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Climate Change, Seasonality and Visitation to Canada's National Parks

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EXECUTIVE SUMMARY: For over a decade, the scientific community and park professionals have recognized that climate change will have critical implications for park conservation policy and management (International Union for Conservation of Nature, 1993; Welch, 2005). The implications of global climate change for nature-based park tourism has only recently begun to be assessed.

Nature-based tourism and related outdoor recreation are strongly influenced by climate. Climate can affect the physical resources that define the foundation of many tourism and recreation activities as well as the length and quality of tourism and recreation seasons. Any changes in the length and quality of tourism and recreation operating seasons brought about by changes in the climate would have considerable implications for visitation and related aspects of park management

Canada's national parks are a major resource for nature-based tourism, with approximately 16 million person visits in 2003. Visitation to Canada's national parks is highly seasonal and greatly affected by the country's regional climates. This paper examined the potential impact of climate change on the annual number of visitors and the seasonal pattern of visitation in Canada's national parks. Multivariate regression analysis using four climate variables and monthly visitation data for 1996 to 2003 was used to develop a monthly climate-visitation model for 15 high-visitation parks. Each park-specific model was then run with two climate change scenarios to assess potential changes in park visitation under a range of climatic conditions projected for the 2020s, 2050s and 2080s.

Results indicate that Canada's national parks could experience an increase in visitors under climate change due to a lengthened and improved warm-weather tourism season. In the 2020s, overall visitation levels were projected to increase 6% to 8%, with a number of parks projected to experience larger increases (+12% to 30%). The largest increases in visitation occur during the spring and fall months. Visitation was projected to increase between 9% and 29% system-wide in the 2050s and between 10% and 41% in the 2080s.

Perhaps more importantly, the affects of climate change will be combined with other factors influencing park visitation in the future. When the potential affects of climate change were combined with those of demographic change (population, ageing and ethnic diversity) total person visits for the mid-2020s were projected to be at least three times greater (+20% to 23%) than that projected under climate change alone.
If these findings are indicative of the impacts of climate change on future visitation, the implications for tourism and park management are substantive. Management implications of the findings include a probable need for more intensive visitor management strategies, especially in parks where

visitor increases could significantly stress natural resources or lead to the escalation of conflicts among user groups. Although the primary focus of climate change adaptation within Parks Canada has thus far been the maintenance of ecological integrity, this research suggests that changes in visitor management strategies will be a required component in the development of Parks Canada's climate change adaptation framework.

KEYWORDS: National parks, tourism, climate change, Canada

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Introduction

Nature-based tourism is a major component of Canadian tourism and Canada's system of national parks represents a significant resource (Gray, Duwors, Villeneuve, Boyd, & Legg, 2003). In 2003, there were approximately 16 million visits to Canada's national parks (Parks Canada, 2004). The economic impact of national park visitation in Canada is equally significant. National park-based tourism contributes nearly US $960 million to Canada's gross domestic product and the equivalent of 38,000 full-time direct jobs (Outspan Group, 2001).

A principal determinant of nature-based tourism in Canada is the climate. Climate influences the physical resources that provide the foundation for nature tourism and related outdoor recreation, and the length and quality of tourism and recreation seasons (i.e., natural seasonality as defined by Butler (2001)). In Canada, national park visitation is highly seasonal with nearly 70% of annual person visits occurring between May 1 and September 30 (Parks Canada, 2004). Any changes in the length and quality of tourism operating seasons, including those induced by global climate change (Scott, McBoyle, & Schwartzentruber, 2004), could pose risks and opportunities for parks and nearby communities. For example, longer tourism seasons would be advantageous for park revenues (Parks Canada operates under a revenue-retention model) and the economic sustainability of communities where nature-based tourism is a significant component of the economy, but would also negatively affect the ability of park managers to maintain ecological integrity, particularly in parks where current visitor levels already represent an ecological stressor.

Climate change research regarding Canada's national parks has to date focused primarily on the projected impacts on ecosystems and the associated implications for conservation policy and planning (Scott & Suffling, 2000; Scott, Malcolm, & Lemieux, 2002; Scott, 2003). Scott and Suffling (2000) identified a wide range of potential impacts on park ecosystems in the scientific literature including the projected disappearance of glaciers from Banff National Park, projected declines in polar bear populations in Wapusk National Park and projected changes in bird migration routes that would negatively impact Point Pelee National Park. Scott and Suffling (2000) also indicated that since park visitation is highly seasonal, there could be increased visitation opportunities in many of Canada's national parks. They recommended that a more detailed analysis of park tourism is needed in order to better understand the impact of climate change on nature-based tourism and the implications for park management. Despite the importance of climate to the nature-based tourism sector, there has been very limited study of the potential impacts of climate change on park visitation (only Konopek, 2005; Richardson & Loomis, 2004) and none has examined impacts at a system level (only individual parks).

Building on the recommendation of Scott and Suffling (2000), this paper presents an empirical assessment of climate and visitation in Canada's national park system. The specific objectives of this study were to: (1) explore the strength and regional variability in the relationship between current climate and visitation; (2) develop a model of climate and visitation in high-visitation parks in order to examine the implications of projected climate change for future visitation levels and seasonal visitation patterns; and, (3) explore the implications of projected changes in visitation for national park management in Canada.

Data and Methods

This analysis examined the relationship between climate and visitation in order to understand the potential impact of climate change on the volume of visits and seasonal pattern of tourism in Canada's national parks. The study used visitation data obtained from Parks Canada, the federal agency responsible for managing the country's national parks. The data consisted of the total number of visitors entering each of Canada's national parks per month between January 1996 and December 2003. The visitation data did not specify the activities visitors planned to do while in the park, only total visits. The recreational activities that visitors participate in vary from park to park due to the natural and recreational amenities available. As there is strong regional variation in the climatic range and season length of the dominant winter and warm-weather recreation activities in each park, it was anticipated that climate would have a disparate impact on visitation to individual parks. The average season length for winter recreation is projected to decrease under a warmer climate (Scott, McBoyle, & Mills, 2003; Scott, 2005), but some of the potential losses in visitation would be compensated by expanded opportunities for warm-weather recreation. Without information that correlates activities (e.g., skiing, hiking) with visitors, the climate change projections presented in this study will provide insight into the expansion of suitable climatic conditions for warm-weather recreation and tourism.

At the time of analysis, Canada's national park system consisted of 39 parks. Not all parks were included in this study due to data limitations and low visitation levels in some northern parks. In some parks, visitor totals were duplicated over successive years for particular months, seasons and even years. Parks Canada officials indicated that duplication occurred when procedures were unavailable to officially record visitors entering the park (e.g., no staff at entrance gates during the winter months). Duplicated records were used by Parks Canada as a reasonable estimate of monthly and annual visits, but limited our ability to model the influence of climate on visitation. Parks with duplicated visitation records were removed from the analysis. The availability of climate stations posed another methodological barrier. Some parks were not located near a station with sufficient current climate records for the full period of visitation data (i.e., 1996 to 2003) and an adequate historical record for use in the climate change impact assessment (i.e., 1961–90). Parks that did not have the required climate data records were also removed from the analysis. National parks in Canada's northern territories (there are 10 of them) were also not included in this study. Canada's northern parks are generally isolated geographically from climate stations and, more importantly, from tourist populations. Other than Kluane National Park and Reserve, most northern parks receive less than 1,000 visitors annually (Parks Canada, 2004). Even if climatic conditions were to become more suitable for tourism under climate change, accessibility to these northern parks remains a significant barrier for tourism expansion. As Table 1 indicates, 15 of Canada's 39 national parks with reliable visitor and climate data were used in this study. The 15 parks collectively represented 86% of all national park visits in Canada in 2003. They also represent four of Canada's five geographic regions and a range of prevailing climates.

Exploration of the influence of climate on the seasonal pattern of park visitation was undertaken using temperature and precipitation data from the nearest Meteorological Service of Canada climate station to each park. Table 1 summarizes the climate station used with respect to each park. The climate change scenarios for each were developed from monthly global climate models (GCM) available from the Canadian 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. 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 2010–39; the 2050s represent 2040–69; and, the 2080s represent 2070–99). All scenarios represent climate changes with respect to the 30-year baseline climate (i.e., 1961–90).

In accordance with IPCC recommendations for impact assessments, more than one GCM and greenhouse gas emission climate change scenario was used in this study in order to capture the range of possible future climatic conditions in Canada. The two GCMs used were the National

Table 1
Summary of the National Parks Used in the Case Study

National Park[1]	Province	Geographic Region	% of Total Visitors in 2003[2]	Visitation Data Record[3]	Climate Station[4]
Pacific Rim Reserve	British Columbia	West	4.8	1997-1999	Tofino, BC[b]
Waterton Lakes	Alberta	West	2.3	1996-2003	Lethbridge, AB
Prince Albert	Saskatchewan	West	1.5	1996-2003	Prince Albert, SK
Mount Revelstoke & Glacier	British Columbia	Mountain	3.8	1996-2003	Calgary, AB[a]
Kootenay	British Columbia	Mountain	11.5	1996-2002	Calgary, AB[a]
Yoho	British Columbia	Mountain	7.0	1997-2002	Calgary, AB[a]
Banff	Alberta	Mountain	29.1	1996-2003	Banff, AB
Jasper	Alberta	Mountain	11.7	1996-2003	Jasper, AB
Point Pelee	Ontario	Central	1.8	1996-2003	Windsor, ON
Pukaskwa	Ontario	Central	0.1	1996-2003	Sudbury, ON
La Mauricie	Quebec	Central	1.1	1996-2003	Trois Rivieres, QC[c]
Prince Edward Island	Prince Ed. Island	East	5.5	1999-2000	Charlottetown, PE
Kouchibouguac	New Brunswick	East	1.4	1996-2003	Miramichi, NB
Cape Breton Highlands	Nova Scotia	East	2.5	1996-1999	Sydney, NS[c]
Terra Nova	Newfoundland	East	1.6	1996-2003	St. John, NF

1) Mount Revelstoke and Glacier National Park are separate parks in Canada's national park system, but Parks Canada aggregates their visitor numbers.
2) Total visitors to Canada's 39 national parks in 2003 was 15,931,821
3) Records shorter than 1996-2003 due to duplication in visitor numbers
4) Missing climate records (1961-90): a – 1 day; b – 44 days; c – 32 days; d – 1,620 days

Center for Atmospheric Research (NCAR) model and the Centre for Climate System Research (CCSR) model. The specific climate change scenarios used were NCARPCM B21 and CCSRNIES A11. These two climate change scenarios were selected from 19 available scenarios because the NCARPCM B21 scenario generally projects the smallest increase in annual mean temperature in Canada this century, while the CCSRNIES A11 scenario projects the largest increase.

A difficulty noted by the climate change impacts research community is that many impact assessments, including this study, require climate change information at finer spatial scales than are generally available from GCMs (Wilby, Charles, Zorita, Whetton, & Mearns, 2004). There are several methodological approaches to producing higher resolution climate change scenarios (e.g., regional climate models, statistical downscaling, spatial and temporal analogues, and simple application of 'climate change factors' to a reference climate), and each have strengths and weaknesses depending on the application (Wilby et al., 2004). For this study GCM scenarios were downscaled to each park's respective climate station using the Long Ashton Research Station (LARS) stochastic weather generator (Semenov, Brooks, Barrow, & Richardson, 1998). Weather generators are inexpensive computational tools that replicate the statistical attributes of a local climate and can be used to produce site-specific, multiple-year climate change scenarios. LARS was selected for this study because it has been found to simulate precipitation statistics in Canada better than other weather generators (Qian, Gameda, Hayhoe, de Jong, & Bootsam, 2004).

To project future park visitation in Canada's national park system under a changed climate, multivariate regression analysis was first employed to develop an empirical relationship between climate and monthly visits at each of the 15 national parks for the years of available data (Table 1). Three monthly-level temperature (maximum, minimum and mean temperature) and one precipitation (total precipitation) variables were used. The resulting regression model for each national park was then applied to monthly climate data from its respective climate station for the 1961-90 period to establish 30-year climatological baselines for comparing future trends in visitation under climate change. This step should not be construed as an attempt to model actual visitation at each park in any given year between 1961 and 1990. All 15 national parks have been in operation for that long, but major factors affecting visitation over that length of time (e.g., population growth, fuel prices, transportation access, economic fluctuations) were not considered. Rather the purpose of running the models with the climate data from 1961-90 is to establish visitor levels in a climatologically average year during the baseline period, and 30 years is the standard used by climatologists to establish climatic averages. The regression model for each park were then run with both climate change scenarios (NCARPCM B21 and CCSRNIES A11) for the 2020s, 2050s and 2080s to project and examine potential changes in visitation under a range of future climate conditions with respect to the 1961-90 baseline.

The primary objective of this study was to assess the explanatory power of climate on park visitation and the subsequent implications of projected climate changes. In order to better isolate the potential impact of a changed climate on visitation, non-climatic variables that could affect visitation over time (e.g., population change, tourism infrastructure development, transportation linkages, and economic conditions) were not included in the regression analysis. Non-climate variables were also excluded for two methodological reasons. First, the composition of visitor origins (i.e., proportion of local, regional, national, international) is not known for some of Canada's national parks, so an accurate method of accounting for variables such as local population growth was not available. Second, the visitation data used in this study was for a short time period (1996 to 2003), thus variables such as population change and tourism infrastructure development were not likely to have a major influence on visitation in most park areas.

Results

Seasonal patterns in park visitation

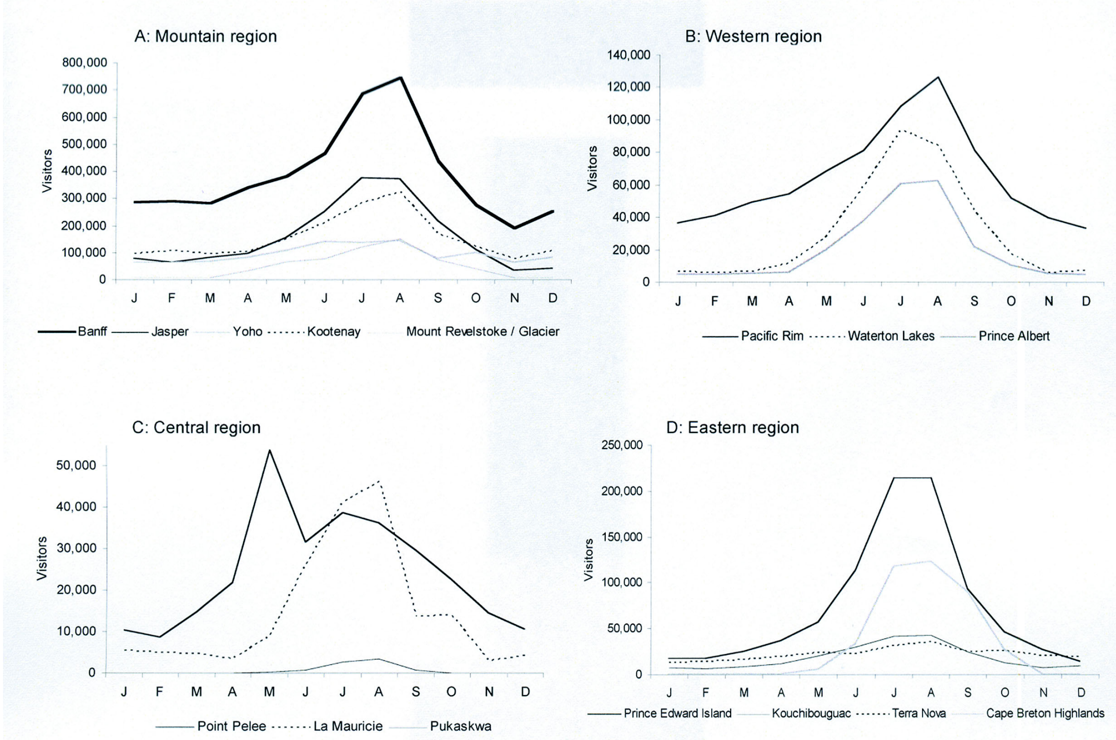
Monthly visitation to individual Canadian national parks varies substantially, but there is a well-defined seasonality in visitation across the entire park system. Figure 1 illustrates monthly visits during the 2003 tourism season for the 15 parks analyzed in this study. Visitation tends to be highest during the summer months of July and August at most parks, when most Canadians have school or work-related holidays (i.e., institutional seasonality), and lowest during the winter months. The one notable exception to this pattern is Point Pelee National Park (Ontario), where visitation is highest in the month of May when hundreds of thousands of birds use the park as a stopover on their annual northern migration. The summer peak seasonal pattern is also much more pronounced in some parks, as is illustrated by a comparison of parks in the Eastern Region (Figure 1 - D)

Regression models of visitation

Regression analysis was used in this study to determine the explanatory power of climate for person visits to Canada's national parks. Initially, linear multiple regression analysis using four climate variables (maximum, minimum and mean temperatures, and precipitation) was employed, and resulted in one-variable visitation models for 14 of the 15 national parks. Maximum and minimum temperatures were each found to be the strongest predictor of monthly visits in seven of the 15 parks. Two climate variables (precipitation and maximum temperature) were found to be the strongest predictors of monthly visits at one park - Pacific Rim Reserve. Pacific Rim Reserve is located on the leeward side of the Coast Mountains on Vancouver Island and has a cool, wet maritime climate.

An important limitation of the linear regression models was revealed in the initial analyses and is demonstrated in Figure 2 using Kouchibouguac

Figure 1
Regional Variability in Monthly Park Visitation in Canada, 2003



and Waterton Lakes national parks. The relationship between climate and person visits appears not to be linear, and more importantly, the one-variable linear models (Figure 2 - A and B) continue to project an increase in visitation as temperature (maximum or minimum) increases. Conceptually, this relationship is unrealistic because at some critical temperature, conditions would likely become too uncomfortable for most people (i.e., heat stress) and visitation would begin to stabilize and then decline. Both graphs also reveal distinct climate-visitor relationships at different times of the year. In Waterton Lakes National Park for example (Figure 2 - B), July and August were characterized by visitation levels in excess of 80,000, with very little monthly variability with temperature. This pattern would suggest that visitation is currently near a maximum regardless of the prevailing climatic conditions, in part because of institutional seasonality (i.e., school holiday period in much of Canada and the United States), and in part because climatic conditions are almost always highly suitable at that time of year. Visitation in all other months was less than 60,000 and demonstrated substantial variability with temperature. The combined affect of natural and institutional seasonality was observed at other parks. In order to address the role of institutional seasonality and the disparate relationships between climate and visitation at different times during the year, visitation during the peak and shoulder tourism seasons were subsequently modeled separately.

To capture and express the relationship between climate and park visitation during peak and shoulder seasons in a robust manner (i.e., high R-squared value), a number of regression functions were examined. Attempts were made to define the percent increase in visitation per 1°C increase in temperature (exponential function), but reliable exponential relationships were not available for individual parks or geographic regions. The weak exponential relationship between climate and visitation was likely a function of the temporal level of data available for this study (monthly level data, as opposed to daily level). The disparate relationships evident between climate and visitation during the peak and shoulder seasons (Figure 2) also reduced the robustness of logarithmic functions. Consequently, cubic and linear regression relationships were able to best capture the relationship between climate and visitation. Table 2 summarizes the climate-visitation regression models developed for each of the 15 national parks. Figure 3 illustrates the strength and nature of the shoulder and peak season models for the same parks illustrated in Figure 2. Two regression models, one for the peak season and one for the shoulder season, were defined for all but three national parks (Kootenay, Yoho and Pacific Rim Reserve). Visits to Kootenay and Yoho national parks were best represented by one-variable, one-season models (i.e., year round), while Pacific Rim Reserve continued to be best represented by a multivariate (temperature and precipitation) season model.

Table 2
Regression Models of the Relationship between Climate and Park Visitation

National Park	Model (s)[1]	Predictor of Visits	Model Type[2]	R^2	Equation Used in Study (Visits =)
Pacific Rim Reserve	Y	T-max and precip	L	0.83	$= 4,149.93 + 3,712.86(T) - 23.34(P)$
Waterton Lakes	S	T-min	C	0.94	$= 3.95x^3 + 194.34x^2 + 2,903.2x + 19,536$
	P(Jul/Aug)	T-min	L	0.01	$= -230.59x + 102,253$
Prince Albert	S	T-min	C[a]	0.88	$= 1.11x^3 + 68.11x^2 + 1,330.80x + 12,143$
	P(Jul/Aug)	T-min	L	0.15	$= 2,676.6x + 24,881$
Mount Revelstoke & Glacier	S	T-max	L	0.24	$= 113.97x + 7609$
	P (Apr-Oct)	T-max	C	0.86	$= -7.78x^3 + 573.76x^2 - 6,453.70x + 48,368$
Kootenay	Y	T-max	C	0.84	$= 8.56x^3 + 88.55x^2 + 639.11x + 77,115$
Yoho	Y	T-min	C	0.82	$= 0.99x^3 + 101.88x^2 + 3,214.45x + 88,904.$(
Banff	S	T-max	C	0.71	$= 8.51x^3 + 286.07x^2 + 1,438.10x + 250,271$
	P (Jul/Aug)	T-max	L	0.22	$= 7,763.0x + 512,497$
Jasper	S	T-max	C	0.85	$= -1.47x^3 + 351.31x^2 + 2,357.50x + 58,615$
	P(Jul/Aug)	T-max	L	0.01	$= 211.20x + 316,544$
Point Pelee	S	T-max	C	0.89	$= -0.42x^3 + 43.07x^2 + 251.76x + 11,667$
	P (May)	T-max	L	0.41	$= 1,248.90x + 36,232$
Pukaskwa	S	T-min	C[b]	0.89	$= 0.07x^3 + 2.82x^2 + 33.82x + 150.85$
	P(Jul/Aug)		L	0.02	$= -48.80x + 3,918$

Continued

Table 2 continued
Regression Models of the Relationship between Climate and Park Visitation

La Mauricie	S	T-min	C	0.84	$= 1.18x^3 + 54.84x^2 + 675.09x + 6{,}217.8$
	P(Jul/Aug)	T-max	L	0.03	$= 897.67x + 29{,}424$
Prince Edward Island	S	T-min	C	0.92	$= -6.62x^3 + 153.69x^2 + ,3961.30x + 33{,}589$
	P (Jun-Aug)	T-min	L	0.88	$= 24{,}289x - 115{,}782$
Kouchibouguac	S	T-max	C	0.94	$= -0.18x^3 + 39.88x^2 + 167.50x + 7{,}059.5$
	P(Jul/Aug)	T-max	L	0.06	$= 802.93x + 27{,}461$
Cape Breton Highlands	S	T-max	L	0.15	$= 88.39x + 4{,}197$
	P (May-Oct)	T-min	C[c]	0.92	$= 33.40x^3 - 187.47x^2 + 3{,}257.3x + 17{,}513$
Terra Nova	S	T-min	C	0.86	$= -1.92x^3 - 10.48x^2 + 713.76x + 19{,}246$
	P(Jul/Aug)	T-min	L	0.11	$= 667.61x + 24{,}856$

1) Model: P – peak season; S – shoulder (months other than those included in peak season);Y – year round (nature of climate-visit relationship negated the need to split into two seasons)
2) Model type: C (cubic regression) and L (linear regression)
Some models were truncated at specific temperature thresholds when visits declined to zero (based on trend line):
a) truncated at -35°C; b) truncated at -24°C; c) truncated at 0°C;

Figure 2
Examples of Linear Regression Visitation Models

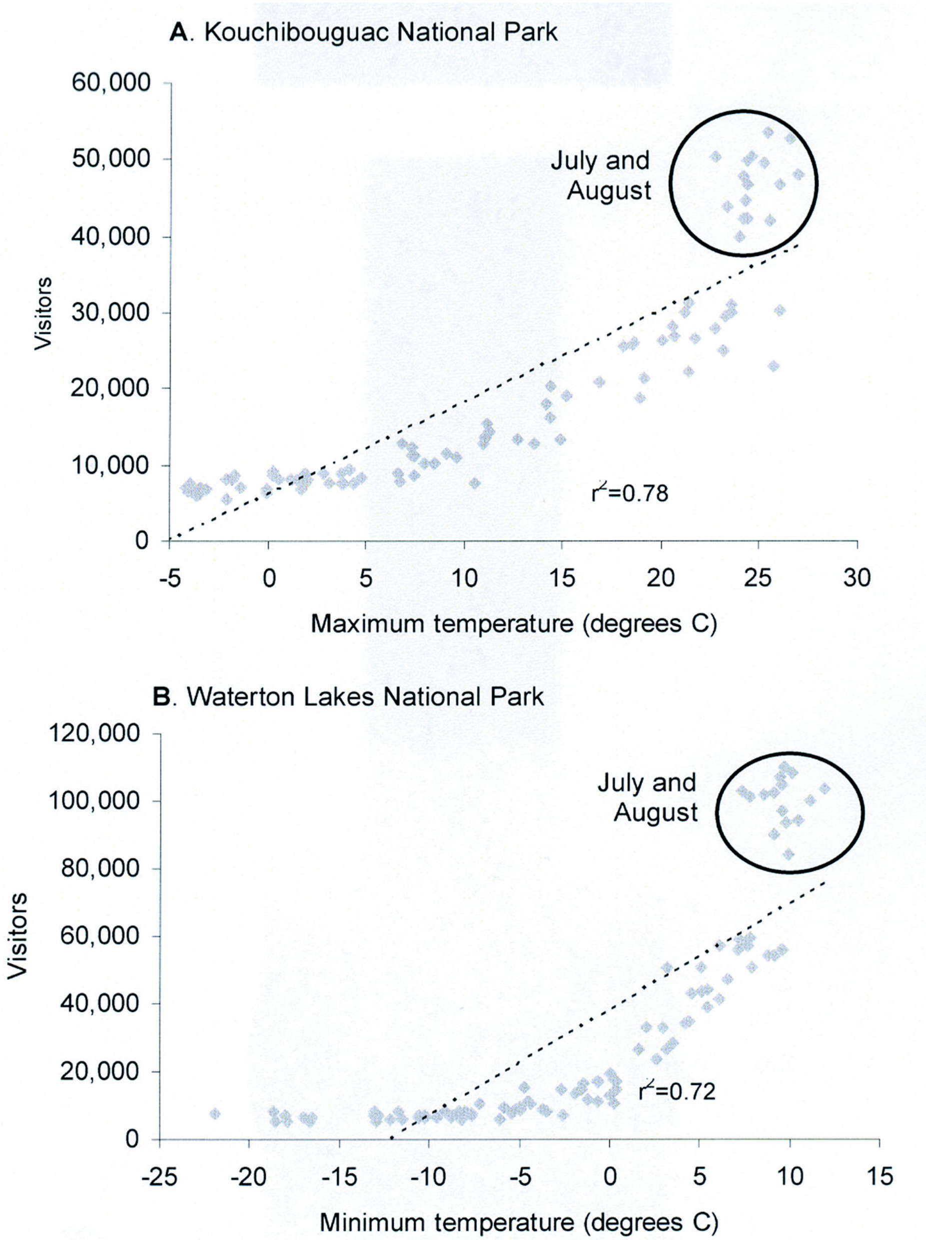
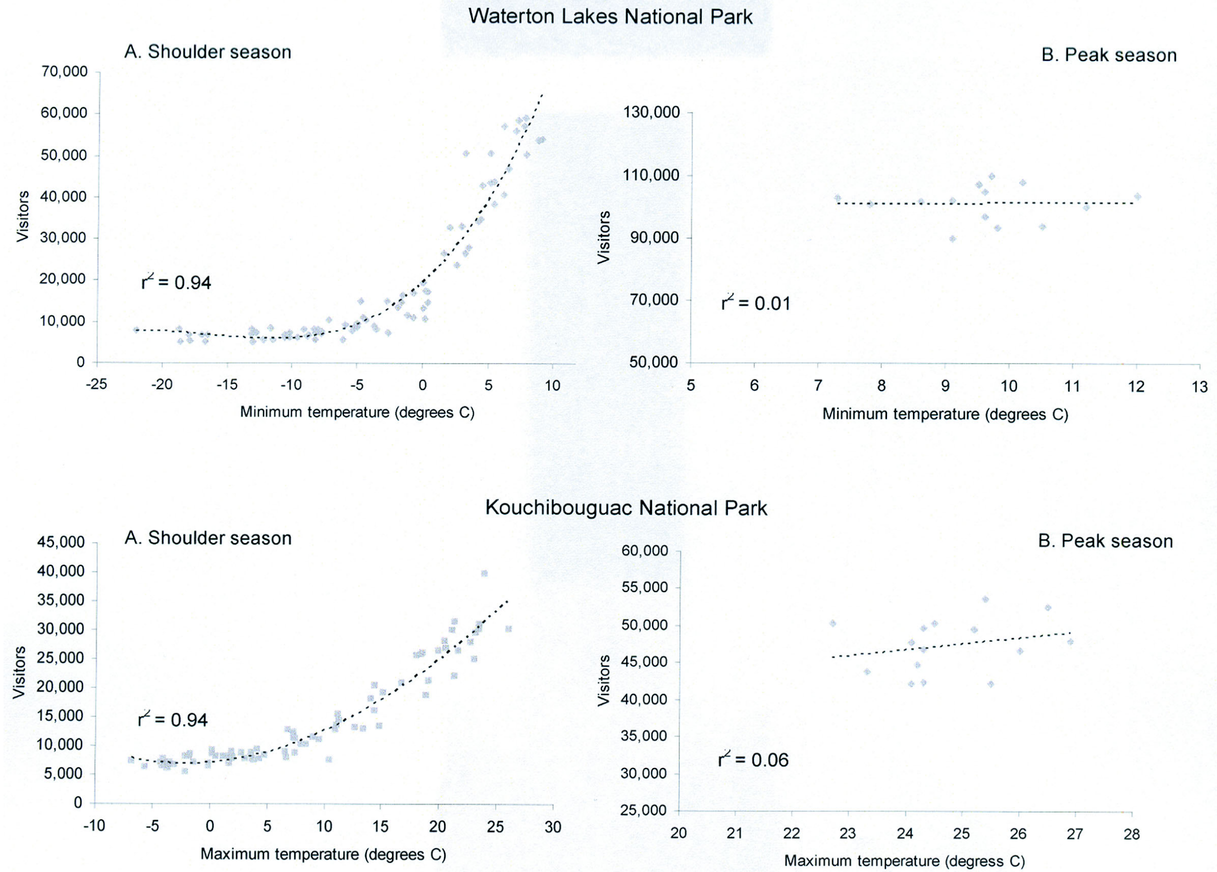


Figure 3
Shoulder and Peak Season Regression Models for Kouchibouguac and Waterton Lakes National Parks



Influence of climate change on park visitation

The climate-regression models were run with the two climate change scenarios to explore how changes in the climate may influence the number of people who visit Canada's parks. Table 3 summarizes the projected increases in visits at individual parks and system wide. A comparison of the projected changes under the two climate change scenarios suggests that all of Canada's national parks could expect to experience an increase in visitation under either climate change scenario.

Total system-wide visits were projected to increase between 6% (NCARPCM B21) and 8% (CCSRNIES A11) in the 2020s, with a number of individual parks projected to experience much higher increases in visitation. The warmer climate change scenarios of the 2050s and 2080s have even greater implications for park management. In the 2050s, system-wide visitation was projected to increase between 9% (NCARPCM B21) and 29% (CCSRNIES A11), which translates into an additional 1.1 million to 3.3 million person visits annually. In the 2080s, the number of people visiting Canada's national parks was projected to increase 10% under the least-change scenario (NCARPCM B21) and 41% under the warmest climate change scenario (CCSRNIES A11). Under the warmest climate change scenario for the 2080s, visitation was projected to more than double in eight of the 15 national parks.

There was also regional variability in projected visitor increases. Interestingly, Canada's most popular national parks, which are the mountain parks, were generally projected to experience the smallest increases in visitation under both climate change scenarios. Comparatively, some eastern and central parks were projected to experience the largest increases. Prince Edward Island, Cape Breton Highlands and Pukaskwa national parks were all projected to experience at least a doubling of visitor levels by the 2080s under the warmest climate change scenario. At present, visitation to these three parks is highly seasonal, as less than 10% of annual visitation occurs outside the warm-weather months. Any future improvement in the climatic conditions during the warm-weather months would seem to substantially benefit tourism in these three parks.

The seasonal timing of projected changes in visitation is important to park managers, as changes would influence a range of management issues including user-fee collection, environmental operations and even staffing requirements. Figure 4 illustrates the projected monthly changes in visitation at three selected national parks in the 2050s; the three patterns shown are representative of key patterns seen across all 15 parks examined in this study. In the majority of parks in the study, the largest increase in visitation was projected to occur during the spring (April to June) and fall (September to November) months (Figure 4 - A). This pattern suggests that conditions become more climatically suitable for warm-weather recreation and tourism during the shoulder season. If higher visitation is sustained in the spring and fall months under a changed climate, such a change could require an extension in the operating period of facilities at many of Canada's national

Table 3
Projected Changes in Annual Park Visitation under Climate Change

National Park	Modeled Annual Visitors[1] 1961-90	NCARPCM B21 2020s	NCARPCM B21 2050s	NCARPCM B21 2080s	CCSRNIES A11 2020s	CCSRNIES A11 2050s	CCSRNIES A11 2080s
Pacific Rim Reserve	537,282	+9.8%	+13.2%	+15.6%	+7.6%	+37.2%	+49.4%
Waterton Lakes	418,358	+6.1%	+10.1%	+14.4%	+10.2%	+36.3%	+60.0%
Prince Albert	203,376	+6.7%	+10.4%	+11.7%	+14.6%	+35.7%	+55.1%
Mount Revelstoke & Glacier	462,448	+8.8%	+14.8%	+17.1%	+26.1%	+56.0%	+78.7%
Kootenay	1,628,373	+5.7%	+9.8%	+11.6%	+8.1%	+31.5%	+52.4%
Yoho	1,066,544	+3.5%	+5.5%	+6.7%	+5.1%	+19.1%	+29.9%
Banff	4,413,741	+2.5%	+4.0%	+4.7%	+3.0%	+11.9%	+19.8%
Jasper	1,879,078	+3.5%	+6.1%	+7.1%	+3.9%	+18.5%	+31.0%
Point Pelee	331,932	+4.8%	+6.5%	+9.1%	+13.0%	+28.6%	+39.4%
Pukaskwa	8,367	+12.2%	+14.2%	+16.4%	+22.6%	+40.2%	+58.8%
La Mauricie	171,710	+5.5%	+8.8%	+10.9%	+15.7%	+35.2%	+54.3%
Prince Edward Island	845,850	+14.1%	+21.2%	+23.8%	+22.4%	+50.6%	+73.6%
Kouchibouguac	229,055	+5.1%	+7.9%	+9.8%	+5.2%	+22.4%	+33.3%
Cape Breton Highlands	366,307	+22.9%	+36.6%	+40.3%	+30.0%	+78.2%	+126.2%
Terra Nova	239,736	+3.4%	+5.8%	+7.0%	+3.9%	+9.3%	+12.7%
Total visitation	**12,802,157**	**13,500,332**	**13,905,030**	**14,107,002**	**13,850,828**	**16,094,033**	**18,049,845**
% change in visitation		**+5.5%**	**+8.6%**	**+10.2%**	**+8.2%**	**+28.7%**	**+41.0%**

1) Modeled visits were within +/- 25% of observed visits in 2003 at all parks (six parks were within +/- 5%; 11 parks were within +/- 10%)

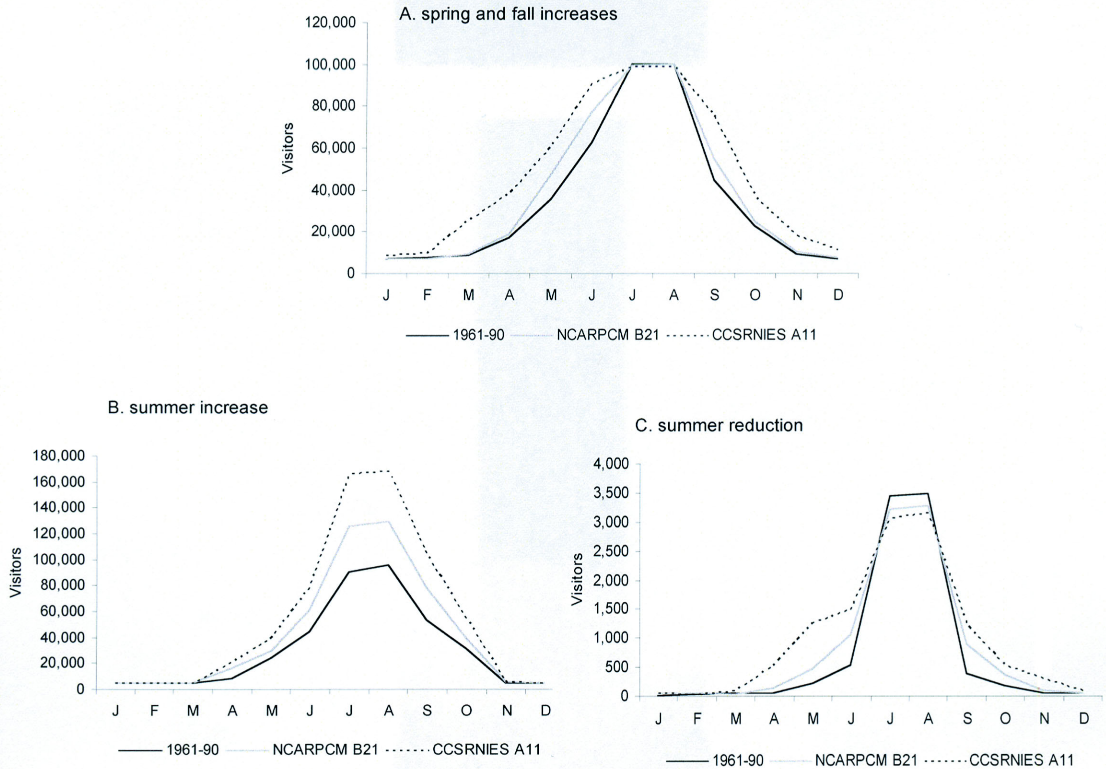
parks. In a few parks, visitor increases were projected to be highest during the summer (Figure 4 - B). Any increase in visitors during the peak tourism period would certainly place extra strain on park resources that can be operating near capacity during July and August. The final pattern was unique to Pukaskwa National Park (Figure 4 - C). Although visitation was projected to increase during the spring and fall months, there was a notable reduction in visitation during the summer at this park. This pattern is partially explained by the fact that the relationship between visitation and temperature during the park's peak season was negative in the regression analysis. Thus, increases in average temperature under climate change would contribute to further reductions in visitation at Pukaskwa National Park.

The park visitation projections discussed in this section thus far only consider the impact of climate change and do not include the influence of other factors that could affect park visitation (e.g., population growth, ageing society, travel costs). Importantly, there is likely to be synergistic effects between climate change and some of these other factors. The Canadian Tourism Commission (2003) has assessed the potential impact of projected demographic changes in Canada and the United States to 2025 on major tourism markets in the two countries. As a result of demographic change, the soft outdoor adventure market in Canada, which includes common nature-based tourism activities undertaken in parks such as hiking and canoeing, is projected to increase 9% for Canadian visitors and 25% for American visitors by the year 2025. Because of the commonalities in activities, the affects of demographic change on the soft outdoor adventure market was considered a proxy for the affect on national park visitation. Most visitors to Canada's national parks are from Canada (~70%), while the remainder come primarily from the United States (Outspan Group, 2001). Using this visitor ratio (70% Canadian, 30% American), the impact of demographic change on visitation to Canada's national parks was projected to be two to three times greater (+14%) than climate change alone (+6% to 8%) in the mid-2020s. Climate and demographic change will act synergistically and the combined affect in the mid-2020s was projected to increase visitor levels between 20% and 23% (Table 4). The combined effect could translate into an additional 2.5 to 2.8 million visitors annually.

Discussion and Concluding Comments

This study is the first-known assessment of climate change on visitation in any system of national parks. The study used multi-year, monthly observed visitor data from 15 of Canada's high-visitation national parks to develop climate-visitation regression models and assess potential changes in the volume and seasonality of person visits under climate change. The results of the climate change impact assessment suggested that person visits would increase system-wide, even under the most conservative climate change scenario. Projected increases in visitation were in the range of 6% to 8% in the 2020s and 9% and 29% in the 2050s, with most of the growth

Figure 4
Seasonal Patterns in Projected Changes of Visitation[1] (2050s)



1) Number of parks projected to experience each prevailing pattern: spring/fall increase (8 parks); summer increase (6 parks); summer reduction (1 park)

Table 4
Projected Impact of Demographic and Climatic Changes on Park Visitation to the 2020s

National Park	Modeled Annual Visitors 1961-90	Climate Change Only[1]		Demographic Change[2]	Climate Change and Demographic Change[3]	
		NCARPCM B21	CCSRNIES A11		NCARPCM B21	CCSRNIES A11
Pacific Rim Reserve	537,282	581,400	589,420	611,427	671,347	657,895
Waterton Lakes	418,358	440,000	460,983	476,091	505,133	524,653
Prince Albert	203,376	216,906	226,989	231,442	246,948	265,232
Mount Revelstoke & Glacier	462,448	503,233	583,276	526,266	572,577	663,726
Kootenay	1,628,373	1,720,586	1,759,677	1,853,088	1,958,715	2,003,189
Yoho	1,066,544	1,103,631	1,121,147	1,213,727	1,256,208	1,275,991
Banff	4,413,741	4,526,076	4,547,070	5,022,837	5,148,408	5,173,522
Jasper	1,879,078	1,944,993	1,953,207	2,138,391	2,213,234	2,221,788
Point Pelee	331,932	347,849	375,225	377,739	395,870	426,845
Pukaskwa	8,367	9,386	10,259	9,522	10,683	11,674
La Mauricie	171,710	202,315	221,858	195,406	206,153	226,085
Prince Edward Island	845,850	965,289	1,035,407	962,577	1,098,301	1,178,195
Kouchibouguac	229,055	240,658	240,964	260,665	273,958	274,219
Cape Breton Highlands	366,307	450,152	476,309	416,857	512,318	541,915
Terra Nova	239,736	247,858	249,037	272,820	282,095	283,460
Total visitation	**12,802,157**	**13,850,828**	**13,850,825**	**14,568,855**	**15,351,949**	**15,728,388**
% change in visitation		**+5.5%**	**+8.2%**	**+13.8%**	**+19.9%**	**+22.9%**

1) Based on change values (%) in Table 3 for the 2020s
2) Based on a 9% increase in Canadian visitors (70% of 1961-90 modeled annual visits) and a 25% increase in international visitors (30% of 1961-90 modeled annual visits)
3) Ex.Banff (2.5% increase under the NCARPCM B21 climate change scenario). To determine the combined effect of climate change and population growth, 5,022,837 was multiplied by 1.025 (2.5%) to yield 5,147,408 visits.

occurring outside the traditional peak summer tourism season. The combined effect of climate change and demographic change was projected to have a meaningful impact on visitation (+20% to 23%) as early as the mid-2020s. Although the projected increases in visitation as a function of climate change are higher for the 2050s, changes in visitation in the near-term, whether a function of demographic change, climate change, or more importantly a synergistic affect of demographic and climatic change, will be relevant for park planning and management over the next two decades.

If these findings are suggestive of the longer-term effects of climate change on visitation, to say nothing of future increases in use from population growth, the implications for tourism and park management are substantive. Even in the short-term, the implications have relevance to park planning. Parks Canada would certainly benefit economically in the near-term (2020s) from a projected increase of 3 million visitors annually (Table 4). Gateway communities with park-based tourism economies, such as Banff, Alberta (Banff National Park) and Terra Nova, Newfoundland (Terra Nova National Park), could also benefit if the opportunities to increase visitation can be accomplished in a sustainable manner.

Conversely, significant increases in visitation or changes in seasonal visitation could exacerbate existing visitor pressures in some of Canada's national parks. Parks that already report visitor-related ecological stress would require more intensive visitor management strategies, and parks that do not currently indicate visitation as a key ecological stressor may in the future. Higher visitation in the near-term (2020s), and certainly over the long-term (2050s and 2080s), could also exacerbate crowding issues at popular park attractions (e.g., Sulphur Mountain in Banff National Park; Cabot Trail in Cape Breton Highlands National Park), and contribute to higher occurrences of conflicts among park users.

Although Parks Canada stands to benefit financially from higher visitation resulting from demographic and climatic change, there could also be significant financial and social costs associated with accommodating an additional 3 million more annual visitors two decades from now. For instance, higher visitation and extended tourism seasons will result in additional staff costs for environmental services and park patrols in order to ensure visitor safety and satisfaction and compliance with regulations. The additional stress placed on existing park infrastructure such as roads, trails and campgrounds could also lead to increased maintenance costs. As Parks Canada operates on a cost-recovery system, it is currently uncertain whether the additional revenue that would be generated from higher visitation would be sufficient to offset the additional costs.

It is recognized that the natural environment and recreational amenities offered in protected areas are important for motivating visitors to come to Canada's national parks. Ecological resources are also projected to be impacted by climate change. For example, glaciers are projected to eventually disappear from Banff National Park, polar bear populations are projected to decline in Wapusk National Park which was established to protect the animals, the beaches of Prince Edward Island National Park are projected to erode and be inundated by sea level rise, and Point Pelee National Park could be negatively impacted by climate change-induced changes in bird migration routes (Scott & Suffling, 2000). Complimentary behaviour-based tourism research is needed to explore how visitors would respond to such ecological changes in Canada's parks. In particular, research is needed to explore how such ecological changes would augment or moderate the direct impact of a changed climate assessed in this study.

Parks Canada is in the very early stages of developing a climate change adaptation framework (Welch, 2005). Although the primary focus of climate change adaptation policy and planning to date has been the maintenance of ecological integrity, changes in visitor management strategies will also need to be a fundamental component of Parks Canada's adaptation framework.

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