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Daniel Scott
University of Waterloo

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Research article

Implications of climate and environmental change for nature-based tourism in the Canadian Rocky Mountains: A case study of Waterton Lakes National Park

Daniel Scott*, Brenda Jones, Jasmina Konopek

Canada Research Chair in Global Change and Tourism, Faculty of Environmental Studies, University of Waterloo, 200 University Avenue West, Waterloo, Ont., Canada N2L 3G1

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Abstract

In western North America, Rocky Mountain national parks represent a major resource for nature-based tourism. This paper examines how climate change may influence park tourism in the Rocky Mountain region by focusing on both the direct and indirect impacts of climate change for visitation to Waterton Lakes National Park (WLNP) (Alberta, Canada). A statistical model of monthly visitation and climate was developed to examine the direct impact of climate change on visitation. The model projected that annual visitation would increase between 6% and 10% in the 2020s and between 10% and 36% in the 2050s. To explore how climate-induced environmental change could also indirectly affect visitation, a visitor survey was used ($N = 425$). The environmental change scenarios for the 2020s and 2050s were found to have minimal influence on visitation, however the environmental change scenario for the 2080s (under the warmest climate change conditions) was found to have a negative effect on visitation, as 19% of respondents indicated they would not visit the park and 37% stated they would visit the park less often. The contrasting result of the two analyses for the longer-term impact of climate change was a key finding. The management implications of these findings and methodological challenges associate with climate change impact assessment for tourism are also discussed.

Keywords: Climate change; Environmental change; National parks; Tourism; Canada

1. Introduction

Nature-based tourism is an important element of the tourism industry in North America. National parks in Canada and the United States are central components of this tourism market (Jones & Scott, 2006). Eagles, McLean, and Stabler (2000) estimated that there were over 2.6 billion visitor days in parks and protected areas in Canada and the United States in 1996, 300 million of which occurred in national parks.

A sizable share of park tourism in North America is concentrated in national parks located in the mountainous regions of western Canada and the United States. In Canada, approximately 65% (or ~10 million visits) of all national park visits in 2003 occurred in the six national parks located in the Rocky Mountains (Parks Canada, 2004); 10 million people visited the four US-based Rocky Mountain national parks during the same year, representing 17% of all national park visits in the United States in 2003 (National Park Service, 2005). The economic impact of tourism in the Rocky Mountain region is equally significant. Tourism-related expenditures by visitors to three mountain national parks in the Province of Alberta (Banff, Jasper and Waterton Lakes) were estimated to exceed US$765 million (Alberta Economic Development, 2000). In the United States, Yellowstone National Park generates an estimated US$2 billion in economic benefits for the states of Montana, Wyoming and Idaho (Gourley, 1997).

Climate directly affects nature-based tourism by limiting when specific recreation and tourism activities can occur

*Corresponding author. Tel.: +519 888 4567x5497.
E-mail address: dj2scott@fes.uwaterloo.ca (D. Scott).

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(e.g. season length with snow cover or open water), recreation/tourism demand (e.g. proportion of people willing to swim or camp under certain conditions), and the quality of a recreation/tourism experience (utility) (e.g. hiking in warm, sunny conditions versus a cold rain or extreme heat).

In the Rocky Mountain region, this climatic influence manifests itself through a marked seasonality in park visitation; nearly two-thirds (64%) of annual person visits in Canada's six mountain parks occur during the traditional warm-weather months of May–September (Parks Canada, 2004). Scott and Suffling (2000) and Scott (2003) argue that any direct changes in the length and quality of warm-weather tourism seasons induced by global climate change could present opportunities to increase visitation in national parks in this region. Visitor increases precipitated by a warmer climate would have benefits for park revenues and the economies of gateway communities near each park, but could also exacerbate visitor-related environmental pressures in some high-visitation mountain national parks in Canada and the United States.

Climate indirectly affects nature-based tourism by impacting the physical resources that define the nature and quality of natural environments on which mountain tourism depends (i.e. climate-induced biophysical change). Any changes in the natural characteristics of mountain environments could negatively influence tourism by reducing the perceived attractiveness of the region's mountain parks (Elsasser & Bürki, 2002; Scott, 2003; Wall, 1992). For example, drought conditions during the summer of 1988 contributed to widespread forest fires in Yellowstone National Park, which resulted in evacuations of campgrounds and seasonal visitor accommodations being closed 4 weeks earlier than normal (Franke, 2000). Total annual visits to Yellowstone in 1988 were reduced 15% (compared to 1987) and park officials estimated that the forest fires resulted in a loss of tourism-related economic benefits of US$60 million (Franke, 2000).

Progress has been made in documenting climate-induced biophysical changes in the mountain region of western North America and a number of studies have examined the potential biophysical impacts of climate change to the end of the 21st century. Analysis of biome-scale vegetation modeling suggests that under climate change mountain parks in this region would experience both latitudinal and elevational environmental changes with the potential for species reorganization and loss of biodiversity (Scott, Malcolm, & Lemieux, 2002). In an analysis of Glacier National Park (Montana), Hall and Farge (2003) projected that forests would advance upslope approximately 20 m per decade through 2050. While similar advancements in the tree line are projected for Yellowstone National Park, the results of vegetation modeling further suggested that the range of high-elevation species would decrease, some tree species would be regionally extirpated and new vegetation communities not currently found in the park would emerge (Bartlein, Whitlock, & Shafer, 1997).

Glaciers in western North America are important tourist attractions for mountain parks, but they have been retreating over the past century and are projected to continue to do so under climate change. Glacier National Park has lost 115 of its 150 glaciers over the past century and scientists estimate that the remaining 35 glaciers will disappear over the next 30 years (Hall & Farge, 2003). Similar projections have been made for glaciers in Canada's Rocky Mountain parks with glaciers less than 100 m thick projected to disappear over the next 30–40 years (Brugman, Raistrick, & Pietroniro, 1997). If such glacier retreat is realized in the Rocky Mountains, Glacier National Park would lose its namesake and the very resource that defines it. Scott (2005) also argued that the projected glacial retreat in Canada could severely hinder the snocoach tours (specially designed buses take visitors onto the Athabasca glacier) that attract 600,000 visitors annually to the Columbia Icefields between Banff and Jasper national parks.

Mountain ecosystems depend on fire for regeneration, but forest fires pose a threat for park tourism. Under climate change, the frequency and severity of forest fires in the mountainous region of western Canada is projected to increase. Vegetation and fire behavior modeling by Li, Flannigan, and Corns (2000) suggested that west-central Alberta would experience a one-point shift in the fire fuel moisture code under a mean temperature increase of 4 °C (+7.2 F), which would contribute to an increase in the frequency of fires that burn more than 1000 ha. Stocks et al. (1998) projected that the geographic area in western Canada currently designated as having an 'extreme' fire danger would expand in the 2050s. Similar regional projections were made by Flannigan et al. (2001) and Weber and Flannigan (1997). If the fire season becomes more severe under climate change, it is possible that visitors to mountain parks may experience more restrictions on their activities (e.g. campfire bans; trail and park closures).

As lakes and streams warm, temperature-induced habitat loss and range shifts are projected to occur, contributing to losses in recreationally valued fish populations. Research on the thermal habitat for salmonid species in the Rocky Mountain region of the United States found that a projected 4 °C (+7.2 F) summer warming in the region would reduce habitat area by 62% (Keleher & Rahel, 1996). Simulation studies of cold-water fish habitats revealed that the southern boundaries of some cold-water fish in the United States could move 500 km northward under climate change (Magnuson, 1998). Increases in lake and river temperatures could place pressure on cold-water fish species in the Rocky Mountain region, thus providing opportunities for the geographic expansion of cool- and warm-water species that have higher temperature tolerances.

There remains a great deal of uncertainty as to how potential climate change impacts on seasonality and mountain landscapes would impact park visitation around the world and in western North America. In the only empirical study to examine the potential impact of climate change on mountain park tourism, Richardson and Loomis (2004) assessed the direct and indirect impacts of climate change on visitation to Rocky Mountain National Park (RMNP) (Colorado, USA). Regression analysis of historical monthly visitation data (1987–1999) and four climate variables for the park's peak and shoulder seasons was used to model the current influence of climate on park visitation and the projected changes under climate change for the 2020s. Richardson and Loomis (2004) found that visitation to RMNP would increase 7–12% in the 2020s as the warm-weather tourism season was extended. Visitors to the park were also surveyed to determine how their visitation patterns (number of visits and duration of stay) might change under a range of early environmental change scenarios. Although hypothetical, the environmental change scenarios were partially developed on the basis of climate change studies of the potential environmental impacts in the park. Environmental changes in the 2020s were found to have minimal effect on visitor behavior, as visitation was projected to increase between 10% and 14% under the two environmental scenarios used in the visitor survey.

With the results of their regression analysis of visitation data and tourist survey projecting similar increases in park visitation, Richardson and Loomis (2004) concluded that climate change through the 2020s would have a positive effect on park visitation in the Rocky Mountains, and suggested that the results for RMNP would be representative for a number of mountain parks in the United States (Glacier, Grand Teton and Yellowstone) and Canada (Banff, Jasper and Waterton Lakes).

The Richardson and Loomis (2004) study only examined the potential impacts of early stages of climate change projected for the 21st century and thus the implications of much greater warming and environmental change projected for the latter half of the century (IPCC, 2001) remain an important knowledge gap. While climate change scenarios for the 2020s have the most relevance for contemporary tourism planning and there remains substantial uncertainty about the magnitude of long-term climate change projections (i.e. 2050s, 2080s) (IPCC, 2001), the potential implications of longer-term changes should be explored for strategic relevance to park managers, the tourism industry and broader climate change policy (i.e. the costs of impacts verses mitigation). It remains uncertain whether Richardson and Loomis' (2004) findings would be representative of the potential influence of long-term climate change on mountain park visitation. Will climate change-induced seasonality and environmental changes continue to have a positive effect on visitation or will environmental changes projected for mountainous regions in western North America towards the end of the 21st century begin to have a negative impact on visitation?

This paper presents an empirical assessment of climate and visitation in the Canadian Rocky Mountains in order to determine how visitors may respond to future climate change and related environmental change. Using a similar methodological approach to Richardson and Loomis (2004), the specific objectives of the study were to: (1) develop a model of climate and park visitation in order to examine the implications of changed climatic conditions on future visitation levels and seasonal visitation patterns; (2) survey park visitors to determine how a range of potential climate-induced environmental changes may influence their intention to visit the park and visitation frequency; and, (3) compare the implications of direct climatic changes and indirect climate-induced environmental changes on park visitation at three time steps commonly used in climate change impact assessments (2020s, 2050s and 2080s). Conceptually, the analyses of the potential direct and indirect impacts of climate change are considered separate and therefore the respective methodologies and results are presented individually and then compared in the final discussion section.

2. Data and research methods

The focus of this study is Waterton Lakes National Park (WLNP), which is located along the foothills of the Canadian Rocky Mountains in southwestern Alberta adjacent to the Canada–US international border. WLNP is described by Parks Canada as a place 'where windswept mountains rise abruptly out of gentle prairie grassland' (Parks Canada, 2005). WLNP, the smallest of Canada's six Rocky Mountain national parks (525 km; ~130,000 acres), receives nearly 400,000 visitors annually (Parks Canada, 2004); 84% of annual visitation occurs between May and September, clearly demonstrating the seasonal influence of climate. WLNP is also bordered on the south by Glacier National Park (GNP) in the state of Montana, and together the two parks make up the Waterton-Glacier International Peace Park (WGIPP). Established in 1932, WGIPP protects a diverse ecosystem comprised of grasslands, pine and aspen forests, alpine meadows and glacier-covered mountains.

2.1. Climate and park visitation

Monthly recorded visitation data (number of person visits) from WLNP for the 1996–2003 (January–December) tourism seasons were used in this study to assess the influence of climate on visitation. Analysis of the direct influence of climate on visitor levels was undertaken using data from the nearest Meteorological Service of Canada climate station that contained suitable monthly observations for 1996–2003 for use in modeling the relationship between current climate and visitation and a quality historical climate record (i.e. 1961–1990)[1] to establish a climatic baseline for the climate change impact assessment.

[1]Climate data met quality standards for inclusion in the Meteorological Service of Canada's national archive and there were no prolonged periods of missing data.

Monthly level temperature and precipitation data were obtained for the airport station in the City of Lethbridge (Alberta), located approximately 125 km northeast (~79 mile) of WLNP.

The climate change scenarios used in the analysis were developed from monthly global climate models (GCM) available from the Government of Canada's Climate Impacts and Scenarios (CCIS) Project. The scenario data available from CCIS are constructed in accordance with the recommendations set out by the United Nations Intergovernmental Panel on Climate Change (IPCC) Task Group on Scenarios. Climate change projections for three future timeframes were examined, each of which were based on a 30-year period of climate data (i.e. the 2020s represent the period 2010–2039; the 2050s represent 2040–2069; and, the 2080s represent 2070–2099). All scenarios represent climate changes with respect to the 30-year baseline climate (1961–1990).

In accordance with IPCC guidelines for climate change impact assessments, more than one GCM and greenhouse gas (GHG) emission scenario were used in this study to represent uncertainty in future climatic conditions in the study area. The two climate change scenarios utilized in this study were the National Center for Atmospheric Research (NCAR) GCM with a B2 emission scenario (a low greenhouse gas emission future) and the Center for Climate System Research (CCSR) GCM with an A1 emission scenario (a high greenhouse gas emission future). The two climate change scenarios used in this study (NCARPCM B21 and CCSRNIES A11) were selected from among 19 available scenarios; the NCARPCM B21 scenario generally projects the smallest increase in annual mean temperature in the region this century (+2 °C; 3.6 F), while the CCSRNIES A11 scenario projects the largest increase (+7 °C; 13 F).

Visitor projections for WLNP under a changed climate were undertaken using statistical analysis. First, multivariate regression analysis using three monthly level temperature variables (maximum, minimum and mean temperature) and one monthly level precipitation variable (total precipitation) was employed to establish the nature and strength of the empirical relationship between climate and monthly person visits during the 1996–2003 tourism seasons. The resultant regression model was then applied to monthly climate data from the Lethbridge climate station for the 1961–1990 baseline to establish visitation in a climatically 'normal' year, against which future climate change scenarios (also averages of 30-year model runs) would be compared. This step should not be interpreted as an attempt to model past visitation to WLNP between 1961 and 1990. Rather, the purpose of running the regression model with climate data from 1961 to 1990 is to establish visits in a 'climatologically average' year during the baseline period; 30 years is the standard used by climatologists to establish 'current' climatic averages. Under the assumption that current visitation patterns would remain unchanged in the future (i.e. the analysis does not account for other factors that influence visitation—population growth, transportation costs), the regression model was then run with both climate change scenarios (NCARPCM B21 and CCSRNIES A11) for the 2020s, 2050s and 2080s to assess the potential impact of climate change on the number and seasonal pattern of visitation in WLNP with respect to the 1961–1990 baseline.

Visitor data made available for this analysis from Parks Canada provided counts of total visits and did not distinguish the origin of visitors (i.e. local, regional or international) or the activities visitors participated in. Without specific information correlating activities (e.g. skiing, hiking) with visitors, the projections put forward in this study will emphasize the implications of climate change for seasonal visitation resulting mainly from a longer and improved season for warm-weather tourism activities. The winter tourism season is less important to WLNP (less than 10% of total annual visitation) than the warm-weather tourism season, so although snow and ice-based recreation is anticipated to decrease under a warmer climate (Scott, 2003, 2005), losses are expected to be compensated for through larger gains in warm-weather recreation.

2.2. Environmental change and visitation

Any projected change in WLNP's seasonal pattern of visitation resulting from a changed climate will not occur in isolation, as visitation will also be indirectly influenced by climate-induced changes in the natural environment that nature-based tourism depends on. Analysis of the indirect impact of climate change on park visitation was undertaken in this study through a visitor survey that explored how climate change-induced environmental change in WLNP might affect visitor behavior.

Three environmental change scenarios were developed for WLNP to reflect the types of environmental changes and the magnitude of change anticipated to occur in the Canadian Rocky Mountains over the next century. A range of environmental changes identified in Scott and Suffling's (2000) climate change impact assessment of Canada's national parks were considered in each scenario, including wildlife and vegetation compositions, forest fire occurrences, the number of glaciers lost, water temperatures and the probability of campfire bans. The scenarios were hypothetical, but were based on available scientific literature on documented environmental changes in the Rocky Mountains of western North America and projected biophysical changes from region-specific climate change impact assessments in the scientific literature (Brugman et al., 1997; Hall & Farge, 2003; Stocks et al., 1998), and other studies of environmental changes in the Rocky Mountains (Harding & McCullum, 1997; McCarty, 2001; McDonald & Brown, 1996; Rhemtulla, Hall, Higgs, & MacDonald, 2002).

Once created, each scenario provided a plausible story about the anticipated environmental changes in WLNP in the 2020s, 2050s or 2080s (under the warmest climate change scenarios) with respect to current conditions.

TYPES OF ENVIRONMENTAL CHANGE	Scenario 1	Scenario 2	Scenario 3
Total number of mammal species found in the park (currently = 60)	75	100	90
Mammal species lost from the park	0	6	12
Population of grizzly bears, moose and big horn sheep	no change	small decline	moderate decline
Number of glaciers in the park (currently = 30)	30	10	0
Vegetation composition in the Park	(% of park)	(% of park)	(% of park)
Alpine Meadows & Tundra	15%	10%	1%
Forest	70%	65%	55%
Grassland	15%	25%	44%
Number of rare plant species lost from the park	0	5	10
Occurrence of forest fires	no change	moderate increase	large increase
Chance of a campfire ban during your visit	10%	33%	75%
Average fishing catch rate	10% increase	15% increase	20% decrease
Lake water temperature	2^0C warmer	4^0 C warmer	7^0 C warmer

Fig. 1. WLNP visitor survey—environmental change scenarios. *Note*: Respondents were not provided any time frame for the three scenarios, but scenario 1 approximates the 2020s, scenario 2 approximates the 2050s and scenario 3 approximates the 2080s.

Unlike Richardson and Loomis (2004) who examined implications of potential environmental changes into the 2020s, this study continued to further examine how projected climate change into the 2050s and 2080s might affect tourist behavior. Survey participants were asked to reflect on each scenario as a holistic package of environmental changes and consider whether they would still visit WLNP if the identified changes occurred, and, if so, whether they would visit more or less frequently. Participants were also asked whether they would visit a mountain park other than WLNP if the types and magnitude of long-term environmental changes identified for WLNP were not occurring elsewhere (i.e. destination substitution). Participants could not respond differently to individual potential changes (i.e. warmer lake temperatures were desirable, but loss of glaciers was unacceptable). The scenarios provided in the survey instrument are presented in Fig. 1.

The presentation of the environmental change scenarios in the visitor survey was similar to Richardson and Loomis (2004) to provide consistency for comparison of results and because pre-tests suggested that graphics and numerical change estimates would be easier for respondents to interpret than a detailed text-based scenario. The participants in the WLNP survey were not informed of the time period that each environmental change scenario represented (i.e. changes under the warmest climate change scenario for the 2020s, 2050s or 2080s). This was done to avoid biasing the participant's responses (e.g. 'I will not be alive in 2080, so these impacts are less important or will not change my intention to visit'). Before the survey was administered, it was pre-tested ($N = 30$) and appropriate revisions were undertaken.

The visitor survey was administered in WLNP during the summer of 2004 (July 24–August 20) at a variety of locations throughout the park including campgrounds, scenic rest stops, public beaches, backcountry hiking areas and visitor parking lots. A range of survey locations was selected with the purpose of identifying visitors engaged in different recreation and tourism activities. At each location, visitors were approached randomly (i.e. every third person or group) and informed of the study's purpose and asked if they were willing to complete the survey. If visitors were in a group, the person with the birthday closest to the survey date was asked if they would participate. The random sampling approach ensured that each visitor had an equal opportunity to participate. Willing participants took the survey with them and were asked to return it by mail in the pre-paid return envelope provided. Mail-return surveys were used in order to give respondents adequate time to consider the three environmental change scenarios and so as not to interfere with people's activities. A total of 800 surveys were distributed in WLNP; 425 usable surveys were returned (53% response rate).

3. Results

3.1. Direct influence of climate and climate change on visitation

Similar to other national parks in the Rocky Mountains of western North America, there is marked seasonality to WLNP's visitation. Fig. 2 illustrates monthly visits to WLNP for the 2000–2003 tourism seasons. Person visits were found to be highest during the summer months of July and August (~110,000 per month) when most Canadians have school or work-related vacations (i.e. institutional seasonality). The winter period between November and March traditionally experienced the lowest levels of visitation (~6000 visits per month).

Comparison of WLNP's tourism seasons revealed some notable inter-annual variability in visitation. Annual person visits declined 8% in 2003 over 2002 with the most significant monthly reductions occurring in July (−7%), August (−17%) and September (−15%). Officials with Parks Canada have suggested that the reductions were in response to forest fires in a number of mountain parks during the hot and dry summer of 2003 in western North America. Although WLNP did not experience fires, Parks Canada acknowledged that fire-related park closures (e.g. trails, access roads) and wide-spread media coverage of the fires in nearby Canadian (e.g. Kootenay, Jasper) (Parks Canada, 2003; Winks, 2003) and US (e.g. Glacier National Park) (Mann, 2003; Newhouse, 2003) mountain parks deterred visitors from WLNP.

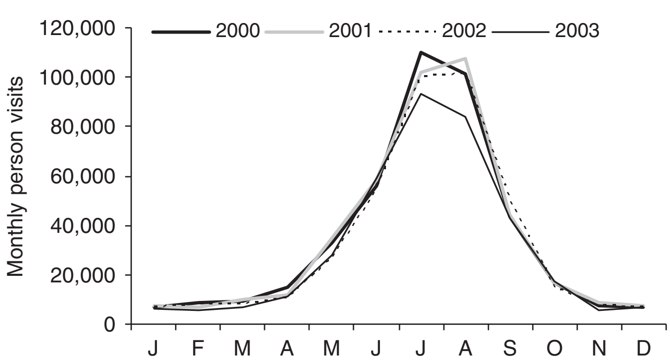

Fig. 2. WLNP visitation, 2000–2003.

Although institutional seasonality (i.e. summer school holidays) plays an important role in seasonal visitation to WLNP, Fig. 2 demonstrates that climate (i.e. natural seasonality) is also important factor. A primary objective of this study was to estimate the potential direct impact of climate change on annual person visits to the park. In order to assess the potential impact of climate change on visitation, a multivariate linear regression analysis involving four monthly climate variables (maximum, minimum and mean temperature and total precipitation) was undertaken. The regression analysis resulted in a one-variable model ($r^2 = 0.67$) with minimum temperature being identified as the strongest predictor of monthly visits t-statistic $= 13.83$; $p < 0.005$). Fig. 3 (Graph A) demonstrates the nature and strength of the relationship between total monthly visits and minimum temperature in WLNP.

Closer examination of the linear regression model in Fig. 3 (Graph A) revealed two important limitations. First, the regression model continued to project an increase in visits as minimum temperature increased. Conceptually, at some critical temperature conditions would likely become too uncomfortable for most people (i.e. heat stress), and rather than increasing, visitation would begin to stabilize and then decline. Similarly, at some minimum temperature, visitation would decline to zero. Second, the relationship between temperature and visitation to WLNP is clearly not linear and distinct climate–visitor relationships are evident at different times of the year. July and August are characterized by visitation levels in excess of 80,000 and little variation with temperature, while visitation in all other months was less than 60,000 but varied substantially with temperature. Due to the combined effect of natural and institutional seasonality, a second regression analysis was undertaken in which visitation in WLNP's peak (defined as July and August; visits $> 80{,}000$) and shoulder (defined as September–June; visits $< 80{,}000$) tourism seasons was modeled separately.

Fig. 3 (Graphs B and C) illustrates the nature and strength of the regression models for WLNP's peak and shoulder seasons. Minimum temperature was found to be the strongest predictor of visits in each season, with a strong relationship in the shoulder season ($r^2 = 0.94$), but a weak relationship during the peak season ($r^2 = 0.01$). Since the r^2 value in the peak summer season was low (0.01), future changes in minimum temperature are projected to have minimal impact on visitation to WLNP during the peak

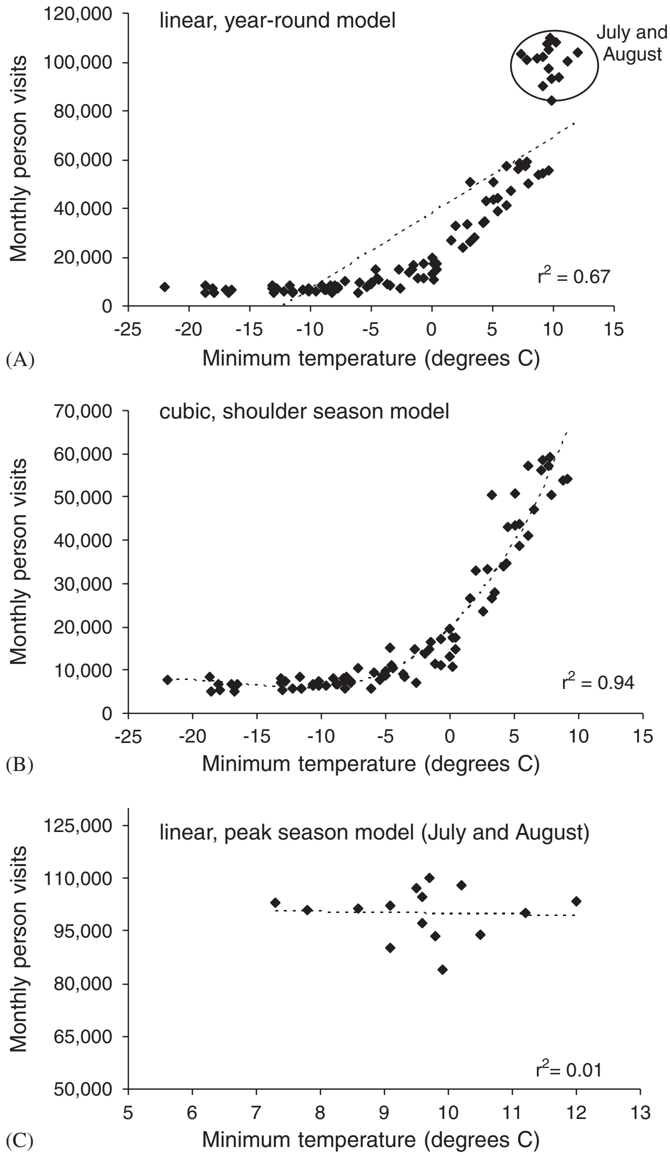

Fig. 3. Linear and cubic regression models for WLNP.

season. The regression expressions used in this study were:

$$\text{Shoulder season (September} - \text{June)} = 3.95x^3 + 194.34x^2 + 2903.20x + 19,536,$$

$$\text{Peak season (July and August)} = -230.59x + 102,253.$$

When the regression models were run with the two climate change scenarios, the resulting projections suggested that WLNP would expect to experience an increase in visitation under a warmer climate relative to baseline conditions. In the 2020s, total annual visits were projected to increase 6% (NCARPCM B21) to 10% (CCSRNIES A11) over the modeled 1961–1990 baseline average (418,358 person visits annually). These results were consistent with Richardson and Loomis' (2004) regression analysis of visitation (+7% to 12%) in RMNP under their 2020s climate change scenarios. In the 2050s, increases were projected to range between 10% (NCARPCM B21) and 36% (CCSRNIES A11), which translates into an additional 42,000–152,000 person visits to WLNP annually. The strong growth in visitation in the shoulder season resulting from climate conditions becoming more suitable for warm-season tourism during the spring (April–June) and fall (September–November) could lead to an extended peak tourism season in WLNP (Fig. 4). In the 2080s, the number of people visiting WLNP was projected to increase 11% over current baseline conditions under the least-change scenario (NCARPCM B21) and increase 60% under the warmest scenario (CCSRNIES A11).

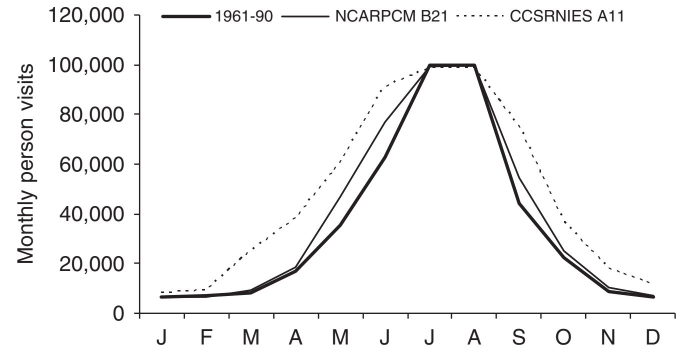

Fig. 4. Projected changes in seasonality in WLNP under climate change (2050s).

If these findings are suggestive of the long-term effects of a more suitable climate for tourism in WLNP, to say nothing of future increases from population growth in Canada and the United States (which were not included in this analysis), the implications for visitation and park management are substantive, but can be interpreted either positively or negatively. As for the benefits, elevated visitor levels would result in higher revenues for Parks Canada, primarily from the collection of additional entrance and recreation service fees in WLNP. The Town of Waterton (population of ~150), located inside WLNP, and communities around the park would also benefit from higher visitor levels as long as growth could be achieved in a sustainable manner. Higher visitation and a longer tourism season would also contribute to higher operating costs and enhance existing visitor-related environmental pressures. Increased need for services (e.g. campgrounds) and visitor management could put stress on existing staff resources in WLNP. The additional stress placed on existing park infrastructure such as roads, trails, water systems and waste management could also lead to increased maintenance costs, as it is anticipated that infrastructure will need more frequent upgrades and/or repair with higher use. Implications of higher visitation for the park's ecological integrity mandate remain uncertain.

3.2. Influence of climate change-induced environmental change on visitation

The results of the above analysis of the potential direct impact of a changed climate suggested that WLNP could experience substantial increases in visitation as the climate in the Canadian Rocky Mountains becomes more favorable for warm-weather tourism and recreation. The regression model only considered the implications of a changed climate for visitation to WLNP, yet the park is also anticipated to undergo concurrent biophysical changes as the climate warms. To explore how park visitation may be affected by climate change-induced environmental change a survey was administered in WLNP that asked visitors to consider the frequency of future visits under three hypothetical scenarios of environmental change in the park.

More than 75% of survey respondents indicated that viewing mountain landscapes and viewing wildlife were either 'important' or 'extremely' important to their decision to visit WLNP. By contrast, less than 15% of respondents indicated that recreational activities including golf, fishing and boating were important for motivating them to come to WLNP. These results suggest that WLNP's mountain landscape is a critical factor in attracting visitors, and any environmental changes that diminish that landscape could have a negative effect on park tourism.

Fig. 5 summarizes the projected impact of climate change-induced environmental change in WLNP on park visitation. After considering the environmental changes outlined in scenario 1 (~2020s), the majority of respondents (99%) indicated that they would still visit WLNP and 10% indicated that they would visit more often. These results were consistent with Richardson and Loomis' (2004) analysis of visitation in RMNP under their 2020s scenarios. In WLNP, a majority of respondents (97%) again indicated that they would visit the park if the environmental changes in scenario 2 (~2050s) were realized, however 14% of those who said they would still visit, would visit less often.

For many respondents, the environmental changes described in scenario 3 (~2080s) represented a critical threshold of acceptability. Of the 425 respondents, 19% indicated that they would no longer visit WLNP if the environmental changes in scenario 3 were realized. An additional 37% of respondents indicated they would visit less often. With most respondents indicating that they would not visit or would visit the park less often, it is possible that the considerable environmental changes projected to occur later this century may contribute to

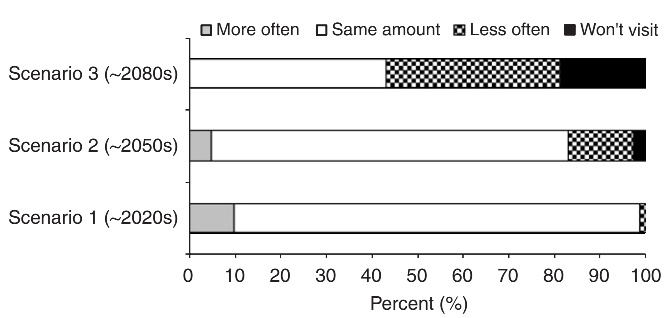

Fig. 5. Projected impact of environmental change on WLNP visitation.

reduced annual visitation at WLNP. This finding represents a notable contrast to the large increase in visitation projected by the previous analysis that only considered the impact of a direct change in climate later in the century (i.e. 14–60% increase in the 2080s). The results of the survey suggest that long-term environmental changes may diminish the attractiveness of WLNP's landscape to some visitors and offset some of the potential gains in visitation made possible by an extended and climatically improved warm-weather tourism season.

The projected environmental changes in WLNP later this century could negatively impact visitation by reducing the attractiveness of the park landscape and thereby providing a comparative advantage to other mountain parks where the impacts of climate change may be less pronounced. When respondents were asked if they would visit another mountain park in the region not experiencing the changes in scenario 3 (~2080s), 34% of respondents indicated they would go to the alternative destination.

4. Discussion and concluding comments

This case study examined the potential impact of climate change on nature-based tourism in WLNP, one of Canada's Rocky Mountain national parks. The study used two separate methodological approaches to examine the potential direct and indirect impacts of climate change on park visitation. A multi-year data set of monthly observed visitation were used to develop regression-based climate–visitation models in order to explore how a changed climate could directly impact the timing and number of annual visitors to WLNP. A visitor survey was then used to explore how climate change-induced changes to WLNP's natural landscape might indirectly influence future visitation.

The climate-visitation model projected that annual visitation to WLNP would increase under all of the climate change scenarios examined, but particularly under the warmer scenario (CCSRNIES A11). The direct affect of a changed climate was projected to increase visitation to WLNP by 6–10% in the 2020s. The findings for the 2020s are consistent with Richardson and Loomis (2004) and together are likely representative of other Rocky Mountain national parks in Canada (e.g. Banff, Jasper and Waterton Lakes) and the United States (e.g. Glacier, Grand Teton and Yellowstone). If climate change scenarios for the 2050s were realized, visitation to the park was projected to increase 10–36%. For the same time periods (2020s and 2050s), the visitor survey revealed that climate change-induced environmental changes would likely have minimal impact on visitation, as most respondents (>90%) indicted that they would not change their intentions to visit WLNP or the frequency of their visits. As such, the direct effect of climate change in lengthening and improving the warm-weather tourism season would appear to be the dominant impact on visitation in the early to mid-decades of the 21st century.

A key finding was the contrast between the climate-visitation model and the visitor survey with regard to the impact of climate change late in the 21st century. The climate-visitation model projected the direct impact of a changed climate would increase visitation to the park (+11% to 60%—2080s), but the survey found that the indirect impact of climate-induced environmental change in the park might reduce visitation, with 56% of respondents indicating that they would no longer come to the park or would visit less often if the environmental changes in scenario 3 (~2080s warmest scenario) were realized.

Although climate-induced environmental change was found to have a potentially important negative impact on visitation under scenarios for the latter part of the 21st century, caution needs to be taken when interpreting these survey results. There is much greater uncertainty in longer-term scenarios because of greater uncertainties in climate change projections (IPCC, 2001) and how society and tourist preferences may evolve over such long timeframes. As such, while the environmental changes posed in scenario 3 may result if the warmest (high emission) climate change scenarios for the 2080s were realized, if a low-emission future were realized, environmental change closer to that outlined in scenario 2 may occur. Notably, scenario 2 has virtually no impact on visitors' intentions to visit the park.

The long-time frames involved also present critical methodological challenges. Although respondents were not given the time frames of the scenarios in the survey, the large magnitude of environment change portrayed in scenario 3 would take several decades to manifest (~2080s or later). The majority of people visiting the park in the 2080s would not be born until the 2040s. By this time, some of the environmental changes projected (e.g. disappearance of the glaciers) may have already occurred and consequently the sense of loss felt by a respondent in 2005 may not be shared by a visitor born in the 2040s. It currently remains uncertain whether these 'future visitors' will be deterred from visiting mountain parks in western North America if they have never experienced the landscape attributes that current visitors use to define and measure the quality of mountain experiences. The lived experience of visitors in the 2080s will be very different (perhaps unimaginably so) than those in 2005, and therefore it remains uncertain whether the negative impact of environmental change on visitation later in this century would occur to the extent the survey results suggest.

Understanding the behavior of 'future tourists' is an important conceptual barrier for climate change impact and adaptation studies in the tourism sector (and other economic sectors—e.g. farmers, planners) to overcome. Regardless of whether respondents in 2005 can accurately represent the behavioral intentions of visitors in the 2050s or 2080s, the salient findings of the survey component of this study stand—the magnitude of environmental change required to become meaningful for altering people's intentions to visit Rocky Mountain national parks is very substantial, and based on current understanding, is several decades away even under the warmest climate change scenarios. That is not to suggest climate change and climate-induced environmental change should not be a concern to park managers, but rather the near-term focus of climate change adaptation in mountain parks should be on managing the impacts of climate change for conservation mandates (Hannah et al., 2002; Scott & Lemieux, 2005) and increased visitation over the next 20–30 years, resulting from an extended and climatically improved warm-weather tourism season.

Mountain tourism is clearly influenced by the climate (Scott, 2005), and this study has provided important insight into the potential direct and indirect impacts of climate change on visitation in one Rocky Mountain national park in western North America. Given the economic importance of national parks to nature-based tourism in North America, it is hoped that this study will encourage further research into the impact of climate change on park tourism in other regions of Canada, the United States and world-wide.

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