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Last chance tourism: a decade review of a case study on Churchill, Manitoba's polar bear viewing industry

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ABSTRACT

For over 50 years, Churchill, Manitoba has provided visitors an opportunity to see polar bears in their natural environment. Over the same time period, an increase in temperatures and related reductions in sea ice has negatively impacted the health of polar bears in the Western Hudson Bay. In 2008, the term 'last chance tourism' was coined, linking the demand to travel to the North with a desire to see these animals 'before they are gone'. This creates a paradox as tourists require energy-intensive modes of transportation to reach the Arctic, thereby contributing to greenhouse gas emissions. This paper compares the polar bear viewing industry's total greenhouse gas contribution and tourists' knowledge about climate change with results from a 2008 study and discusses any changes over the last ten years. During the 2018 polar bear viewing season, greenhouse gas emissions were estimated to be 23,017 t/CO2, an increase from 2008. The results also indicated that although most tourists believe climate change is happening, fewer associate air travel to this — a similar finding identified ten years ago. Findings from this research show that consumption patterns have not changed despite a growing awareness of climate change and its impacts.

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Climate change; polar bears; last chance tourism; Churchill; greenhouse gas emissions

Introduction

According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, there is now a high degree of confidence that due to the dependence on fossil fuel energy, the warming of the climate system is *extremely likely* to be human induced (IPCC, 2014). Globally, every continent has experienced an increase in average temperatures but compared to temperate and tropical regions, temperatures across the Arctic have increased at more than twice the rate of the global average in the past 50 years (IPCC, 2018; NSIDC, 2020). Consequently, distinctive Arctic features such as sea ice and snow are undergoing significant changes, which in turn have negative impacts on migratory birds and other Arctic wildlife, including keystone species like the polar bear (Cusset et al., 2019; Hamilton & Derocher, 2019; IPCC. 2018; Mudryk et al., 2018; Pulliainen et al., 2020).

In Canada, climate change has negatively impacted the Western Hudson Bay (WHB) polar bears' health and population sizes (Lunn et al., 2016). All polar bears depend on sea ice for hunting, using it as a platform to catch their main source of food: ringed seals (Stern & Laidre, 2016;

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Stirling, 2011). From October to November, the WHB polar bears congregate around the western shore of the Hudson Bay and wait for the formation of sea ice in order to begin their eight-month feeding and breeding period (Stirling, 2011). Warmer temperatures are creating later ice freeze-up periods and earlier break-up periods, thus limiting the accessibility for polar bears to hunt (Andrews et al., 2017). Lunn et al. (2016) suggests that the population of the WHB polar bears will fluctuate over time, however, because this subpopulation depends largely on sea ice, the long-term trend for the WHB polar bears is likely to be negative.

The polar bear has become a symbol of global climate change and a symbol of the 'last chance tourism' (LCT) trend (Dawson et al., 2010; Lemelin et al., 2010; Struzik, 2014). Evidence to date illustrates that tourists are drawn to locations whose landscapes, natural systems, or cultures are vulnerable to changes caused by global warming or other anthropogenic factors including globalization and modernization (Dawson et al., 2010; Groulx et al., 2016; Lemelin et al., 2010; Piggott-McKellar & McNamara, 2017). In one of the first LCT studies, Dawson et al. (2010) studied Churchill, Manitoba, a tourism destination centered around polar bear viewing and largely portrayed by the media as a place to visit 'before it's gone' (BBC Travel, 2020; Rowley, 2008). With climate change continuing to negatively impact polar bears, more tourists are travelling to northern regions, like Churchill, for a chance to see these animals before they are extirpated (Dawson et al., 2010; Groulx, 2015; Lemelin et al., 2010). This demand to travel creates a paradox in that not only are LCT destinations vulnerable to change, but due to the dependence on energy-intensive modes of transportation, accommodations, and local activities, these tourism destinations are anthropogenic factors influencing change. Dawson et al.'s (2010) work assessed the carbon footprint of the LCT market generated by this destination and studied tourists' understanding of climate change in a tourism context. Using visitor surveys and online carbon calculators to calculate greenhouse gas emissions from this industry, Dawson et al. (2010) estimated a polar bear viewing experience to be between 6 and 34 times more energy intensive than the average global experience[1]. Moreover, the authors found that although tourists believe climate change was occurring, they did not understand how their travel behaviour influences these changes.

Research on LCT destinations has evolved since this first study, expanding beyond polar bear viewing to areas around the world (e.g., the Great Barrier Reef in Australia, cruise tourism in Antarctica, glacier viewing in Montenvers-Mer-de-Glace). In addition, these studies provide a better understanding of tourists' motivations to travel, as well as opportunities for LCT destinations to reduce the effects of climate change (Groulx et al., 2016; Lemieux et al., 2018; Miller et al., 2020; Piggott-McKellar & McNamara, 2017; Salim & Ravanel, 2020). Despite these efforts, few studies have quantified the carbon intensity of a LCT destination (see Eijgelaar et al., 2010 for an exception), and no known studies have examined a tourism destination on the longitudinal scale to identify how carbon intensity in these LCT markets may evolve over time. The lack of longitudinal studies is a significant knowledge gap as the rates of climate change, scale of expected impacts, and global awareness of the climate crisis have all changed drastically in the past decade. To address this gap, authors of this study returned to Churchill to redeploy the methodology originally adopted by Dawson et al. (2010), enabling a longitudinal comparison of Churchill's polar bear viewing industry over the past ten years.

Literature review

Last chance tourism

Travelling to a destination before it 'disappears' is a tourism trend that is expected to remain popular, especially as the effects from climate change continue to worsen (Lemelin et al. 2019). People are drawn to places like Lake Salda, Turkey to see the degrading coastal area; to Australia to see the coral bleaching; and to Montenvers-Mer-de Glace, French Alps to see the melting glaciers (Coghlan, 2012; Eijgelaar et al., 2010; Kucukergin & Gürlek, 2020). It is important to note

that studies to date show little to no evidence that tour operators themselves are supporting the concept of LCT, nor are they marketing their industry as such (Denley et al., 2020; Gössling et al., 2012; Lemieux et al., 2018; Stewart et al., 2013). Promoting the vulnerability and potential disappearance of their attractions would seem contradictory for these industries (Dawson et al., 2011). Instead, visual, written, and verbal communications carrying messages about LCT destinations tend to be transmitted by media sources like news outlets, travel writers, social media, and television programs (Dawson et al., 2012; Gössling et al., 2012; Scott et al., 2012).

Rather than focusing on the ecological or ethical issues associated with LCT, the media channels listed above tend to glamorize the demise of disappearing locations, ecosystems, and animal species, encouraging viewers to see destinations before they are gone or to visit before a destination becomes too crowded (Burns & Bibbings, 2009; Lamers et al., 2012; Lemelin et al., 2012). Individual tourists perceive these messages and the effects of climate change on LCT destinations differently (Johnston et al., 2012; Scott et al., 2012; Stewart et al., 2012). Some tourists will embark on LCT experiences to support their self-perceived ethical and environmental values, along with their desire to learn about wildlife and environmental issues (Groulx et al., 2016; Lemelin, 2006; Lemelin et al., 2008; Miller et al., 2020). Others perceive their travels as a prestigious experience, believing they are 'awarded' an elite traveler's status by visiting a vulnerable location containing a rare feature or landscape (Lemelin et al., 2012; Salim & Ravanel, 2020).

Although it does not appear to significantly shape travel decisions like carbon offsetting (see Groulx, Boluk, et al., 2019), most LCT tourists have some understanding about climate change and report a desire to learn about the situation and what they can do to reduce their impacts (Denley et al., 2020; Groulx et al., 2016; Gunter, 2018; Piggott-McKellar & McNamara, 2017). In Montenvers-Mer-de-Glace, visitors were motivated to see the disappearing glaciers to understand and observe the impacts of climate change and to share these experiences with future generations (Salim & Ravanel, 2020).

Existing research suggests that tourists can create an emotional bond with the environment and may in turn be encouraged to make positive changes to their lifestyles and behaviours at home (Lemelin et al., 2010; 2012; Miller et al., 2020). However, such changes may be rather dependent on individual context, as LCT studies have also shown an inconsistency between tourists' values towards environmental issues and behaviours. Tourists are typically travelling long distances, using energy-intensive modes of transportation (e.g., plane or cruise), and contribute significantly to the effects of climate change (Dawson et al., 2010; Eijgelaar et al., 2010; Piggott-McKellar & McNamara, 2017). Moreover, these tourists have been shown to repeat this travel pattern across multiple contexts and/or to suspend their pro-environmental behaviour during times of travel (Denley et al., 2020; Eijgelaar et al., 2010; Weaver, 2009). Kucukergin and Gürlek (2020) found that although tourists travelling to Lake Salda were environmentally conscious, they were likely to share their travel experiences with others which would trigger a demand for travel and continue to damage this at-risk location.

Tourism's carbon footprint

In 2008, the UNWTO alongside the UNEP and the WMO authored the *Climate Change and Tourism: Responding to Global Challenges* report, which highlighted both the effects of climate change for tourism (e.g., changes in tourism seasons, availability of tourism products and attractions) and tourism's contribution to climate change. Transportation to, from and within a destination accounted for 75% of emissions generated from the tourism industry, with 40% generated by air travel (UNWTO, UNEP, & WMO, 2008). Accommodations and a range of tourist activities such as visits to sites and attractions, restaurants, bars, and events such as festivals or concerts, accounted for 21% and 4% respectively (Gössling, 2011; UNWTO, UNEP, & WMO, 2008). This contribution was estimated to be 5% of global CO2 emissions, and was expected to be on the rise due to growing tourism demand, increased long haul travel, and more frequent holidays.

Confirming hypotheses from earlier studies referenced above, recent studies have shown that in response to economic development, the demand for travel has increased at a rate much faster than the consumption of other products and services (Lenzen et al., 2018). There has been an increase in tourists travelling longer distances for shorter periods of time, and a preference for energy-intensive forms of transportation and luxury amenities (Holden, 2014; Lenzen et al., 2018). In 2018, Lenzen et al. estimated tourism emissions to have risen to 8%, with air travel accounting for 20% of total tourism emissions. International tourism is of concern as more people demand air travel to reach their destination (Ritchie et al., 2021). It was estimated that international tourism increased by 65% from 2005 to 2016 with over 730 million people choosing to travel by plane (almost double from 2005) (UNWTO & ITF, 2019). In response, international tourism contributed to 23% of emissions from global tourism (Lenzen et al., 2018). The number of international tourists, especially those travelling by air travel, is expected to rise to 1.1 billion by 2030, with emissions rising accordingly (UNWTO & ITF, 2019). Importantly, these trends stem from global travel patterns prior to the COVID-19 pandemic, and the UNWTO (2020) estimates that in the first 10 months of 2020, international arrivals were down 900 million over the previous year. With the pandemic ongoing and causing deep disruptions to the air travel industry on a global basis, it is uncertain how demand for air travel will respond in the future.

Set against travel and tourism's contribution to global emissions, measuring the carbon footprint of LCT destinations is relevant because understanding the paradoxical motivations that drive this particularly high emitting sector may inform pathways to promoting sustainable travel behaviour. Dawson et al. (2010) and Amelung and Lamers (2007) were among the first scholars to calculate the carbon footprint of a LCT destination, both within the context of polar tourism, where the strong dependence of travel by air or cruise ship is responsible for the production of very high per capita greenhouse gas emissions (Hall, 2010). Amelung and Lamers (2007), estimated emissions from cruise ship tourism in Antarctica to be 15 t/CO2 per tourist, which included emissions from their flight and cruise. In a similar study, Farreny et al. (2011) estimated an average tourist trip to Antarctica to generate 5.44 (a significant change in emissions due new available information and improvements in the calculations). By contrast, polar bear viewing tourists emit between 1.54 to 8.61 tonnes of CO2 from flight, accommodations, and activities (Dawson et al., 2010). In response to Arctic regions becoming more accessible and an increase in marketing of wider tourist attractions in these areas, the tourist footprint has drastically increased (over 600% in winter seasons) in the past two decades (Runge et al., 2020).

The mitigation strategies proposed by the UNWTO, UNEP, & WMO (2008) to reduce emissions from the tourism industry included encouraging short haul travel and providing market incentives for tourism operators to improve their energy emissions. However, Lenzen et al. (2018) have identified no evidence to support a reduction in carbon emissions. In a thorough analysis of carbon offsetting, Ritchie et al. (2021) identified that the only option tourists have to offset their carbon emissions is through voluntary carbon offsetting, which has had very little adoption and success rates. Studies have shown that tourists are increasingly likely to choose tour operators or airlines based on their environmentally sustainable or "green" initiatives (Hagmann et al., 2015). However, these efforts are not always advertised to tourists and information regarding the emissions of their trip are not always provided which may unconsciously influence tourists to take more energy intensive modes of transport or participate in harmful activities (Dawson et al., 2010; Gössling, 2018; Hagmann et al., 2015).

Last chance tourism literature has evolved since 2010 when this concept was first introduced and has since focused on motivations for travelling to LCT destinations (see Lemelin & Whipp, 2020 for a complete discussion on the evolution of LCT literature). Over the past ten years, there has been very little work done to quantify the emissions from LCT destinations while understanding how tourists perceive the relationship between climate change and places they are visiting. This study aims to provide an updated analysis on the emissions from polar bear tourism and to understand how carbon emissions from LCT destinations evolve over time.

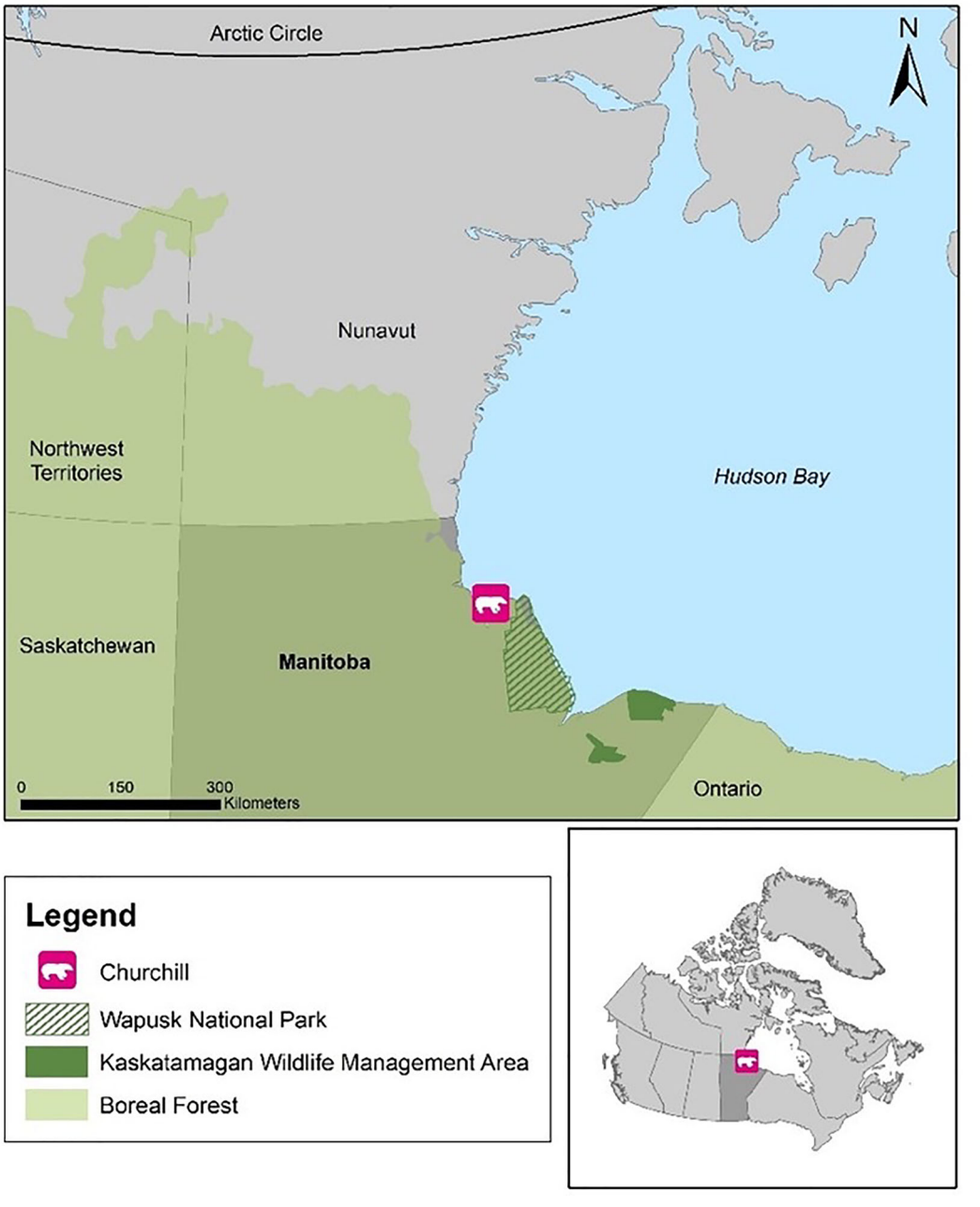

Figure 1. Map of Churchill, Manitoba. Credit: Melissa Weber.

Methods

Study area

Churchill, Manitoba is a small Canadian sub-arctic town located on the edge of the Hudson Bay at the junction of the boreal forest and the Arctic tundra (see Figure 1) (Distasio et al., 2011). Churchill's population of approximately 900 people fluctuates on a seasonal basis as many of its residents work in health services, international shipping, scientific research, and the tourism industry (Distasio et al., 2011; Statistics Canada, 2016). Tourism is a major driver for Churchill's

Figure 2. Tundra Vehicle and Polar Bear in the CWMA. Credit: Jamie D'Souza.

economy. Throughout the year, the community and surrounding landscape hosts a wide variety of attractions including migratory bird spotting, beluga whale watching, Aurora Borealis gazing, and polar bear viewing (Government of Manitoba, 2017). Polar bear viewing, which occurs every October to November, attracts an average of 12,000 tourists annually and generates $7.2 million to Churchill's local economy (EcoRessources Consultants, 2011; Struzik, 2014)[2].

Amidst the diversity of tourism options, polar bear viewing tours are offered primarily in the Churchill Wildlife Management Area (managed by the provincial conservation authority) with two main tour operators (Frontiers North Adventures and Great White Bear) holding permits to conduct tours along those trails within the management areas (Travel Manitoba. 2017) (Figure 2). Lazy Bear Expeditions also offers tundra vehicle tours outside of the Churchill Wildlife Management Area and in other areas around Churchill. While these tour operators monopolize the tundra vehicle viewing tours, private tours, accommodations, and activities are provided by a wider range of operators which include: Churchill Nature Tours, Churchill Northern Studies Centre, Churchill Wild, Discover Churchill, Heartland International Travel & Tours, Natural Habitat Adventures, and others (everythingchurchill.com).

Accommodation can be found in town, at the Churchill Northern Studies Centre, or in lodges directly on the tundra. Tourists have the option of booking one-day viewing tours, with round-trip transportation from Winnipeg to Churchill or a multi-day package which includes accommodation, dogsledding, helicopter tours and visits in and around town (Figure 2).

Study design

This study draws on a quantitative approach to calculate the greenhouse gas emissions from individuals travelling to Churchill and to identify tourists' awareness of the impacts of climate change (to and from tourism activities). These methods were integrated as early as the study design phase through administration of a visitor survey reflective of methods used to study LCT (see Dawson et al., 2010; Groulx, Boluk et al., 2019; Miller et al., 2020). Several of the closed-ended survey questions were replicated and adapted from Dawson et al. (2010) to directly identify changes in the industry over a ten-year period (Creswell, 2014). Only questions replicated

from the original study were considered in this longitudinal analysis. Due to the lack of availability of the raw data from Dawson et al. (2010) no statistical comparisons could be made in this study; only direct comparisons to the original study.

The survey was divided into five sections: trip characteristics, motivations to travel, perceptions about climate change, opinions on mitigation strategies, and demographics. These questions were closed-ended questions using a five-point Likert scale. Responses pertaining to a participant's trip to Churchill were used in conjunction with online carbon calculators to evaluate the greenhouse gas emissions from Churchill's polar bear viewing industry.

According to Lenzen et al. (2018), the carbon footprint of tourism should include carbon emitted from tourism activities as well as those from tourism commodities (e.g., food, accommodation, transportation, shopping). To allow for a direct comparison with Dawson et al. (2010), the carbon footprint of Churchill's polar bear viewing industry focused on transportation, accommodations, and activities. Accommodation and activity estimates from survey respondents were taken directly from Dawson et al. (2010) and the UNWTO-UNEP-WMO (2008) report, as these emission estimates have been previously validated and no new relevant carbon factors that relate to the tourism industry were available at the time of this study. These calculations consider emissions from commercial accommodation in a developed country, emissions used to travel to and from the tundra vehicle launch, the tundra vehicle trips, helicopters tours, travel to the dog sledding location, and a tour of the town. By contrast, transportation emissions were updated for this study, following a bottom-up approach that is frequently used in the tourism field. Specifically, the bottom-up approach used allows for energy use to be calculated based on a tourist's choice transportation mode (Becken & Hay, 2007; Dawson et al., 2010; Farrney et al., 2011). Bottom- up approaches also allow comparison of responses with existing data based on tourism activities (where available), as was used to calculate Antarctica cruise ship emissions (Farreny et al., 2011).

Online carbon calculators are interactive web-based tools used to quantify a carbon footprint and are used when direct measurement of emissions is not available (CarbonZero, 2020; Jardine, 2009). They are openly available to the public and are used by governments for international emission reports, by businesses to determine their carbon emissions, and by individuals who wish to reduce their environmental impacts either at home or from travel (Jardine, 2009). Online carbon calculators have grown with the emerging climate trends and now include options for users to donate towards investments in renewable energy projects (Birnik, 2013; Padgett et al., 2008).

In this study, online carbon calculators were used to calculate transportation emissions. There are no roads to Churchill and due to the closure of the local train at the time of this study, air travel was the only mode of transportation available to tourists to reach Churchill. Air travel is therefore the only mode of transportation considered in the greenhouse gas emission analysis. In calculating emissions from aviation, carbon calculators employ a straightforward technique using travel distances and standard emission factors (ranging from 1-5) to estimate CO2 emissions (Dawson et al., 2010). For individual passengers travelling by plane, emissions are calculated based on the point of origin and destination as well as assumptions about the plane type, the engine type, freight load and seating configuration, all of which will vary among different calculators (Jardine, 2009).

Paper and electronic surveys (via tablets and iPads) were distributed to tourists who participated in a polar bear viewing tour during the 2018 polar bear viewing season (October 16 to November 16). As in similar tourism studies (Dawson et al., 2010; Groulx, 2015; Groulx, Boluk, et al., 2019), survey participants were selected using convenience sampling in two areas in Churchill: the Churchill Northern Studies Centre (a non-profit field station) and the Churchill Airport. This approach was utilized for participant diversity and for the researcher to survey as many people as possible (Ramkissoon et al., 2013). Due to the mobility of tourists (e.g., no

centralized point where they can be sampled reliably) and the proprietary nature of visitor lists, a randomized sample was not feasible.

At the Churchill Northern Studies Centre, surveys were distributed one to two times a week to tourists who were staying at the centre and participating on multi-day tours, following evening presentations given by their trip leaders. The survey was designed to be self-completed by the participants. Self-administered surveys allow participants to express themselves as honestly as possible without feeling compelled to give the 'right' answer (Fowler, 2009; Needham & Vaske, 2008. Participants were able to complete the survey immediately or hand it back to the researcher the next day. At the Churchill Airport, surveys were distributed twice a day, three times a week, to tourists who had participated in one-day and multi-day tours, following their arrival and check-in, and were submitted before boarding the plane. Surveying typically took place in the afternoon and evening as there were more scheduled departures at these times. Upon completion of the survey, tourists were invited to enter a draw to win a signed copy of "Arctic Icons: How the town of Churchill learned to love its polar bears" by Edward Struzik. Of 662 tourists who were approached, 513 surveys were returned. Reasons tourists chose not to complete the surveys included: because they were tired, uninterested, they wished to complete one survey among two people, or due to a language barrier.

Online carbon calculators: Analytical process

To calculate the greenhouse gas emissions from transportation (primarily from air travel), survey respondents were asked to describe their travel routes from their original destination to their arrival destination (Churchill, Manitoba). Almost all the respondents travelled to Winnipeg, Manitoba (the gateway city to Churchill) by plane. No specific addresses were provided by respondents to allow for an accurate calculation of travel emissions by other modes of transportation (e.g., car) used to travel to Winnipeg. Therefore, any greenhouse gas estimates for travel only considered travel routes by plane. Using the information about respondents' trip characteristics (e.g., mode of travel, length of travel, etc.), the greenhouse gas emissions from air travel were calculated using online carbon calculators, following methods from Dawson et al. (2010) as closely as possible. An estimate of total travel emissions from each individual tourist was calculated using three online carbon calculators: Carbon Zero, Atmosfair, and Climate Care (Becken & Hay, 2007; Dawson et al., 2010; Jardine, 2005). These three calculators have been used to examine tourists' understanding of online carbon calculators, to estimate the carbon emissions from flights, and to calculate the emissions from Churchill's polar bear viewing industry (Dawson et al., 2010; Jardine, 2009; Juvan & Dolnicarl., 2014). The three calculators had common data input needs (route specific information, passenger load and cabin class). The Atmosfair online carbon calculator was explicitly chosen because it was used by Dawson et al. (2010). The other two calculators used in the 2008 study (Zerofootprint and Carbonneutral), are no longer available and could not be used for this analysis. Different calculators will provide varying results for the same flights due to underlying assumptions (e.g., climatic conditions, flight distances due to detours, flight mass, etc.) (Jardine, 2009). Therefore, an average of emissions calculated from the selected online calculators was used to generate a more robust estimate of the greenhouse gas emissions.

Results

Tourists demographics

The demographic profile for polar bear viewing tourists in this study closely resembles the profiles found in similar LCT studies (see Table 1) (Dawson et al., 2010; Eijgelaar et al., 2010; Groulx et al., 2016; Miller et al., 2020). Dawson et al. (2010) identified an almost equal number of tourists

Table 1. Churchill's polar bear viewing tourists' demographics.

Variable	2007 Results	2018 Results
Average Age	61	64
Gender	Female (66%)	Female (63%)
Level of Education	Post-secondary degree (72%)	Bachelor or Graduate degree (76%)
Country of Residence	Canada (44%)	United States (68%)
	United States (42%)	Canada (17%)
	United Kingdom (8%)	United Kingdom (6%)
	Europe (3%)	Australia (5%)
	Australia (3%)	Europe (3%)
		Asia (1%)

Table 2. Greenhouse gas emissions for polar bear viewing tourists.

City of Origin	Average (t/CO2 $^{-e}$) 2007 Results	Average (t/CO2 $^{-e}$) 2018 Results
Minneapolis, USA (via Winnipeg)	n/a	0.70
Denver, USA (via St Paul)	n/a	1.19
Toronto, Canada (via Winnipeg)	1.54	1.21
Vancouver, Canada (via Winnipeg)	2.00	1.43
New York, USA (via St Paul or Toronto)	1.87	1.46
Los Angeles, USA (via St. Paul)	2.30	n/a
London, England (via Toronto)	4.95	3.75
Frankfurt, Germany (via Toronto)	4.96	n/a
Munich, Germany (via Toronto)	n/a	3.85
Tokyo, Japan (via St Paul)	n/a	5.83
Adelaide, Australia (via Los Angeles)	n/a	8.25
Sydney, Australia (via Vancouver)	8.61	n/a

travelling to Churchill from Canada (44%) and the USA (42%), with a far higher proportion of Canadian travellers than the present study. The higher volume of tourists from the United States in this study may be a response to the low Canadian dollar which has increased visitation from US residents since 2014 (TIAC, 2016). Another explanation may be increased target marketing in many US states, which has influenced more people to travel to Manitoba (Travel Manitoba, 2018).

Survey data indicated that polar bear viewing experiences among visitors in this sample were an average of five days in length. Results also show that during their visit, regardless of which tour operator they chose, tourists (on average) went on two-day polar bear viewing tours, one helicopter ride (weather permitting), and one dog sledding excursion. They also visited the Parks Canada Visitor Centre, the Eskimo/Itsanitaq Museum, souvenir shops and the town's local restaurants. The profile of visitor activities found here is consistent with those identified by Dawson et al. (2010).

Greenhouse gas emissions from churchill's polar bear viewing industry

The estimated greenhouse gas emissions for a personal journey to Churchill via plane from Denver, Minneapolis, New York City, Toronto, Vancouver, London, Adelaide, Munich, and Tokyo ranged from an average of 0.53 t/CO2 $^{-e}$ (e.g., Minneapolis, Minnesota) to an average of 8.08 t/CO2 $^{-e}$ (e.g., Adelaide, Australia) (Table 2)[3]. Dawson et al (2010) and the UNWTO-UNEP-WMO (2008) estimated emissions for accommodations and activities to total

0.17 t/CO2^{-e}. When these calculations are included with travel calculations, a polar bear viewing tourist was found to emit, on average, a total of 0.7 t/CO2^{-e} (e.g., Minneapolis, Minnesota) to 8.25 t/CO2 $^{-e}$ (e.g., Adelaide, Australia) during their five-day trip to Churchill, Manitoba. Compared to Dawson et al. (2010), who estimated greenhouse gas emissions to range from

Table 3. Tourists' knowledge about climate change.

Variable	2007 results	2018 results
If you think climate change is happening, do you think it is: *Caused mostly by human activities* *Caused mostly by natural changes in the environment* *Caused by both human activities and natural changes*	agree or strongly agree **humans** are contributing to the changes in the global climate (88%)	believe climate change is caused by both **human** activities and natural changes (47%) mostly by **human** activities (45%) Total agreeing or strongly agreeing a human influence (92%)
Air travel is a contributor to climate change	agree or strongly agree (69%)	agree or strongly agree (73%)
Polar bears will disappear from the Churchill region due to changes in the global climate	agree or strongly agree (60%) disagree (7%) unsure (28%)	agree or strongly agree (59%) neutral (23%)
Would you still have visited Churchill if the polar bears appeared to be unhealthy (i.e. noticeably skinny)?	definitely (60%)	definitely or probably (56%)
If you were not able to see polar bears in Churchill, would you be willing to go elsewhere to view the bears?	definitely (72%)	definitely or probably (78%)
"After seeing the polar bears, I plan on making some changes to my lifestyle at home to reduce my greenhouse gas emissions"	strongly agree (48%)	agree or strongly agree (57%)
Did you purchase an offset?	yes (7%)	yes (8%)
What is the reason you did not purchase an offset	I don't know what the money is for (21%) I don't know what a carbon tax is (12%) I don't know what company to trust (12%)	I don't know what a carbon offset is (22%) I don't know what the money is used for (18%) It was not offered (11%) I don't think it is necessary or effective (6%) It was not made available (5%)

1.54 t/CO2 $^{-e}$ (e.g., Toronto, Canada) to 8.61 t/CO2 $^{-e}$ (e.g., Sydney, Australia), the average emissions produced per traveller declined by 18%. The difference of the greenhouse gas estimates for individual tourists indicates that there has been a shift in individual emissions over the last ten years, which can be explained by an increase in fuel efficiency standards and targets among governments and the International Air Transport Association.

When estimated for the entire polar bear viewing industry in Churchill, total emissions for the 2018 polar bear viewing season are 23,017 t/CO2^{-e}. This is approximately 10% higher than the 2008 estimates of 20,892 t/CO2 $^{-e}$ and is primarily a function of the growth of tourism within this market between 2007 (n = 8,000) to 2018 (n = 12,000). There was also an increase in average travel distances (e.g., increased visitors from the United States and a decrease in visitors from Canada) in 2018, although given the individual emissions results this factor appears less influential than total volume of travelers.

Tourists' awareness about climate change

Any possible longitudinal changes in a LCT market might be explained by tourists' awareness, knowledge and even perceptions about climate change and corresponding change in travel behaviour across the total LCT market. Table 3 shows the responses given by polar bear viewing tourists. Comparing these responses to those given in Dawson et al. (2010), there seems to be a negligible difference among tourists. Similar to Dawson et al. (2010), although tourists are aware human induced climate change is happening, there is a general lack of knowledge of how air travel contributes to these changes.

One notable change is when respondents were asked if they would make lifestyle changes at home to reduce their greenhouse gas emissions, 57% strongly agreed or agreed: a 9% increase

from the 2007 results. These respondents stated they would try to reduce packaging, invest in solar energy, recycle more, drive less, and purchase an electric or hybrid car. Respondents who left this question about personal sustainable behaviour blank (12%) stated that they were already doing enough to reduce their emissions at home, and they did not know what else they could or should be doing. Almost all of the respondents (93%) indicated their tour operators included an educational component to their tours which included discussions on climate change, polar bear health, environmental issues, sea ice and general polar bear information. This is something that has evolved over the last ten years as Dawson et al. (2010) indicated that very little environmental information was provided to tourists during the viewing tours.

Discussion

Carbon footprint of polar bear viewing

When taken in context with the original findings from Dawson et al. (2010), results from a carbon footprint analysis completed in 2018 shows that the average individual carbon footprint of polar bear viewing tourists has decreased by 18%, while the total carbon footprint of the local market has increased by 50%. This is consistent with findings from Groulx et al. (2017) which suggests that each person's trip has a smaller carbon footprint in absolute terms but more intensive for each day of travel. By replicating Dawson et al.'s (2010) methodology, this study provides the first longitudinal evidence, that we are aware of, showing the persistence of carbon intensity with the LCT marketplace due to an ongoing dependence on air travel. Within the present study, this outcome was influenced by the closure of the rail line, which meant all survey respondents were required to fly from Winnipeg to Churchill. More notably, with the average individual carbon footprint of polar bear viewing tourists declining, the overall growth in carbon production is largely a function of a 10% increase in the estimated size of the visitor population between 2008 and 2018. When considering global greenhouse emissions, the contribution from the polar bear viewing industry is small (∼0.06%) compared to the coal industry for example (International Energy Agency, 2020). However, the emissions from one trip to Churchill greatly exceeds the emissions from an average global tourist (0.25t/CO2) calculated by UNWTO-UNEP-WMO (2008), and the per capita emissions of the average world citizen, (4.4t/capita according to the International Energy Agency, 2020).

As polar bears continue to be the symbol of global climate change and of the LCT phenomenon, travel to Arctic regions and destinations like Churchill is expected to continue to rise (Miller et al., 2020; Runge et al., 2020). In response, the marketing of nature-based activities and an increase in tourist attractions have increased considerably over the past decade (Runge et al., 2020). As identified by Dawson et al. (2010) tourism operators in Churchill been increasingly promoting one-day experiences for tourists to see the polar bears over the past 15 years. It has been estimated that on a per-day basis, domestic travel is more carbon intensive compared to international travel due to the shorter stays, the dependence of air travel, and contributes less economically to local businesses (Becken & Hay, 2012; Groulx et al., 2016). A study in Landmannalauger, Iceland found that overnight visitors decreased by 14% in a period of ten years in response to the accessibility of the destination (Saeþórsdóttir & Hall, 2021). Another carbon intensive trend on the rise is tourists travelling to other destinations for similar experiences (Lemieux et al., 2018). If Churchill was no longer able to provide polar bear viewing experiences due to the extirpation of the regional population, polar bear viewing tourists indicated they would be willing to travel elsewhere to see the bears. With a rise in global media attention focused on polar bears, and an increase in polar bears being spotted further north in search of food, viewing tours have grown over the past decade. Polar bear viewing in Kaktovik, Alaska for example has increased from 260 visitors per season to 3015 over a period of six years (Miller et al., 2020). However, tourists seeking polar bear viewing experiences would have to travel

further north in Canada or to other northern destinations worldwide (e.g., Norway or Russia) which would on the whole generate an even greater carbon footprint than estimated here (Government of Canada, 2018)[4].

Some LCT authors suggest that these high energy products and experiences may need to be phased out to reduce emissions as we move towards a low carbon future (Eijgelaar et al. 2010). However, in a small town like Churchill, the polar bear viewing industry is an important economic industry, thus phasing out polar bear viewing would not be a viable option (Travel Manitoba, 2017). In 2019, the United Nations World Tourism Organization and the International Transport Forum authored the *Transport- related CO2 Emissions of the Tourism Sector* report. This report indicates that to reduce emissions from tourism activities, destinations and actors within the sector need to adopt stronger measurement tactics and greater disclosure of emissions linked to attainable targets. The report also calls for instruments and strategies to mitigate emissions moving forward. Existing literature suggests promoting slow travel, which focuses on improving the visitor experience by travelling at a slower pace and protecting the environment by using a less energy intensive mode of transportation (Clancy, 2014). The roundtrip train journey from Winnipeg to Churchill takes approximately four days and goes through 1697 km of unique northern landscapes and communities (viarail.com)[5]. As a trip to Churchill is a once in a lifetime experience for most visitors, new destination packages paired with upgrades to aging railroad infrastructure and appropriate marketing could be examined as a strategy to shift a portion of Churchill's polar bear viewing market to a less carbon intensive form of travel. Travel by rail would not only reduce the carbon footprint but, would allow tourists to experience different parts of northern Manitoba and possibly see different wildlife before reaching Churchill. To date, only Frontiers North Adventures promotes train travel, and in this case, it is only in one of their packages.

Interestingly, the train reopened in the fall of 2018 just before most visitors surveyed in this study arrived in Churchill, but after they would have made travel plans as trips are typically booked earlier in the year due to limited space on tours. It is ultimately uncertain how many tourists would have opted to travel by train. Likewise, tourists participating on one-day trips to Churchill would not have the option to take the train. Although the rail line was available during the 2008 study, Dawson et al. (2010) reported only 14% of their survey respondents opted for taking the train. They assumed this low number was in response to time constraints of tourist's vacation and that trains are often late due to poor infrastructure and maintenance. For rail to be a viable and attractive option for tourists, Dawson et al. (2010) proposed that there needs to be more government investment to fix the tracks, and improve schedules, times, and services. Additional research is needed explore the condition of the rail service and ridership since its reopening.

Tourists understanding of climate change influenced by travel

Despite growing global awareness of climate change and increasing recognition of the especially rapid and influential impacts on the Arctic, last chance tourists' travel behaviour seems resistant to change (Denley et al., 2020). Visitors travelling to Montenvers- Mer-de Glace were aware of the anthropogenic influence on climate change but continued to travel to see the glacier despite the greenhouse gas impacts causes by tourism (Salim & Ravanel, 2020). Moreover, as Dawson et al. (2010) suggests, there is still a lack of conceptual clarity among tourists about how destinations are impacted by anthropogenic activities. These attitudes have also been observed by tourists visiting the Great Barrier Reef in Australia, who didn't understand the collective impacts tourists have on the area, despite their expressed concern about the demise of the coral reefs (Piggott-McKellar & McNamara, 2017). Furthermore, there continues to be a lack of understanding of how travel, specifically air travel, influences climate change. Dawson et al. (2010) argued that this lack of understanding of how travel contributes to climate change may be because

tourists cannot necessarily see the environmental impacts (e.g., the decrease in polar bear populations) from their single visit to Churchill. Because the effects from air travel take time to trigger temperature climatic changes, a tourist may not be able to recognize the impacts of change on their single trip (Becken, 2004; Gössling & Peeters, 2007; Hall, 2010). If a tourist sees at least one polar bear on their viewing tours they may not be convinced that polar bears are disappearing. Consequently, in observing LCT in Kaktovik, Alaska, Miller et al. (2020) reported that the more polar bears tourists see the less likely they are to change behaviour habits or even understand the impacts of change.

Studies have shown that tourists are choosing tour operators that offer an educational experience in order to learn more and appreciate a species or location they have traveled far to see (Gunter, 2018; Miller et al., 2020). Churchill's tour operators are now providing discussions about environmental issues, climate change and polar bears on their tours, a shift from ten years ago when limited environmental information was being provided (Dawson et al., 2010). Although tourists may not be aware of their impact on climate change from travel, they have indicated that they would be willing to spend more money to make their travel more sustainable which may be an incentive for operators to reduce their environmental impacts, knowing that there is a market willing to make these efforts (Denley et al., 2020). Educational programs are often proposed in helping tourists learn about the impacts of climate change on the LCT destinations, however, there is often a lack of emphasis about what tourists specifically can do (Dawson et al., 2010; Groulx et al., 2016; Miller et al., 2020). Montenvers-Mer-de-Glace, for example, is evolving to make this destination not only a place for glacier viewing but as a major site of climate change education (Salim & Ravanel, 2020). With the rise in social media influencing people to travel to LCT destinations, Kucukergin and Gürlek (2020) stress the need for area experts to provide posts about the state of Lake Salda and to encourage tourists take actions to prevent the disappearance of this destination. A closer examination on Churchill's tour operators is necessary to identify measures they are taking to reduce their impacts.

Evidence suggests that the amount of people who are motivated to change their behaviours represent a small percentage which makes it extremely difficult for their intentions to be translated into actions (Juvan and Dolnicar 2014). Post-trip surveys or interviews would be necessary to identify if tourists had made changes or taken climate actions at home following their trip (Groulx, Fishback, et al., 2019). The challenge is tourists who do want to make a change, don't necessarily know where to obtain this information about ways to reduce their impact while travelling, as it is not frequently discussed during their travels (Hall, 2010). There is an opportunity for tour operators to provide tourists with innovative experiences and examples about how tourists can reduce their emissions not just at home but during their travels as well (Garma, 2014). While education programs may not directly reduce greenhouse gas emissions, compared to switching to low-carbon forms of transportation, especially in a small town like Churchill (Dawson et al., 2011), it is a strategy that allows tourists to reflect on their travel decisions, and begin thinking about the solutions and alternatives that exist, and demand changes to reduce emissions globally as climate change continues to rise.

Conclusion

The aim of this research was to establish a longitudinal comparison of Churchill's polar bear viewing industry over a ten-year period (2008 to 2018). In calculating the carbon footprint from Churchill's unique tourism industry, overall emissions appear to have increased by 10% in response to overall visitor growth compared to Dawson et al. (2010). Similar to the original study, the trend remains that tourists continue to have a limited understanding about how tourism and travel contribute to global climate changes.

The current study is not without its limitations. The use of convenience sampling to obtain survey respondents, in terms of reliability and generalizability, may not provide an accurate representation of the tourists visiting Churchill. Moreover, many surveys were completed at the Churchill Northern Studies Centre, where visitors take part in educational lectures every evening, therefore the responses of the survey may be skewed as a result. Survey times conducted at the Churchill Airport were based on flight schedules at certain times of day which meant that some of Churchill's polar bear viewing tourists may not have been represented in the study. A longer surveying period, a wider distribution of visitor surveys and a different choice of sampling (e.g., random sampling) would be necessary to have a better representation of the polar bear viewing industry. There is a lot of uncertainty in total number of tourists who visited Churchill during the 2018 season, as they were an average of the estimates provided by Dawson et al. (2010) and Struzik (2014). To date, publicly available data pertaining to total number of visitors in Churchill per year does not exist. When calculating the greenhouse emissions, because two of the calculators used by Dawson et al. (2010) were not available, the emissions estimated in this study may have yielded different results and may not allow for a perfect comparison. Using results from carbon calculators can be challenging as each calculator uses different methodologies in their calculations and can produce very different greenhouse gas estimates (Birnik, 2013; Padgett et al., 2008). The final limitation of this study is the assumptions made by conducting a single study with one group of participants, largely from two tour operators (as most participants reported travelling with Natural Habitat Adventures and Frontiers North Adventures). A long-term study is necessary to explore the changes in the industry and examine individual tour operators and trends in tourists' behaviour and knowledge over time, especially as tourists begin to demand more environmental action in their tours. Future research would be important to see how emissions might have changed now that the rail line is accessible again and the reasons tourists would have chosen the train instead of to fly.

Lemelin and Whipp (2019) debate the very existence of LCT destinations. Are they places for tourists to learn about climate change and be motivated to take climate action or is does the act of travelling to destinations at risk amplify the damage? There is no easy answer for a place like Churchill whose economy depends on their tourism industry. LCT destinations, much like Churchill have to be mindful of these risks and opportunities to achieve the most sustainable outcomes for a long period of time (Dawson et al., 2015). With the progression of educational information being provided to polar bear viewing tourists, tour operators and leaders have an opportunity to start talking about the relationship between climate change and tourism and really focus on individual action (Miller et al., 2020). This can be done either at the point of purchase (via from tour operator's websites or from travel agents) or directly on-site during tours to empower tourists to take action (Dawson et al., 2015). To reduce the amplified damage on the industry caused by climate change, Churchill has an opportunity to improve and effectively market travelling by train to reduce the overall impact from tourism. Governmental involvement would be necessary to enforce positive changes in tourism destinations by investing in energy efficient modes of transportations (UNWTO-UNEP-WMO, 2008). As tourism continues to expand and people continue to seek unique experiences in destinations before they disappear, this type of research will be even more important to measure and understand if LCT destinations can evolve over time and what the necessary tools are to be able to effectively influence change.

Notes

1. According to the UNWTO-UNEP-WMO (2008) report and an in-depth analysis of tourism emissions on a global scale, an average global tourist experience is estimated to emit 0.25t/CO2.
2. Little statistical data is available about this small community's tourism industry, therefore the numbers provided are estimates (Western Management Consultants & Econometric Research Limited, 2018).

3. Emission estimates are expressed as CO2 equivalents ($CO2^{-e}$) as a way of comparing emissions from all greenhouse gases, which have varying global warming potentials (Hausfather, 2017).
4. Emissions to travel to other popular polar bear viewing destinations, such as Svalbard, Norway, would range from an average of 3.35 t/ $CO2^{-e}$ (origin: Toronto, Canada) to an average of 7.86 t/$CO2^{-e}$ (origin: Sydney, Australia).
5. The roundtrip train ride from Winnipeg to Churchill would emit approximately 0.058 t/CO2 compared to a roundtrip flight which emits approximately 0.41t/ CO2.

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