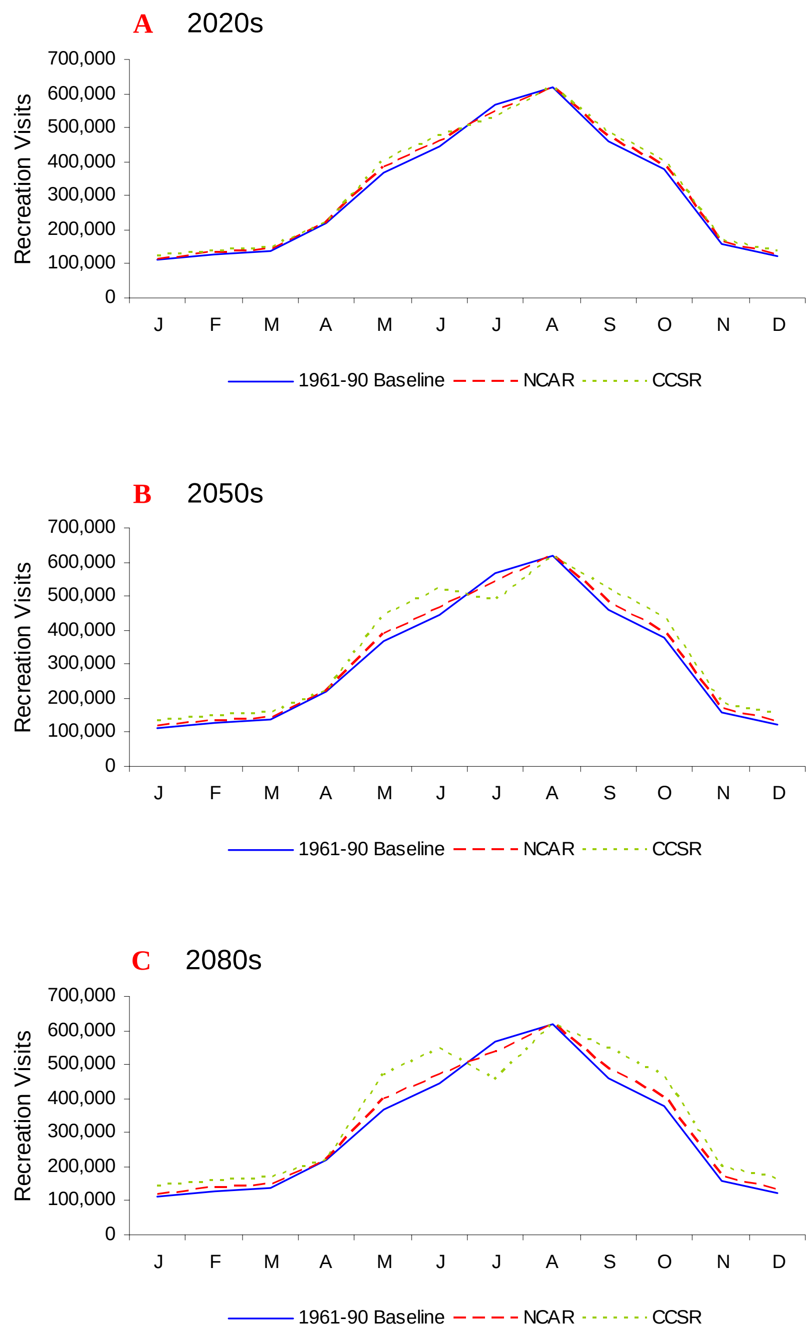


Figure 5 – Projected Changes in Recreation Visits to Channel Islands for the 2020s, 2050s, and 2080s

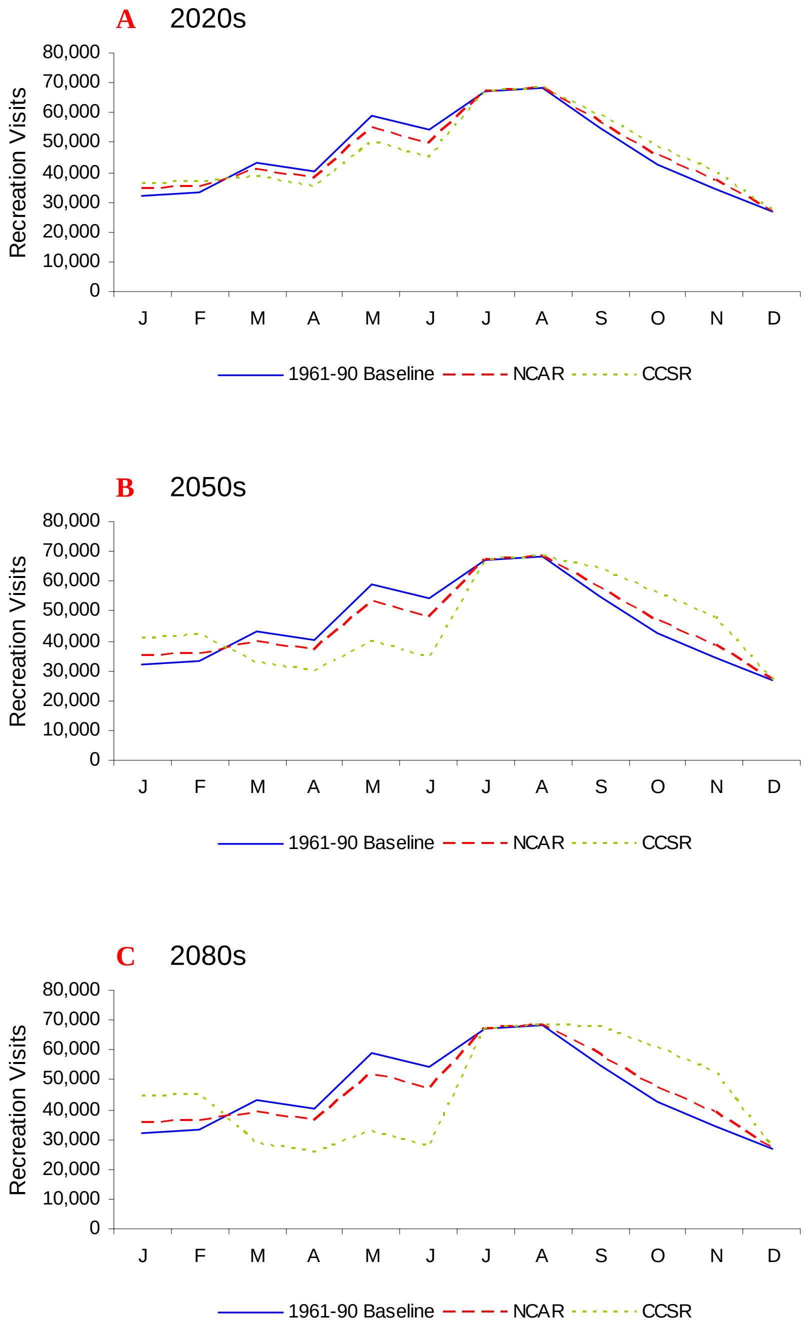


Figure 6 – Projected Changes in Recreation Visits to Grand Teton for the 2020s, 2050s, and 2080s

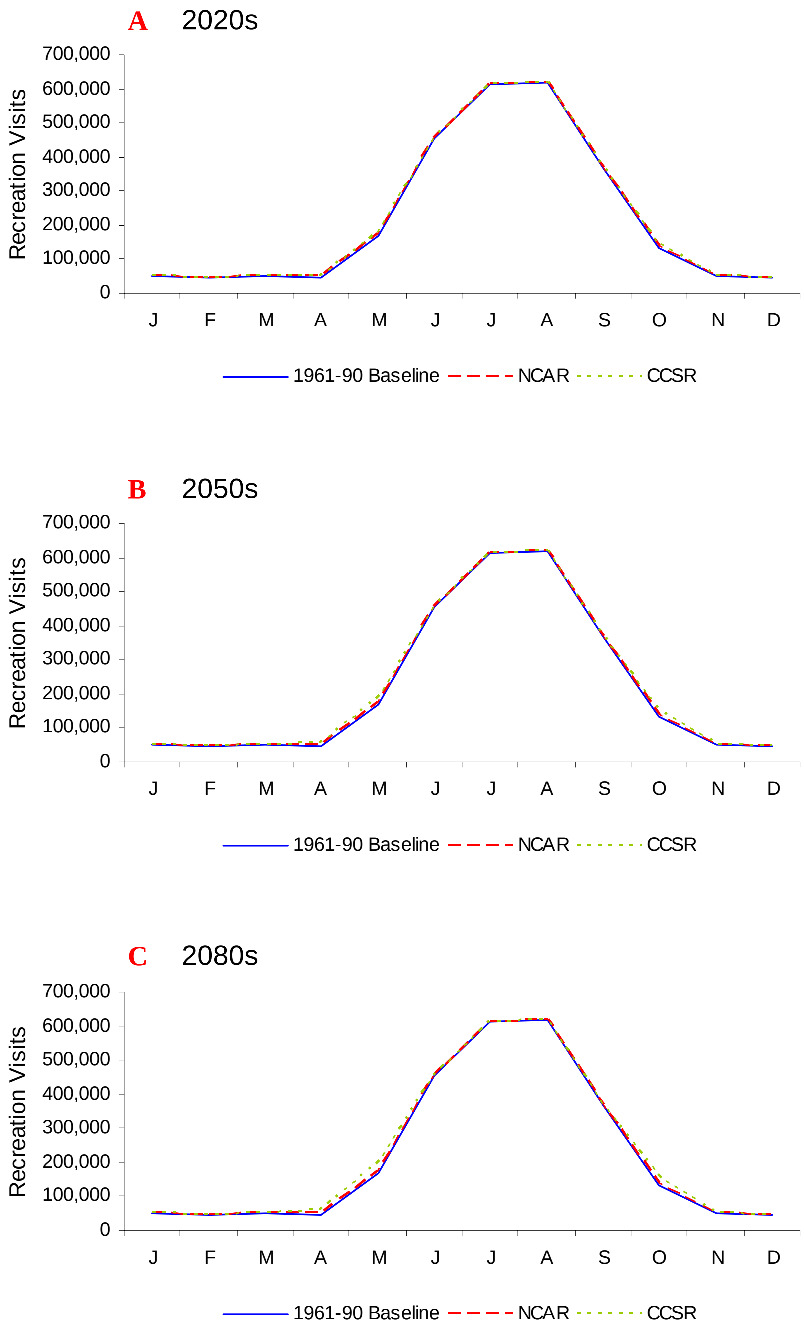


Figure 7 – Projected Changes in Recreation Visits to Rocky Mountain for the 2020s, 2050s, and 2080s

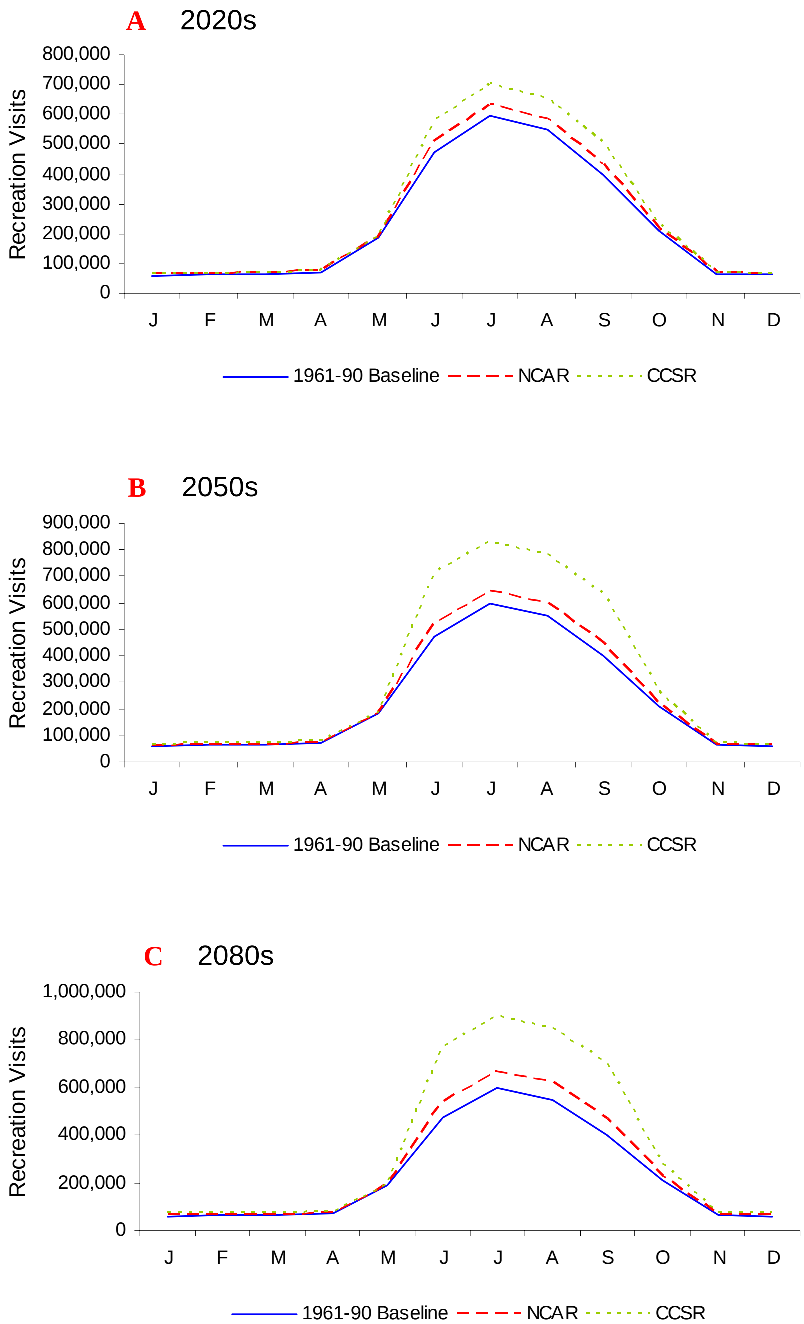


Figure 8 – Projected Changes in Recreation Visits to Mesa Verde for the 2020s, 2050s, and 2080s

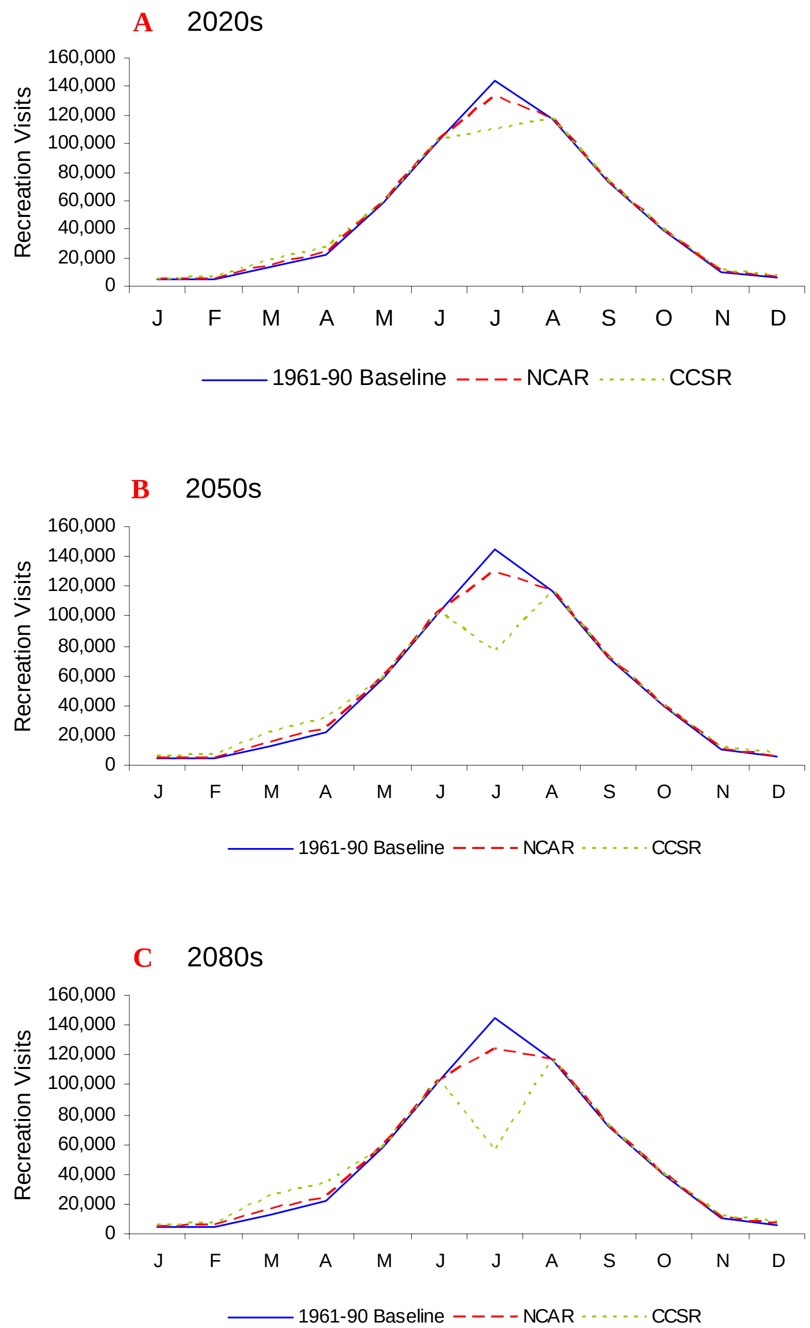


Figure 9 – Projected Changes in Recreation Visits to Saguaro for the 2020s, 2050s, and 2080s

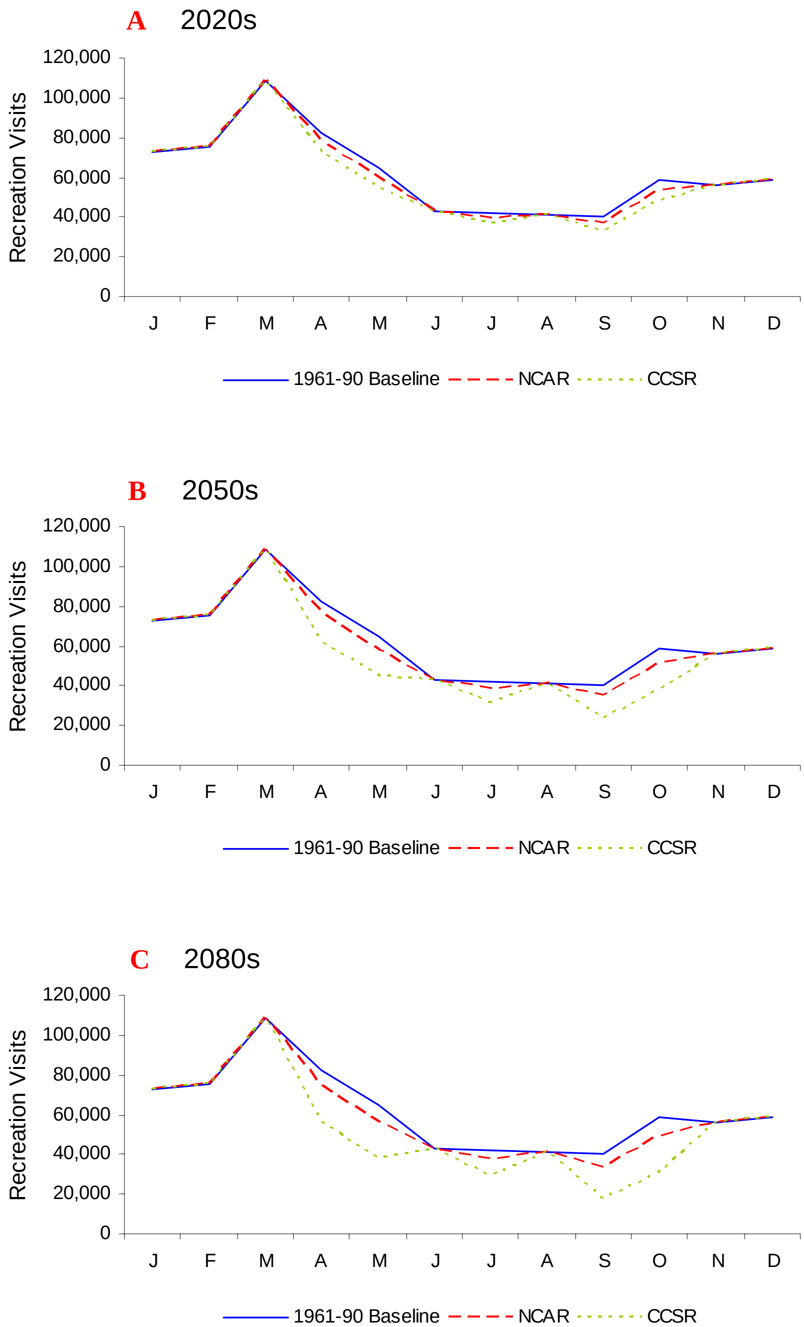


Figure 10 – Projected Changes in Recreation Visits to Hot Springs for the 2020s, 2050s, and 2080s

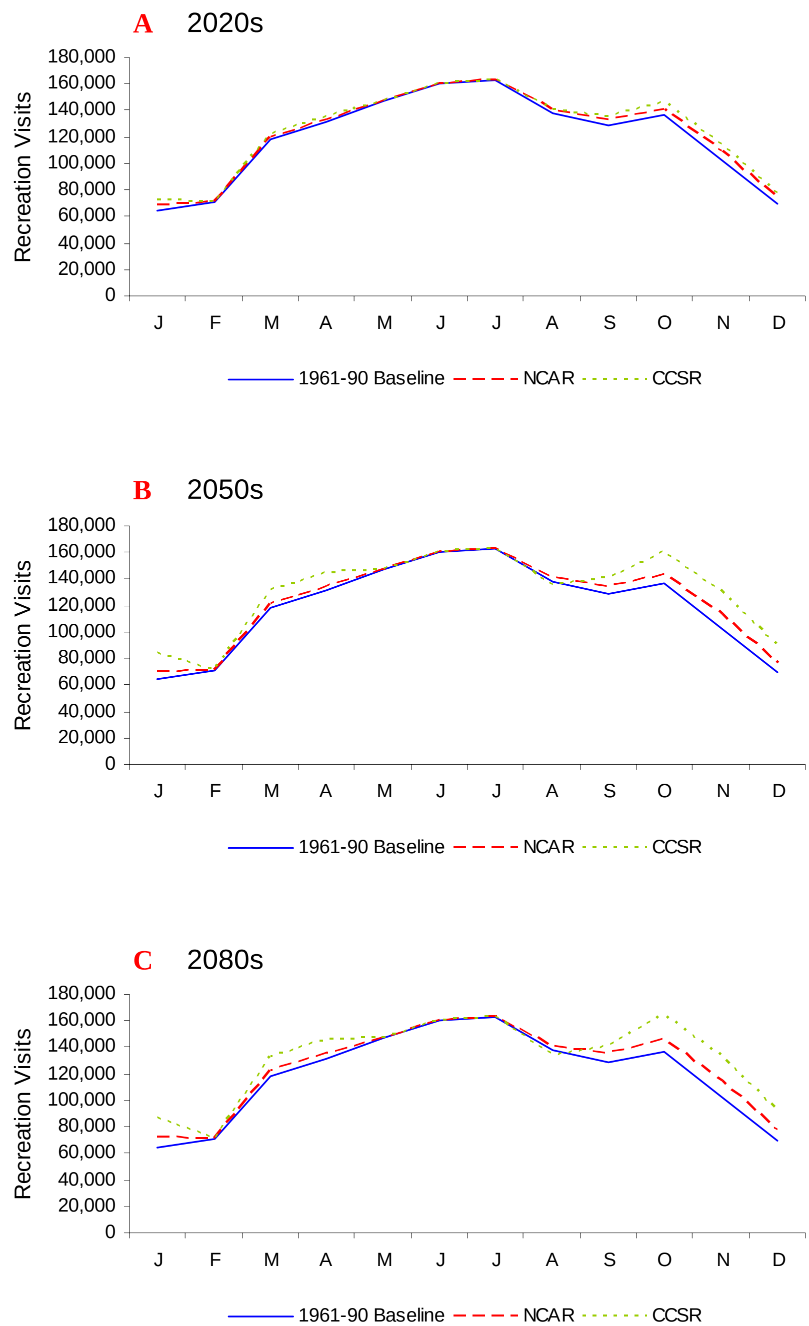
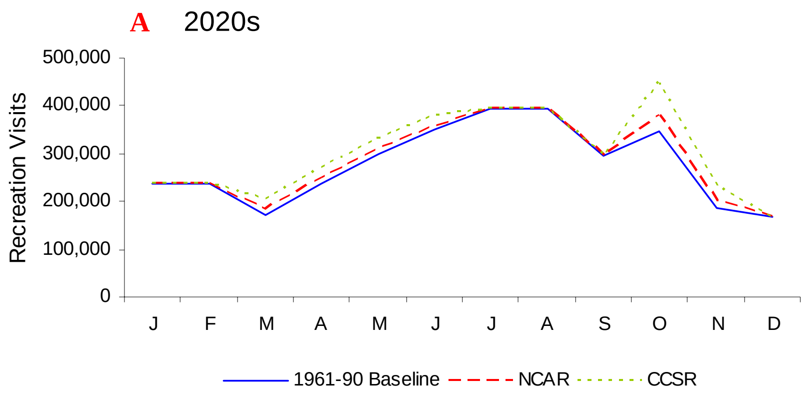
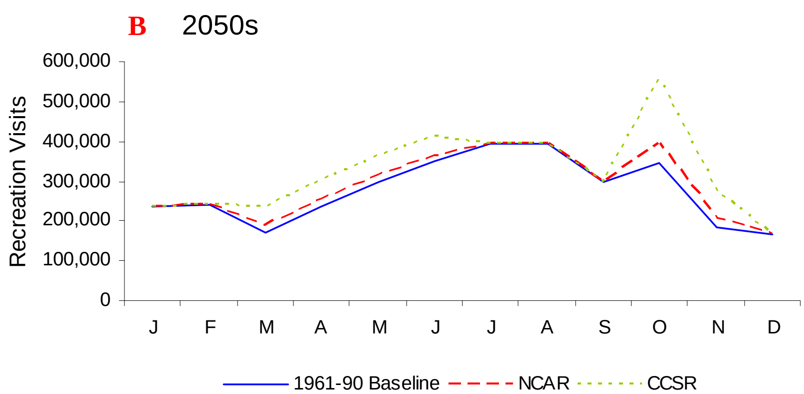


Figure 11 – Projected Changes in Recreation Visits to Cuyahoga Valley for the 2020s, 2050s, and 2080s





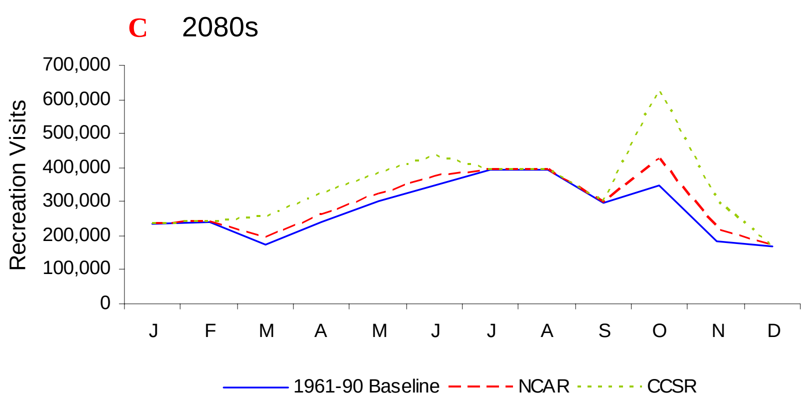


Figure 12 – Projected Changes in Recreation Visits to Acadia for the 2020s, 2050s, and 2080s

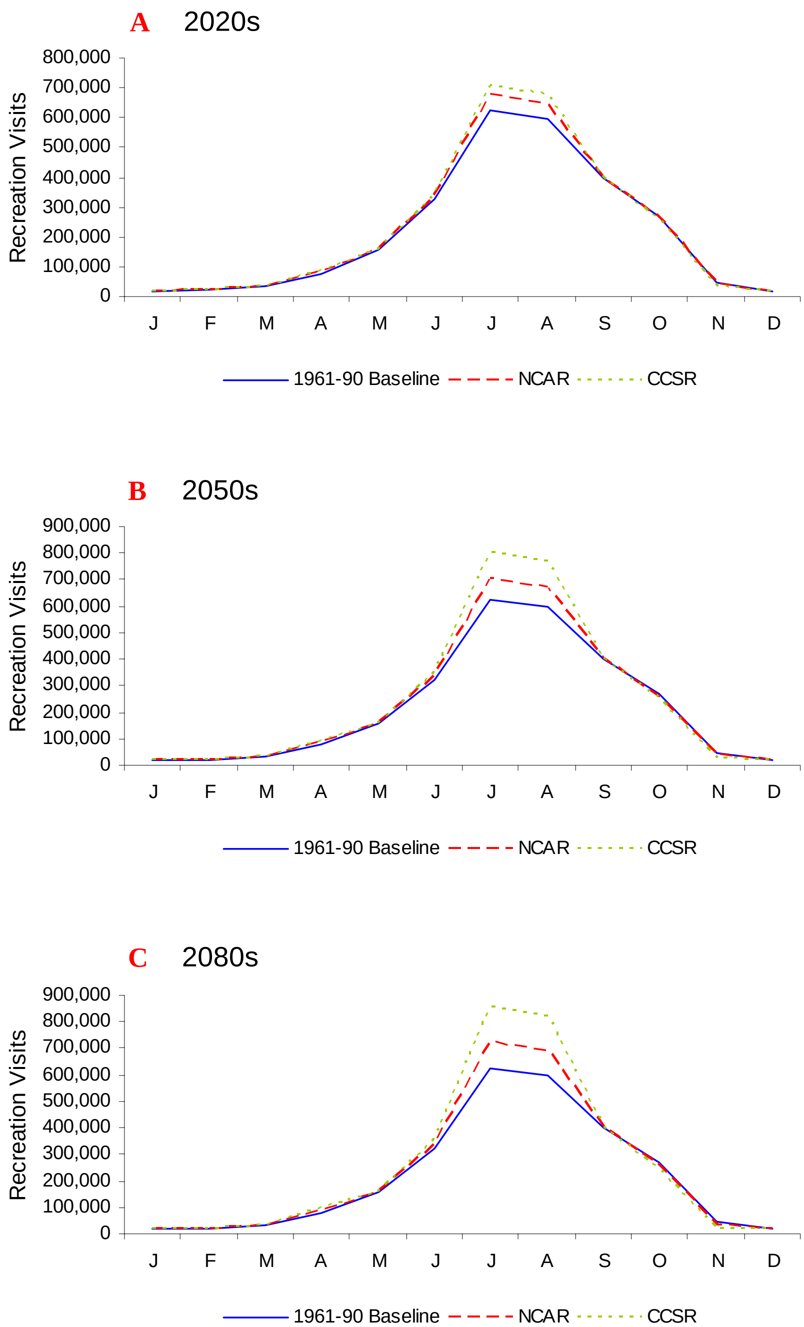
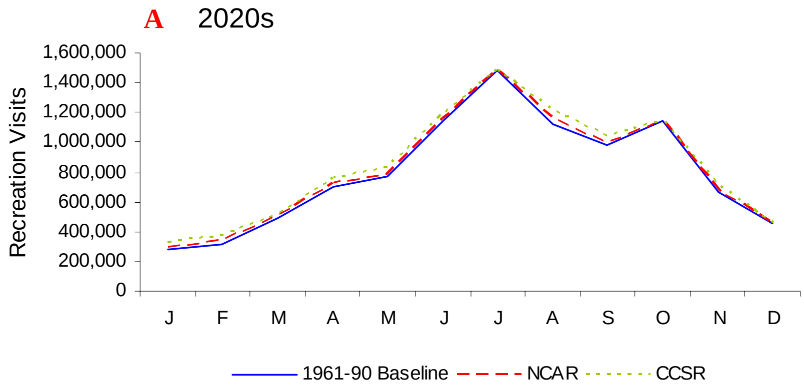
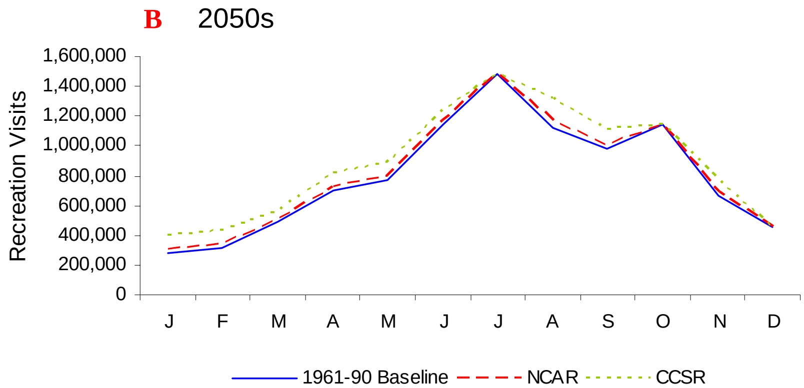


Figure 13 – Projected Changes in Recreation Visits to Great Smoky Mountains for the 2020s, 2050s, and 2080s





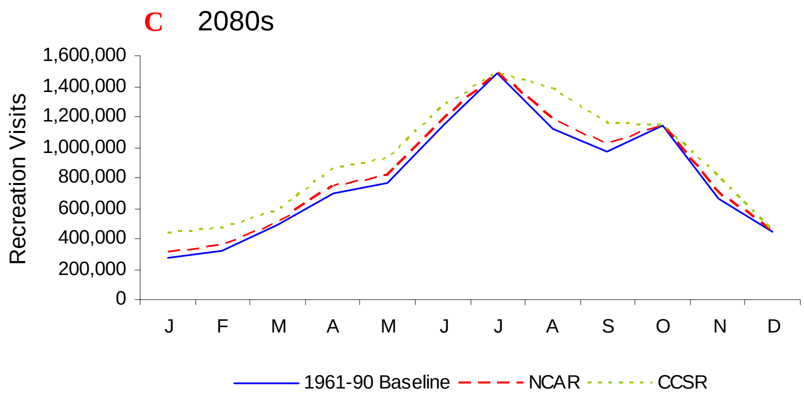
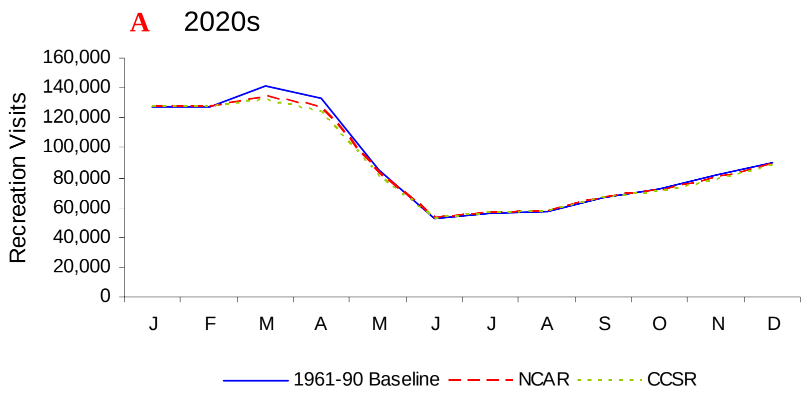
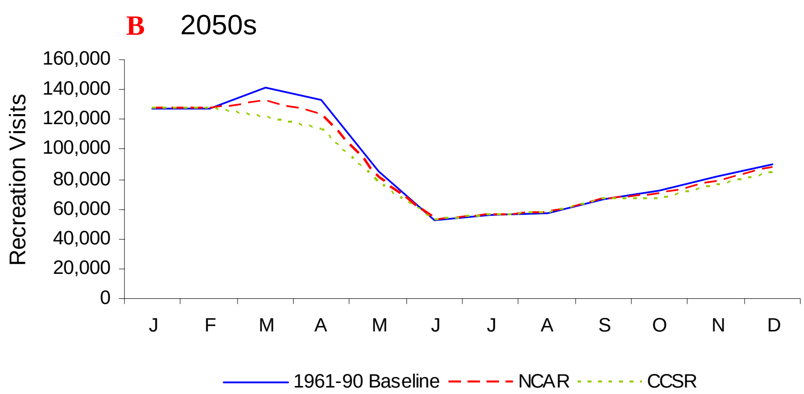
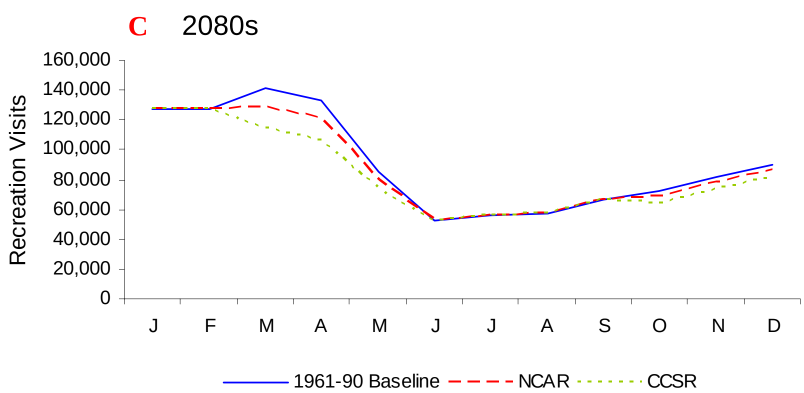


Figure 14 – Projected Changes in Recreation Visits to Everglades for the 2020s, 2050s, and 2080s







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