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The carbon cost of polar bear viewing tourism in Churchill, Canada

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This paper examines the paradoxical issues surrounding long-distance tourism to view polar bears, a form of tourism which is disproportionately (on a per capita basis) responsible for greenhouse gases (GHG) emissions that are negatively affecting survival chances of the species. It also notes that the phenomenon of "last chance tourism" is influencing more tourists to visit the region. The paper describes and explains the evidence that climate change is causing a substantial reduction in sea ice, vital for Arctic wildlife species survival, particularly mega fauna, such as polar bears. Churchill, Canada is one of the few places where tourists can easily view polar bears. A total of 334 on-site tourist surveys and 18 in-depth interviews were conducted to help evaluate tourist perceptions of climate change and to estimate their GHG emissions related to polar bear viewing tourism. Polar bear viewing tourists perceive climate change to be negatively impacting polar bears but do not necessarily understand how they themselves contribute to GHG emissions, or understand offsetting possibilities. The polar bear viewing industry is estimated to contribute 20,892 t/CO_2 per season. Mitigation strategies, including reduction and offsetting programs are outlined.

Keywords: climate change; polar bear viewing; last chance tourism; GHG emissions; Churchill; Canada

Introduction

In its Fourth Assessment Report (AR4), the Intergovernmental Panel on Climate Change (IPCC, 2007) estimated that global mean temperature will increase between 1.8°C and 4.0°C by the end of the twenty-first century. An increase in global temperature by even a few degrees could have significant environmental, social and economic impacts. These impacts will be more prevalent among economic sectors that are reliant on certain environmental conditions or are located in more susceptible geographic regions.

Traditional resource-use sectors reliant on the environment, such as agriculture and forestry, have been considering the implications of climate change for several decades. However, the tourism sector, which is also reliant on certain environmental conditions, has just begun to consider the possible impacts of climate change over the past five to seven years (Scott, Wall, & McBoyle, 2005). Increased understanding of the possible implications of climate change for the tourism sector led the United Nations World Tourism Organization (UNWTO), United Nations Environment Program (UNEP) and World Meteorological Organization (WMO) to identify climate change as the "greatest challenge to the

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sustainability of the global tourism industry in the 21st century" (UNWTO-UNEP-WMO, 2008). This statement was made after successful release of both the Djerba (UNWTO-UNEP, 2003) and Davos Declarations (UNWTO-UNEP-WMO, 2008), which aimed to create awareness of the issue of climate change both within the tourism industry and governmental agencies.

Polar Regions are expected to exhibit some of the first signs of environmental change associated with warming climate. Projections suggest that warming will occur in this region at approximately twice the rate of the global average (Arctic Climate Impact Assessment or ACIA, 2004; IPCC, 2007). As a result, tourism destinations in Polar Regions are thought to be particularly vulnerable to climate change (see Johnston, 2006). However, beyond some preliminary studies examining the implications that changing sea ice dynamics may have for cruise tourism in the Canadian Arctic (see Stewart, Draper, & Dawson, in press; Stewart, Howell, Draper, Yackel, & Tivy, 2007), very limited empirical attention has been paid to the issue of climate change for the Polar tourism sector.

One of the primary pull factors drawing people to visit the Polar Regions is the opportunity to see wildlife, including polar bears, beluga whales, walrus, seals, and penguins. Wall (1998) identified that climate change is likely to have profound impacts on the wildlife-viewing industry considering that the anticipated impacts will not only alter species diversity but also influence significant changes to natural habitat. However, little empirical attention has been given to examining the implications of climate change on wildlife-viewing tourism (Nyström, Folke, & Moberg, 2000; Uyarra et al., 2005) and no known study has considered the amplified impacts that are likely to threaten the viewing of Arctic wildlife species.

More than any other species in the world, the polar bear (*Ursus maritimus*) has become an evocative symbol of global climate change (see Canadian Broadcasting Corporation or CBC, 2009). Many polar bear populations across the Arctic are under threat due to significant decrease in sea ice extent and thickness (ACIA, 2004; Furgal & Prowse, 2008; Richter-Menge et al., 2006; Zhang & Walsh, 2006). The amount of time polar bears are able to spend on the sea ice feeding on ice-dependent seals has a direct relationship with the bears' overall health. This relationship is particularly acute for the Western Hudson Bay subpopulation near Churchill, Manitoba, Canada (Figure 1), who spend several months of the year fasting on land due to the complete annual ice melt in the region (Gagnon & Gough, 2005). The longer the bears are able to feed during the winter months, the better they are able to survive this ice-free fasting period (Stirling, Lunn, & Iacozza, 1999).

Mainly due to a reduction in sea ice in the Hudson Bay region between 1988 and 2004, Western Hudson Bay polar bear populations declined by 22% (Stirling & Parkinson, 2006). If average Hudson Bay regional temperature were to increase by 1°C, thus causing a longer ice-free season (approximately two plus weeks) (Etkin, 1991), female polar bears would lose an additional 22 kg per season (Stirling & Derocher, 1993). However, more recent studies project a 2°C temperature increase in the Canadian Arctic as early as the 2020s (Furgal & Prowse, 2008), suggesting that the impact on female polar bears is likely to be even greater than originally projected. Stirling and Parkinson (2006) even believe that female polar bears in the Hudson Bay region may stop producing cubs within the next 20 to 30 years.

Projections of declining polar bear populations in Western Hudson Bay could have significant implications for the polar bear viewing industry located in Churchill, Manitoba, Canada. For over four decades, Churchill has been known as "the polar bear capital of the world". Polar bears congregate along the shores of the Hudson Bay for approximately six weeks during the fall, where they decrease their metabolic rates and subsist on stored

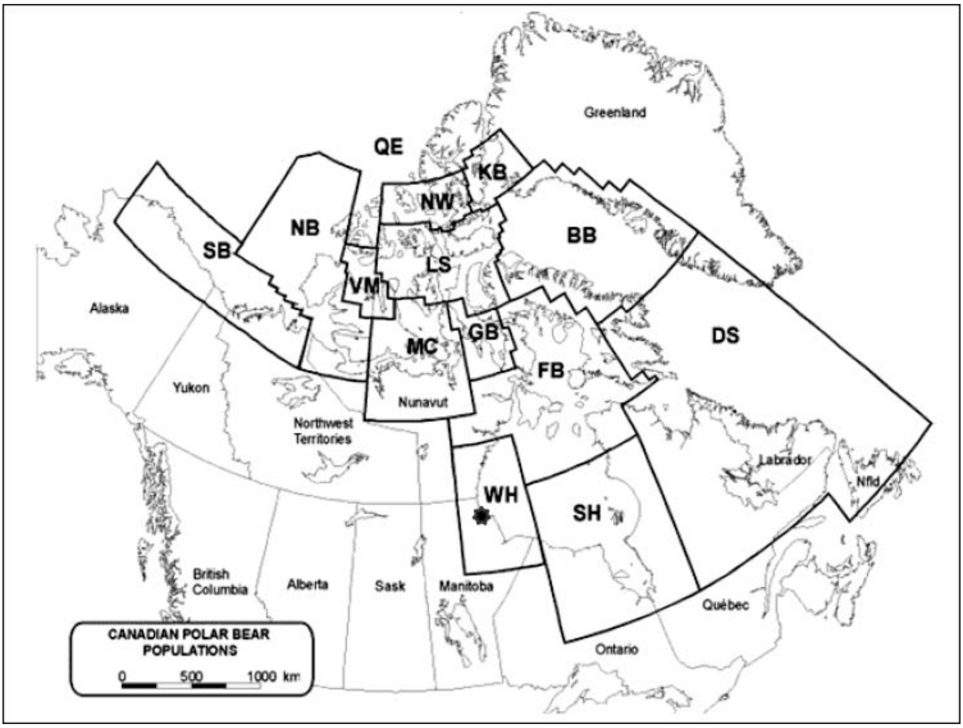

Figure 1. Polar bear subpopulations of Canada, United States and Greenland (Aars, Lunn, & Derocher, 2006). • indicates location of Churchill, Manitoba.

fat reserves (i.e. fasting) thereby allowing them to conserve energy while they await the formation of sea ice (Derocher, Andriashek, & Stirling, 1993; Stirling, Clark, & Calvert, 1997). Tourism operators have capitalized on this "waiting period" because during this period polar bears are relatively inactive and highly visible, thus providing visitors with an opportunity to easily view them in their natural habitat.

In the short term (i.e. 20–30 years), climate change is likely to cause an increase in this "waiting period" (i.e. due to longer ice-free periods), which may lengthen the viewing season for tourism business capitalizing on the polar bear viewing market. However, because health of polar bears is likely to decline as a direct result of the longer ice-free periods, it is questionable as to how tourists are likely to respond. For example, individuals may be uninterested in spending money to see visibly unhealthy bears, or, on the contrary, declining health of polar bears may influence a trend whereby tourists more readily travel to the Arctic to "see the bears before they are gone forever". In either scenario, the long term future sustainability of the polar bear viewing industry under projected climate changes is precarious at best.

In 2003 it was estimated that 3000 polar bear viewing tourists traveled to Churchill between mid-October and late November (Lemelin, 2004). This conservative visitation estimate did not include day-trip tourists, which in the past five years have represented a significant increase in the market share (i.e. charter planes arriving from Calgary in the morning and departing in the evening – a round trip distance of 3046 km/1894 miles). No exact current visitation data is available. However, based on available information, it can be estimated that between 6000 and 10,000 polar bear viewing tourists currently travel to

Churchill to view polar bears each season. There are 18 operating tundra vehicles, which are on average occupied by 15 to 20 tourists (Lemelin, 2004). The majority of tourists participate on two viewing excursions during their visit and the viewing season lasts from 40–60 days. Although the proportion of day-trip visitors is unknown, considering this to be an increasingly popular option for tourists, a reasonable estimation of visitors is likely to be approximately 8000 per season.

The paradox in the high demand for viewing experiences lies in the fact that long-haul air travel necessary to reach remote locations, such as Churchill, means that tourists are disproportionately (on a per capita basis) contributing to the demise of the very attraction they visit, through the emission of greenhouse gases (GHGs). This paradox is not isolated to polar bear viewing, but also exists, for example, when individuals travel thousands of kilometers to visit small island states, locations that are also highly vulnerable to climate change due to projected rise in sea level.

A recent report by UNWTO-UNEP-WMO (2008) estimated that the tourism industry contributes approximately 5% of total global carbon dioxide (CO_2) emissions. The majority of tourism emissions can be attributed to transportation (75% – specifically air travel) with fewer emissions attributed to accommodation (21%) and activities (4%). A strong literature has been developed that examines GHG emissions within the tourism sector (see Table 1).

To date, no study has estimated carbon emissions for tourism enterprises in North America or the Arctic; the literature thus far has been focused almost entirely on the United Kingdom, Western Europe and the New Zealand. In addition, many of these studies have been regionally or nationally focused and there remains a need to examine product-specific emissions at a more local scale in order to facilitate easy comparison (i.e. the "carbon cost" of a scuba diving holiday vs. a ski holiday). Carbon estimates of tourism products will likely become more important with increasing public awareness, and it is possible that tourists will demand information on carbon emissions for specific holidays and activities. There is a wide range of activities for tourists and related emissions can vary significantly from a few kilograms of CO_2 for a hike at a local park (Gössling et al., 2005) to 15 t/CO_2^{-e} for a cruise ship experience to Antarctica (Amelung & Lamers, 2007).

This paper builds on the growing body of knowledge examining GHG emissions within the tourism sector. The study focuses on the polar bear viewing industry in Churchill and employs a survey-based approach with secondary interviews to (1) estimate the GHG emissions of a polar bear viewing experience and of the polar bear viewing industry as a whole, and (2) to understand the perception that polar bear viewing tourists have regarding the climate change. It goes on to suggest a number of mitigation and adaptation measures to reduce the impact of tourism on climate change, and the potential impact of climate change on tourism.

Table 1. Tourism sector emissions literature.

Estimating transportation emissions	Becken, 2002; Becken & Simmons, 2002; Becken, Simmons, & Frampton, 2003; Gössling, 2002; Gössling et al., 2005; Peeters, Williams, & Gössling, 2007
Estimating accommodation emissions	Becken, 2005; Becken, Frampton, & Simmons, 2001; Becken & Simmons, 2002; Becken et al., 2003
Estimating activities emissions	Becken & Simmons, 2002; Becken et al., 2003
Examining perceptions and willingness to pay for carbon offsets	Becken, 2004, 2007; Gössling et al., 2007; Hall, 2007
Critiquing methodologies and carbon offsetting schemes	Becken & Patterson, 2006; Dubois & Ceron, 2007; Gössling, 2007; Gössling, Hansson, Hörstmeier, & Saggel, 2002; Gössling et al., 2005; Gössling et al., 2007

Methodology

Study area

Churchill, Manitoba is located in north-central Canada, within the province of Manitoba (see Figure 1). This small sub-Arctic town of just 1000 people is only accessible by train, ship or air. Access to Churchill occurs through the major city of Winnipeg, which is located 1455 km (911 miles) south of the community. Polar bear viewing occurs within two protected areas located 21 km east of Churchill. The Churchill Wildlife Management Area (CWMA) and Wapusk National Park were established in 1993 and 1996, respectively, to protect polar bear staging and denning areas, nesting grounds for geese and habitat for caribou (Manitoba Conservation, 2008; Teillet, 1988). Polar bears in Manitoba are protected through a number of conservation measures including protected areas (i.e. the CWMA, Wapusk National Park), management strategies (e.g. Polar Bear Alert) and various policies and legislations, such as the Manitoba Wildlife Act, Polar Bear Protection Act and Resource Tourism Operators Act. In the winter of 2008, the province listed polar bears as threatened species under the Endangered Species Act of Manitoba (Manitoba Government, 2008) several months ahead of the United States, which added polar bears to the Endangered Species list specifically because of concerns about the impacts of climate change (U.S. Fish & Wildlife Service, 2008).

The polar bear viewing industry evolved from a few vehicles and operators in the late 1960s and 1970s to the current infrastructure, which includes two tundra vehicle operators who manage 18 vehicles (12 by one company and six by the other) and two tundra lodges. While both of the tundra vehicle operators are permitted to operate in Wapusk National Park, managed by Parks Canada, only one operates its seasonal lodge directly in the park. The other company's lodge borders the park and is situated within the Wildlife Conservation Area. Two helicopter companies, managed by the Manitoba Department of Conservation, are also permitted to operate in this area.

The ability of tundra vehicles to traverse the sub-arctic environment provides the ideal mode of transportation to see and photograph polar bears in relative safety and comfort (see Figure 2). The viewing of polar bears in this area is further facilitated by the habituation and tolerance of these animals to human presence, their curiosity and propensity to entertain wildlife viewers (Lemelin, 2005, 2006).

Survey distribution and methodological design

During the 2007 polar bear viewing season (October–November), surveys were hand-distributed to tourists waiting at the train station, airport, local museum, restaurants and the Churchill Northern Studies Centre (i.e. convenience sample). Of the 400 surveys distributed, 334 were returned (84% response rate), which is a representative of approximately 5% of the estimated annual polar bear viewing market ($n = 8000$).

The survey was designed to be self-completed and focused on three key areas: (1) trip and activity characteristics (i.e. transportation, activities and accommodation); (2) individual perceptions of climate change and (3) demographics. Trip and activity characteristics were used to conduct a bottom-up estimation of the GHG emissions (see Becken & Patterson, 2006) generated by individual polar bear viewing tourists, which were then extrapolated to estimate total emissions generated by the entire polar bear viewing industry in the area. Emissions calculated include transportation between major cities adjacent to the visitor's place of orgin and Churchill, Manitoba; transportation while visiting Churchill; accommodation in Churchill and activities participated by the tourist while staying at the destination.

Figure 2. Tundra vehicle used for polar bear viewing in Churchill, Manitoba. Photo: Jackie Dawson.

CO_2 is the main GHG produced from the combustion of fossil fuels (IPCC, 2007). Estimates of CO_2 emissions from both accommodation and activities were conducted. Specific factors utilized for these calculations are outlined in the Results section of this paper. However, when examining air travel, where emissions mainly occur in the upper troposphere and lower stratosphere, it is also important to consider other GHGs in addition to just CO_2, including water vapor (H_2O) and nitrous oxide (N_2O). These gases when emitted at flight altitude play a larger role in affecting climate change (IPCC, 2007). To account for this, the estimation of air travel emissions in this study includes a multiplier. For easy comparison between emission estimations from the accommodation and activity sectors, where only CO_2 emissions are considered, results for air transport emissions are calculated to CO_2 equivalents (CO_2^{-e}). Calculating total emissions, which include H_2O and N_2O, CO_2^{-e} also allows comparison between the existing studies (i.e. Amelung & Lamers, 2007; Gössling et al., 2005; UNWTO-UNEP-WMO, 2008).

Recognizing the scientific uncertainty in the air travel radioactive forcing index, i.e. increased emissions at altitude (IPCC, 2007), an average of three emission calculations were used in this study. Three commercial online carbon calculators: Atmosfair (AF), Germany (AF, 2008); Carbonneutral (CN), United Kingdom (CN, 2008); Zerofootprint (ZF), Canada (ZF, 2008) that include a multiplier (RFI) were selected for this analysis. Carbon calculators employ a basic technique whereby they use travel distances and standard emission factors to calculate CO_2 emissions (see Gössling et al., 2007 for a full discussion on calculating emissions including evaluation of existing calculators). Evaluations conducted by Clean Air–Cool Planet (2006) rated AF and CN to be very reliable in comparision to 28 other emissions calculators, and recommended these two to consumers. The Tufts Climate Initiative (2006) and Gössling et al. (2007) strongly support the use of AF. Zerofootprint is a newer tool and has not yet been evaluated.

Following the distribution of surveys, 18 in-depth tourist interviews were conducted in order to fully understand the perceptions tourists hold regarding the influence that climate change had on their decision to travel to Churchill. Interviews were informal and lasted between five and 25 minutes. Tourists were interviewed at the Churchill Northern Studies Centre and the local airport. Open-ended questions were asked regarding motivations for visiting Churchill.

The survey instruments used can be found on the web-based version of this paper (www.informaworld.com/JOST).

Results

Tourist profile/demographics

The demographic profile of respondents in this study closely resembles the profile generated by Lemelin (2004) in a survey of 2096 polar bear viewing tourists. A polar bear viewing tourist in this study included typically older (average age 61 years) females (66%), who were often retired and exhibited higher than average levels of education (72% post-secondary). Lemelin (2004) also found that the typical polar bear viewing tourist included older (average age 58 yrs) females (59%), with high level of education (82% post-secondary) and incomes (42% > CDN$100,000). The similarities found between the demographic profiles of this study and that of the more comprehensive survey conducted by Lemelin (2004) ($n = 2096$) provides confidence that this study captured a reasonable representation of the polar bear viewing market.

The majority of respondents in this study were from Canada (44%) followed by the United States (42%), the United Kingdom (8%), Europe (3%) and Australia (3%). The average length of stay was five nights and generally included two full-day trips on a tundra vehicle, a visit to the local museum, several meals at restaurants and souvenir shopping. Other activities that many visitors participated in included a dog sled tour ($n = 138$; 67%) and a helicopter flight ($n = 149$; 71%).

Emission estimates

In order to calculate total emissions for an individual polar bear viewing tourist, and for the entire polar bear viewing industry, estimates of the average emissions generated from transportation, accommodation and activities were conducted.

To calculate transportation emissions from a tourist's place of residence to Churchill, respondents were asked about the country and city of their origin and the mode of transportation they had used. The majority of polar bear viewing tourists traveled to Churchill from within Canada (44%), of which 32% resided in the eastern region of the country and 12% in the western region. The major cities of Toronto and Vancouver were chosen as representative origin destinations for Canadian tourists because these locations best represented the average distance traveled by most respondents of this survey who lived in different urban and rural locations. The second highest cohort of tourists was from the United States (42%) of which 14% were from the eastern states and 28% from the western states. New York and Los Angeles were used to represent the typical east and west coast

Table 2. Estimated CO_2 emissions for transportation routes to Churchill, Manitoba.

	Atmosfair	Carbonneutral	Zerofootprint	Average (t/CO_2^{-e})
New York (via St. Paul & Winnipeg)	1.76	0.94	2.41	1.7
Los Angeles (via St. Paul & Winnipeg)	2.2	1.29	2.87	2.13
Toronto (via Winnipeg)	1.44	0.89	1.78	1.37
Vancouver (via Winnipeg)	1.6	1.01	1.99	1.83
London (via Toronto & Winnipeg)	5.36	2.85	5.19	4.78
Frankfurt (via Toronto & Winnipeg)	5.74	3.07	5.55	4.79
Sydney (via Vancouver & Winnipeg)	10.8	5.28	9.24	8.44

origins for US respondents. Overseas visitors represented 14% of the polar bear viewing market (United Kingdom 8%, Europe 3% and Australia 3%). London (United Kingdom), Frankfurt (Germany) and Sydney (Australia) were used as starting points to account for visitors from these regions.

Almost all polar bear viewing tourists travel to the gateway city of Winnipeg by plane. It is possible to travel from Winnipeg to Chrchill by train; however, due to the long journey (2.5 days) and the deteriorating state of track infrastructure, very few tourists choose train as an option ($n = 14\%$). Because of the limited number of people using the train and an anticipated reduction in future numbers (i.e. in the absence of significant infrastructure investment), train travel is not included in transportation emissions estimations.

The estimated GHG emissions for a personal journey to Churchill from Toronto, Vancouver, New York, Los Angles, London, Frankfurt or Sydney range from 1.37 t/CO_2^{-e} (origin: Toronto, Canada) to 8.44 t/CO_2^{-e} (origin: Sydney, Australia) (see Table 2).

The average respondent spent five nights in Churchill and participated in a variety of activities including two trips on a tundra vehicle to view polar bears, one scenic helicopter flight, one dog sledding tour and one town tour. For consistency, carbon emissions for accommodation and activities have been calculated using emission factors derived from the recent UNWTO-UNEP-WMO (2008) report on climate change and tourism.

Average energy use and concomitant CO_2emissions vary substantially between different types of accommodations. For example, emissions per guest night for a campsite are 7.6 kg/CO_2, which is much less than emissions for a hotel that is on average 20.6 kg/CO_2 per person/per night (Gössling, 2002). Accommodation choices in Churchill are largely limited to basic hotels and a few bed and breakfast facilities. In this study we used an emission factor of 19 kg/CO_2 per guest night. This figure is recommended by UNWTO-UNEP-WMO (2008) as a reasonable average value for tourists staying in commercial accommodation in developed countries. Polar bear viewing tourists, therefore, generate an average of 95 kg/CO_2 per person for five days of accommodation in Churchill (Table 2).

Carbon emissions for a polar bear viewing excursion include both bus transportation to and from the launch site and transportation in a tundra vehicle from the launch site to CWMA. The average distance traveled by bus is approximately 104 km (two round trips). Using an occupancy rate/load factor of 90% and a CO_2 factor of 0.022 kg per passenger kilometer (based on UNWTO-UNEP-WMO, 2008), each tourist emits 2 kg/CO_2 while driving to the tundra vehicle launch site. To calculate carbon emissions for the tundra vehicles, a carbon factor of 10.1 kg per gallon of diesel fuel burned was utilized (EPA, 2005). On average, a tundra vehicle burns 30 gallons (113.6 liters) of fuel per day (Tundra vehicle driver, personal communication, October 20, 2007), thus emitting a total of 606 kg/CO_2 for two wildlife-viewing trips. This calculation was then divided by the average number of passengers on a tundra vehicle per day (estimated at 18 by Lemelin, 2004 and confirmed through observations during this study) in order to calculate the per person carbon emissions, which is estimated to be 34 kg/CO_2 for two polar bear viewing trips.

A helicopter scenic flight is estimated to be 27.2 kg/CO_2 per person per trip (Landcare Research, 2008), vehicle transportation to the dog sledding site totals another 6 kg/CO_2 per person and a town tour by coach adds another 3 kg/CO_2 per person. The total activity emissions for an average polar bear viewing tourist are 36.7 kg/CO_2. Therefore, the total emissions per person for both accommodation and activities were estimated to be 165.2 kg/CO_2 (Table 3).

Consistent with the findings from other studies (i.e. Gössling et al., 2002; UNWTO-UNEP-WMO, 2008), this study confirms that the transportation sector accounts for the highest percentage of CO_2 emissions compared with that of accommodation and activity sectors. However, compared with other tourism activities, the typical polar bear viewing tourist emits higher than average activity emissions. Higher than average activity emissions are not surprising considering all activities provided to polar bear viewing tourist in Churchill involve release of GHG emissions (i.e. local transportation between activities, helicopter tour, transportation in diesel-powered tundra vehicles etc).

An average global tourist journey (i.e. including trips using either air or ground transportation) is estimated to generate 0.25 t/CO_2 (UNWTO-UNEP-WMO, 2008). A polar bear viewing experience is well above this average, ranging from 1.54 to 8.61 t/CO_2 per person. As Figure 3 illustrates, compared with other tourist activity-based studies, the maximum carbon footprint estimated in this study for a long-haul polar bear viewing tourist is amongst the highest, second only to energy-intensive cruise-based journeys to Antarctica (Amelung & Lamers, 2007). However, for shorter-haul polar bear viewing tourists coming from North America, emission levels are on the lower end of this spectrum.

Table 3. Estimated CO_2 emissions for accommodation and other activities in Churchill*.

Accommodation/land-based transportation/activities	Distance/time	CO_2 factor	Total CO_2 emission (in tonne)
Accommodation	5 nights	19 kg/hotel night	0.095
Travel to tundra vehicle launch–return	104 km	0.022 kg/km	0.002
Tundra vehicle trip (2 trips)	30 gal diesel/vehicle/day	10.1 kg/gallon**	0.034
Helicopter scenic flight	15–20 minutes	27.7 kg/trip***	0.028
Travel to dog sledding location	26 (km)	0.22 kg/km	0.006
Tour of town	15 (km)	0.22 kg/km	0.003
Total			**165.2**

Note: *Unless otherwise indicated, emission factors were derived from UNWTO-UNEP-WMO, 2008; **Emission factor derived from Environmental Protection Agency (EPA) (2005); ***Emission data derived from FOCA (2009) (for scenic flight).

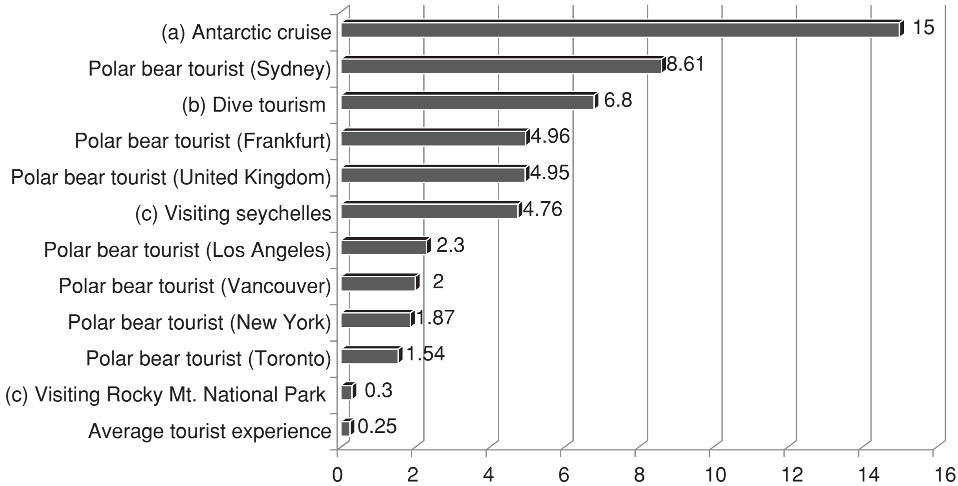

Figure 3. Comparison of estimated carbon emissions for polar bear viewing by origin with other tourist activities (t/CO_2^{-e} per person) Sources: (a) Amelung and Lamers, 2007; (b) UNWTO-UNEP-WMO, 2008; (c) Gössling et al., 2005.

Based on the per person emission estimations in this study, total industry emissions for the six-week polar bear viewing season were estimated to be 20,892 t/CO_2 (Table 4). The environmental cost of long-haul travel is reiterated in these findings. For example, in this study 14% of polar bear viewing tourists traveled from overseas (United Kingdom, Europe, Australia), but their total emission contribution was 33%.

The total emissions calculated for the polar bear viewing industry likely represent a slightly conservative estimate of total industry emissions. Due to appropriate privacy restrictions, the exact addresses of respondents are not known; therefore, emission estimations do not include transportation between a tourist's place of residence and a major airport. Indirect emissions, including tundra vehicle maintenance and infrastructure development were also not included in the calculations, nor were emissions associated with higher than average food miles for Churchill. In addition, train transportation between Winnipeg and Churchill is not considered in the individual or industry emission estimations. Taking the train between Winnipeg and Churchill would reduce emissions for travel by 207.2 kg per

Table 4. Estimated total polar bear viewing industry emissions for Churchill, Manitoba.

Transportation, accommodation and activities	Emissions (t/CO_2^{-e})	Total number of tourists/year	Total emissions per scenario (t/CO_2^{-e})
Toronto, Canada (32%)	1.54	2560	3942
Vancouver, Canada (12%)	2	960	1920
New York, US (14%)	1.87	1120	2094
Los Angeles, US (28%)	2.3	2240	5152
London, UK (8%)	4.95	640	3168
Frankfurt, Germany (3%)	4.96	240	1190
Sydney, Australia (3%)	8.61	240	2066
Activities/accommodation (100%)	0.17 per person	8000	1360
Total		**8000**	**20, 892 t/CO_2**

person. However, since very few tourists currently choose to take the train ($n = 14\%$) due to the long journey hours (one-way journey from Winnipeg takes 2.5 days; see Lemelin, 2004; MacKay, Lamont, & Partridge, 1996; MacKay, & McIlraith, 1997), this reduction is minimal at present.

Tourist perceptions of climate change

The second objective of this study is to understand the perception that tourists hold regarding climate change and to reveal the extent to which respondents comprehend the relationship between human actions (i.e. transportation and viewing of polar bears) and the perpetuation of climate change.

The vast majority (88%) of polar bear viewing tourists agreed, or strongly agreed that “humans are contributing to changes in the global climate”. However, fewer respondents (69%) agreed or strongly agreed with the statement “air travel is a contributor to climate change”. These two perceptions suggest that although there is a general understanding that humans play a role in influencing the changing climate, individuals do not necessarily understand how this process occurs. Even fewer respondents (60%) agreed or strongly agreed with the statement “polar bears will disappear from the Churchill region due to changes in the global climate”. Of note, though, is that only 7% of respondents in this study actually disagreed that climate change will indeed impact polar bears in this region (i.e. via local extirpation); 28% were simply unsure. Although there are studies suggesting that polar bears in this region will not be drastically impacted by the climate change (Dyck et al., 2007), an overwhelming majority of scientists disagree with this study, believing that this subpopulation is indeed highly vulnerable (Stirling, Derocher, Gough, & Rode, 2008; also see Derocher, Lunn, & Stirling, 2004; Derocher, Stirling, & Andriashek, 1992; Derocher et al., 1993; Stirling & Derocher, 1993; Stirling & Patterson, 2006; Stirling et al., 1999). In fact, the informal, open-ended interviews conducted with polar bear viewing tourists during data collection for this study revealed that in many cases ($n = 11$ of 18 tourists), motivation for coming to Churchill was indeed related to the belief that polar bears were in danger of disappearing (Table 5).

Almost half of the polar bear viewing tourists (48%) indicated that “after seeing polar bears [they would] make some changes to [their] lifestyle at home, to reduce greenhouse gas emissions”. Seven percent of the respondents had purchased carbon offsets for their flight to Churchill and an additional 46% indicated that they “would be willing to pay a carbon travel tax in addition to the price of [an] airplane ticket in order to offset any environmental harm caused by air travel”. The average price that individuals are willing to pay to offset the GHG emissions for a flight is 10% of the cost of that flight. Of those respondents who

Table 5. Tourist quotes.

18 October 2007	“I wanted to see the bears with my daughter because my grandchildren and their children may not ever know polar bears except in a zoo”.
23 October 2007	“I’ll tell ya, I’m a single mom and I am unemployed but I still took money out of my precious savings to come up here to see the bears before they are all gone”.
2 November 2007	“I was here seven years ago but I wanted to come up again to show my wife the polar bears before they are gone”.
6 November 2007	“I thought I better come see the bears because the next time I am in this country they will be all gone”.

are unwilling to offset their air travel, the most commonly stated reasons include "I do not know what the money is for ($n = 70$)"; "I do not know what a carbon tax is" ($n = 41$); and "I do not know what company to trust" ($n = 39$).

Discussion

The social and economic implications of climate change are likely to be significant for Churchill considering the significant value of the polar bear viewing industry for this area. Past research in the region has tended to focus on polar bear population dynamics, such as the Canadian Wildlife Service's polar bear research program, established in 1966. Surprisingly, the human dimensions of wildlife management in the Hudson Bay region have only recently been examined (Dyck & Bedeck, 2006; Lemelin, 2005) and as a result, the important social-ecological consequences of change are poorly understood.

Climate change is projected to impact sea ice dynamics and polar bear health including population sustainability. At the same time, the polar bear viewing industry, which has been built upon the presence of polar bears, contributes to GHG emissions and subsequently influences climate change. This paradox is set within the context of ongoing global environmental changes, but local impacts of increased visitation are also important, because increased visitor pressure perpetuates changes to tourism resources, which may in turn motivate other tourists to visit destinations before it is "too late" (see Brock, 2008; Salkin, 2007).

Tourist perceptions and response

Polar bear viewing tourists in this study seem to have a general understanding of the presence and potential impacts of climate change including the negative impacts projected for the Western Hudson Bay polar bear subpopulation. Only 7% of tourists did not feel that polar bears are being negatively affected by changes in the climate. In fact, some evidence even suggests that the very notion that polar bears are vulnerable to climate change is in fact a motivation for tourists to travel to Churchill to view the species "before it is too late". Although it is far too early to call this type of tourist behavior a "trend", the phenomenon of "last chance tourism" has also been documented in popular media and by tourism academics. Last chance tourism has been labeled as "see it before it's gone tourism", "doom tourism", "doomsday tourism", "climate tourism" and "disappearing destinations tourism" (Brock, 2008; Kallenbach, 2009; Lemelin & Johnston, 2008; Salkin, 2007). An increase in this type of tourism activity (i.e. see it before it is gone), which has been observed within this study, will likely to add strain to the environment (both human and ecological) that is already stressed by the effects of climate change. Figure 4 illustrates the supply and demand dimensions of the "last chance tourism" and outlines that these dual dimensions operate simultaneously and continuously, thus contributing to a paradox that the tourists traveling to vanishing destinations, on a per capita basis, contribute to their vulnerability.

Despite a general understanding of the potential impacts of climate change, polar bear viewing tourists do not understand how their behavior contributes to, or could help to mitigate against, future climate change. Thirty percent of the respondents do not understand that air transportation contributes to climate change, and although 46% of tourists indicated that they would be willing to buy carbon offsets for their holiday transportation emissions, a significant barrier to this is an almost complete absence of knowledge as to what a carbon offset actually is, how the money is used to mitigate against climate change and which

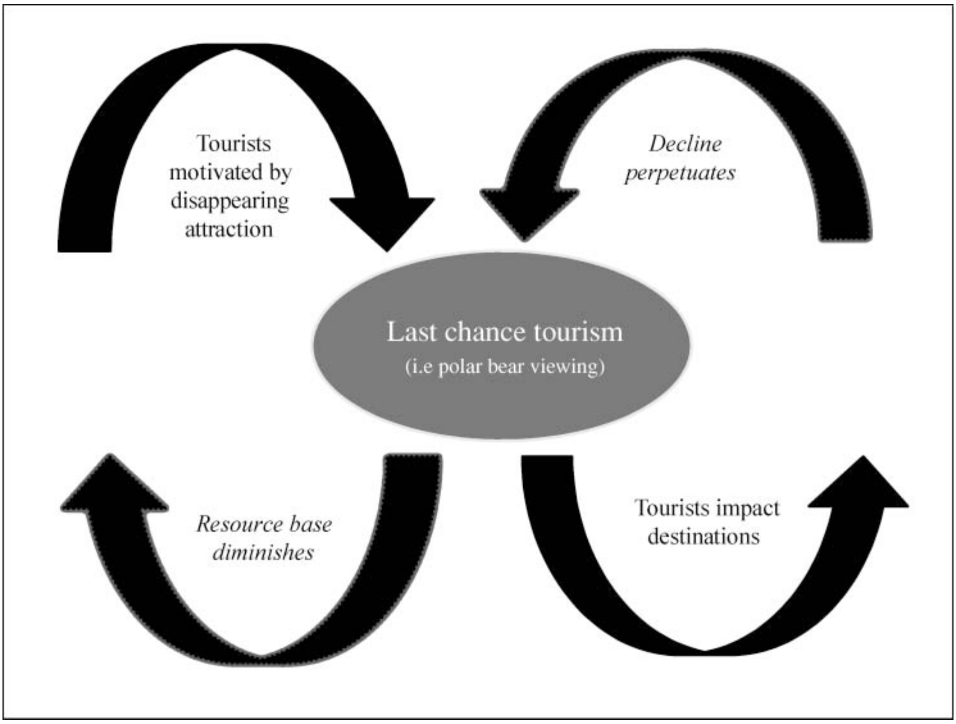

Figure 4. Perpetuation of last chance tourism in a context of ongoing environmental change.

companies are reliable. These findings suggest that a climate change education component that includes information on the impact of climate change on polar bears as well as strategies for reducing GHGs that cause climate change should be included during regular polar bear viewing tours.

Industry-side mitigation options

In addition to a general education curriculum, the polar bear viewing industry could also develop and facilitate an operator-offsetting program. The Tourism Industry Association of Canada (2008) recently urged Canadian tourism operators to measure and monitor carbon emissions, thereby emphasizing the vital need for carbon reduction. An operator can choose to reduce/offset part of their total emissions or alternatively they can reduce/offset all of their emissions and become carbon neutral.

Reduction strategies should be employed wherever possible and could include marketing more heavily to shorter-haul markets (i.e. Toronto, Winnipeg, Calgary, Edmonton, Vancouver, New York, Chicago, St. Paul and Seattle) vs. longer-haul markets (i.e. London, Frankfurt, Sydney), filling coaches and tundra vehicles to capacity when transporting tourists and improving and promoting train travel between Winnipeg and Churchill. The rail service to Churchill requires significant infrastructure investment ahead of tourism operators getting ready to willingly promote this more GHG-friendly travel option. Trains are late by 12 and 24 hours on a regular basis during the polar bear viewing season due to deteriorating infrastructure, routine maintenance and frost heaving of rail lines. Poor rail service has influenced the trend whereby operators charter planes into the community directly from Calgary in addition to regular services by Clam Air and Kivalliq Air from Winnipeg. In addition to GHG reductions, investment in train transportation could also provide an option for economic diversification in the community. The train journey itself could become an experience because of the inclusion of interpretation and stops at historical sites (i.e. similar VIA rail's trans-Rocky mountain line; see VIA, 2009). Improving rail service to Churchill would not only benefit the tourism sector but would also do good for the shipping industry, which is currently operating at less than capacity in the Port of Churchill.

Following the GHG reduction efforts, industry-wide offsetting programs could be implemented. The total cost of offsetting the 20,892 t/CO_2 generated by the polar bear viewing industry each year would be approximately CDN$605,896. To expect the industry to absorb this cost is unrealistic; however, the two polar bear viewing operations could offer offsetting packages as part of the price of each package tour. For example, the two companies could offer a "carbon conscious" program for individuals who want to offset their transportation between Winnipeg and Churchill in addition to their on-site accommodation and activities emissions. Using the average cost to offset one tonne of CO_2 through the three carbon calculators employed in this study (AF, CN and ZF), the cost of the proposed "carbon conscious" program would only be CDN$21.46 per person (5,920 t/CO_2 at CDN$29 per t/$CO_2$). Alternatively, a "carbon neutral" program could be offered whereby tourists' transportation emissions from their place of residence are also offset. The cost of the carbon neutral program would vary depending on the distance traveled (Table 6).

Alternatively, polar bear viewing tourists could be encouraged to offset their emissions individually and in doing so could be offered incentives from the industry (i.e. a reduced price for tundra vehicle tour, souvenir of equal value etc). However, similar voluntary programs, such as this one, have not had a great deal of success (see Gössling et al., 2007).

Considering that 70% of polar bear viewing tourists indicated that they were willing to pay more for the same polar bear viewing experience than they had in 2007, and the proposed offsetting programs (i.e. "carbon conscious" and "carbon neutral") do not reduce revenues for polar bear viewing operators, the companies should seriously consider the implementation of the program. The average cost of a four-day polar bear viewing tour is in the range of CDN$4,000–6,000, meaning that the additional cost of a "carbon conscious" offset ($21.46) is not likely to deter any tourist from participating in this program. By offering both the "carbon conscious" and "carbon neutral" packages, tourists have the option of donating more or donating less for the cost of their emissions. In either case, the polar bear viewing industry would be displaying a commitment toward the environment and the resource on which they rely and could even begin marketing themselves as a "carbon neutral" destination.

Table 6. Cost of proposed "carbon neutral" offsetting program by origin destination.

Origin	Cost of a "carbon neutral" offsetting program (in CDN$)
Toronto, Canada	66.12
Vancouver, Canada	79.46
New York, US	75.69
Los Angeles, US	88.12
London, UK	160.66
Frankfurt, Germany	165.30
Sydney, Australia	271.15

Conclusion

The projected reduction and possible loss of the Western Hudson Bay polar bear subpopulation would be a tragedy from a variety of perspectives. From an environmental viewpoint, it would mean significant and irreversible changes to the Arctic ecosystem, which would be culturally devastating for local populations and would include a complexity of systemic impacts. From the sociopolitical perspective it would indicate the ineffectiveness of policies and legislation set in place to protect wildlife. From the socioeconomic perspective it would also be devastating for stakeholders involved in Churchill's famous polar bear viewing industry.

In Churchill, climate change seems to be influencing increased tourism demand through the phenomenon of "last chance tourism", whereby tourists desire to see destinations and resources before they are gone forever. The paradox lies in the fact that tourists traveling long distances to view polar bears before they are gone are disproportionately responsible (per capita) for increased GHG emissions, which ironically impacts the health of the very resource they go there to see, i.e. the polar bear.

This study, which is the first of its kind in North America, brings additional evidence to the debate about "loving tourism destinations to death". In doing so, this research begs a difficult question: is there a long term future for tourism in globally peripheral destinations such as the Arctic? Clearly, long-haul travel is the largest emitter of CO_2, making this question relevant to all destinations that attract long-haul tourists. In order to compensate for long-haul air travel emissions, significant efficiency gains in air travel would be necessary, but these technologies are not in sight for the next few decades (Peeters, 2007). However, as we illustrate in this paper, actions to mitigate GHG emissions at the local level are feasible. Based on calculations estimated in this study, it is possible for Churchill's polar bear viewing industry to use transport modal shifts, efficiency gains and offsetting ("carbon conscious" and "carbon neutral" programs) to potentially become one of the first carbon neutral destination in North America. This is possible without losing the economic value of the industry. A carbon neutral tourism industry in Churchill would be a small but significant triumph for environmental groups, tour operators, local residents, who are dependent on tourism for their livelihood, and tourists who might wish to view polar bears in their natural environment.

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