Polar bear wildlife viewing in Eeyou Istchee: An assessment of different perspectives and considerations

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Abstract

Wildlife tourism has been proposed as an alternative economic development opportunity for Indigenous communities in the Canadian north. Potential benefits include the employment of community members in land-based activities that enhance cultural identity, contribute to social well-being, support inter-generational knowledge transmission, and promote cross-cultural exchange. The extent to which wildlife tourism delivers on its promise is not well documented and tends to privilege the perspective of external experts over those of community members. Furthermore, a fuller appreciation of community expectations, concerns, and (mis)understandings is often lacking at the outset of a project with implications for its long-term success and acceptance. This thesis examines a polar bear viewing project proposed for the James Bay Cree community of Wemindji. It responds to an invitation from the Wemindji leadership to contribute information on the proposal by addressing two different aspects of the project. Firstly, it avails of geospatial technology to provide a preliminary population survey of the polar bears that can inform an assessment of the economic viability and likely wildlife impact of the project. Secondly, it uses semi-structured interviews with community members to document local perspectives on the project, including local assessments of potential benefits but also local concerns. The results of the population survey show that while geospatial technologies can provide a useful snapshot of polar bear population numbers and location, there are limitations to the accuracy and viability of these methods. The results of the community consultation affirm the value of local insights and the need to take full account of local perspectives before proceeding with a final decision on whether this project should proceed.

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List of Abbreviations

CBT	Community Based Tourism
COTA	Cree Outfitting and Tourism Association
CTA	Cree Trappers Association
EMR	Eeyou Marine Region
EMRIRB	Eeyou Marine Region Impact Review Board
EMRPC	Eeyou Marine Region Planning Commission
EMRWB	Eeyou Marine Region Wildlife Board
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
JBNQA	James Bay and Northern Quebec Agreement
MPA	Marine Protected Area
NSTP	Northern Scientific Training Program
QCBS	Québec Centre for Biodiversity Science
SAR	Search and Rescue
SH	Southern Hudson Bay
TRC	Truth and Reconciliation Commission
UAV	Unmanned aerial vehicle
UNDRIP	UN Declaration on the Rights of the Indigenous Peoples
UNWTO	United Nations Word Tourism Organization
VHR	Very high resolution

Chapter 1: Introduction

Tourism has been hailed for its potential to contribute socio-economic benefits in remote Indigenous communities. Potential economic benefits include diversification of the local economy through the development of new businesses (Reggers, Grabowski, Wearing, Chatterton, & Schweinsberg, 2016) and the creation of job opportunities (Buultjens and Gale 2013; Coria and Calfucura 2012; Zeppel 2006; Shikida A et al. 2010; Zapata et al. 2011). Tourism as a supplementary form of income in Indigenous communities can provide an alternative for those otherwise dependent on employment in resource extraction industries (i.e. mining, forestry). This is characterized by grueling hours and extended stays away from home, family connections, community, land and culture often resulting in negative impacts on individuals, families and the community at large. In contrast the social benefits attributed to tourism that are tied to land-based activities (i.e. hunting, fishing, harvesting, natural resource management, ceremony) include the enhancement of social capital, and an "increased sense of confidence and identity" (Hunt, Altman, and May 2009). Tourism can also support the transmission of knowledge from the elders to youth and "contributions to mental health and community well-being" (Mulrennan, 2014, p. 74).

Indigenous people in Canada, comprised of First Nations, Inuit and Métis, represent 4.3% or 1.4 million of the total population (Statistics Canada, 2011a). They experience disproportional levels of poor health, high unemployment and suicide rates (Cooke, Mitrou, Lawrence, Guimond, & Beavon, 2007; United Nations, 2015) as a result of many decades of "domination, isolation and assimilation by the dominant culture" (Mulrennan, 2014, p. 16). One such policy was the institutionalization of the residential school system in the 1880s. Conceived for cultural assimilation, residential schools continued well into the mid-1900s in Canada (United Nations, 2015, p. 110). The scars from sexual, emotional and physical abuse in victims of seven generations continue to manifest in Indigenous communities through abuse, addiction, and loss of languages (ibid.). The Truth and Reconciliation Commission (TRC), established in 2008 to document the stories of the victims of the residential schools, called for ninety-four (94) recommendations in its final report in 2015. These included a reduction in the gap between the education and employment of indigenous and non-indigenous Canadians; efforts and resources directed to preserving, revitalizing and strengthening Indigenous languages; and ensuring that all Canadians know the

history and respect the culture of Canada's indigenous peoples (Truth and Reconciliation Commission, 2015). Following Higgins-Desbiolles (2003), tourism in Indigenous communities can be viewed as a reconciliation platform where non-indigenous people are provided with an opportunity to interact with Indigenous people and learn about their culture.

Indigenous people are attempting to take control of their present and future well-being by direct action, political negotiations, court actions and alliance building (Mulrennan, 2014). While it has been suggested that Aboriginal peoples are not pro-development, neither are they anti-development and some are keen to participate in development opportunities (ibid.). Prior to contact, many Indigenous groups had established vast trading networks with other indigenous groups (ibid) and were essential participants in the Fur Trade. Today many are actively seeking to diversify their economies. According to the Canadian Council for Aboriginal Business, the growth rate of Aboriginal business ventures is five times that of non-Aboriginal self-owned businesses (Mulrennan, 2014). These ventures are spread across diverse economic activities: primary sector i.e. forestry, mining, fishing, hunting (13%); construction (18%): knowledge and service-based sector (28%) (ibid.). Successes in spirit and hospitality ventures include the Nk'Mip wine cellars, a golf course and a 4.5star resort and spa in Okanagan Valley, BC. Skwàchays, a first in Canada Aboriginal-run art boutique hotel in British Columbia, offers guests an aboriginal experience in not only art (seen as part of the décor of the hotel), but also the food and engagement with the artist through a workshop (Skwàchays, 2016). Similarly Hôtel-Musée Premières Nations in Quebec offers guests a cultural and artistic experience from the décor in the rooms to a visit to the Wendat-Huron museum (Hotel Musée Premières Nations, 2016).

This thesis focuses on a story about an indigenous community actively targeting tourism as an economic development opportunity. Following the ratification of the Eeyou Marine Region Agreement in 2010, Cree interests and opportunities in the James Bay offshore became a focal point of attention. As a strategy to develop tourism in the James Bay area in Quebec, the Cree Outfitting and Tourism Association (COTA), proposed polar bear wildlife viewing as an ecologically sound and economically sustainable venture. As proposed, visitors would be transported by boat from Wemindji to North and South Twin Islands to view the bears. Tours would take place in the summer months between June and September and the community of Wemindji is projected to welcome about seven hundred (700) visitors per year. In addition to

wildlife viewing, visitors would have an opportunity to experience Cree culture by attending ceremonies and taking part in daily activities, such as cooking in a teepee.

1.1 About Wemindji

Wemindji, one of ten Cree communities in the James Bay area, is located at the mouth of the Maquatua River with a population just over 1400. The community was moved in 1958 from Old Factory, 25 km to the south to the village of Wemindji (53.010138, -78.830575) from *wiimin uchii*, meaning "ochre hills" in Cree (Wemindji Website, 2015a). The traditional territory of the Wemindji people is comprised of twenty multi-family hunting territories that extend from the land into the offshore, each under the stewardship of a senior hunting boss or tallyman (*uuchimaau* in Cree) who is responsible for the sustainable and productive use of the land. Over time an elaborate system of resource management has evolved based on values of respect, reciprocity and sharing (Scott, 1988 in (Sayles & Mulrennan, 2010).

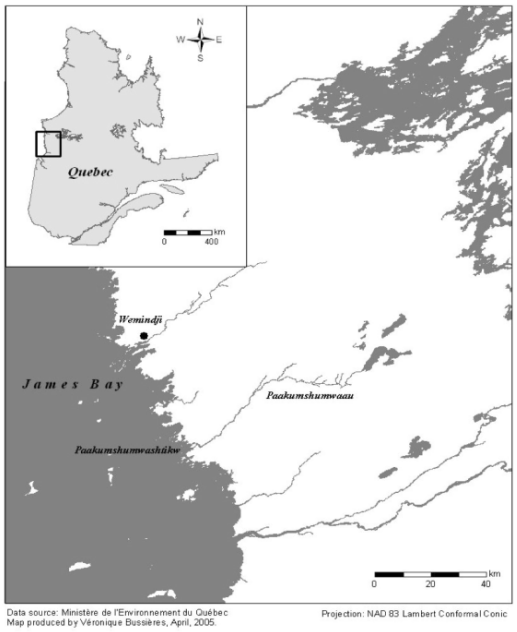

Figure 1.1: Location of Wemindji (Bussiéres, 2005)

Wemindji is served by an elected Band Council consisting of five council members, a deputy chief and a chief (currently Dennis Georgekish). The Band Council is the main representative and decision- making body of the Cree Nation of Wemindji (ibid.). Wemindji is not any typical small village. The community has many amenities similar to larger towns including, sports and recreational facilities, financial services, public security and fire station, a grocery store,

a restaurant and a hotel with a capacity of 30 rooms. Wemindji is accessible by air travel and a permanent road linked to the James Bay highway. The infrastructure in the community is being further developed with most roads paved and numerous construction works in progress, including a new primary school and Youth Center (personal observations and communication with Wemindji residents, August, 2016).

While some families engage in year-round hunting, trapping and fishing, others partake of a mix of traditional and wage labor activities (Sayles & Mulrennan, 2010). According to the 2011 census data, the unemployment rate in Wemindji is 9.7% while the employment rate is 58% (Statistics Canada, 2011b) with a majority employed by the Wemindji Band Council and the various small businesses within the community (Wawatie & Perron, 2015). The Crees' vision is to build a self-sufficient economy fostering entrepreneurship and support of Cree-owned businesses on a national and global platform while adhering to the Cree value of respect for the natural environment and all living things (Wemindji Website, 2015b).

1.2 The Polar Bear Tourism project

A tourism project centered on polar bear viewing was formally proposed to the Wemindji Community Council in June 2013. The proposal was submitted by the COTA, a non-profit organization, incorporated in December 2000 under Part II of the Canadian Corporations Act. COTA's origins extend back over four decades to the negotiation of the James Bay and Northern Quebec Agreement (JBNQA) which was signed in 1975. Since its incorporation, COTA has been active in the development of tourism in Eeyou Istchee. Its mandate, in accordance with Sections 28.4 and 28.6 of the JBNQA, is to: "(1) Provide marketing, booking, and promotion services, for Cree outfitting and tourism operations; (2) Provide business, management, accounting and professional services to Cree outfitters and tourist businesses; and (3) Conduct feasibility studies related to the establishment of individual outfitting or tourism facilities or a network of outfitting or tourism facilities" (COTA 2016, 6). In fulfillment of this mandate, COTA is committed to targeted action in three specific areas: (1) Fostering air access to Eeyou Istchee; (2) Helping operators create market-ready tourism products; and (3) Marketing and promoting the region and facilitating bookings with the establishment of a destination management company" (COTA 2017).

The idea of the polar bear viewing project were three or four years in the making. For example, in the fall of 2010, COTA organized a meeting with a tourism operator (Arctic Kingdom), Cree outfitters, managers, and Dr. Harvey Lemelin, a tourism researcher with the School of Outdoor Recreation, Parks & Tourism at Lakehead University, to discuss plans for a polar bear tourism site assessment in Eeyou Istchee (James Bay) (Lemelin and Dickson 2012). Following that meeting, an exploratory 6-day trip was organized in early spring 2011, which included two international tourists accompanied by the tourism operator and Dr. Lemelin. The objective of the trip was to "assess and determine" the viability of a polar bear viewing tourism project in James Bay (Ibid.,186). During 4 days of aerial viewing along the coast of James Bay and Southern Hudson Bay, only 1 polar bear was spotted. A subsequent 2-day trip on snow mobiles revealed fresh polar bear tracks near Wemindji, however no polar bears were observed. Lemelin et al. (2012) therefore concluded that winter polar bear viewing is not viable in James Bay. In the summer of 2012, COTA hired local Cree guides to visit South Twin and Cape Hope Islands, with the aim of assessing the number of polar bears available for viewing at that time. While we were unable to get details of that site assessment, the results led to a decision by COTA to avoid focusing exclusively on polar bear viewing; instead this would be one component of a broader tourism strategy (COTA-ArcticNet Meetings, 2014).

A strategic business plan commissioned by COTA for the development of a "Coastal Route Project" in Eeyou Istchee focused on the tourism potential of the coastal area between Waskaganish and Whapmagoostui in James Bay and actions required to achieve its tourism potential (Perron, 2013). The report identified several potential tourism products, including coastal tours, a fur trade route, beluga viewing and polar bear wildlife viewing. In June of 2013 COTA presented this tourism strategy to the Eeyou Marine Region (EMR) boards[1], Wildlife Board (EMRWB), Planning Commission (EMRPC) and Impact Review Board (EMRIRB), with the objective of starting a conversation about how to align their strategy with the boards (personal communication with COTA in 2016). Since the boards at that time had just been established and the James Bay tourism project was the first project proposed for Eeyou Istchee, the EMR boards

[1] EMRWB is mandated "to manage and regulate wildlife of the offshore and harvesting." (EMR, n.d., p. 2);
EMRPC is mandated to "guide the development of planning policies, priorities and objectives" (EMR, n.d., p. 2)
EMRIRB reviews project proposal from an "eco systemic and socio-economic impacts" perspectives (EMR, n.d., p. 2)

recommended that COTA defer their presentation of the project to a later time. This would allow the EMR Boards time to have the processes in place to adequately address this proposal (personal communication with EMR representative, 2016)[2]. In a letter addressed to COTA on June 12th 2013, the Band Council of the Cree Nation of Wemindji, under former Chief Rodney Mark, expressed concerns about the economic viability and ecologically soundness of the initiative. Although at this point the wildlife viewing project was in the feasibility stage, the Wemindji leadership urged COTA to conduct an impact assessment related to the polar bears and a feasibility study for the economic viability and sustainability of the project, particularly given the extent of the financial investments that would be required to support the project.

At the time of writing, Wemindji Tourism, an organization under Tawich Development Corporation, the economic arm of the Cree Nation of Wemindji, was in the process of submitting an application for funding from the Wemindji Band Council and Tourism Quebec (the provincial ministry of tourism) to purchase a 36-foot Zodiac boat with a covered deck and seating capacity for 8-12 persons (personal communication with Wemindji Tourism, 2017). This vessel will be used for the coastal tours[3], as part of the James Bay tourism strategy, providing visitors with opportunities to visit the shores of James Bay and the near shore islands. Marine captain trainings were completed in August 2016 and involved 2 Wemindji residents. According to Charlene Wawatie, a representative from Wemindji Tourism, community members have been informed of the tourism project and the Elders consulted on at least three occasions about the proposed tourism project. She also mentioned that the Elders did not voice any objections. Since Twin Islands are part of the Eeyou Marine Region, an impact assessment is required (personal communication with Eeyou Marine Wildlife Board) and ultimately permission is needed from the EMRIRB to carry out commercial activities in eastern James Bay. The mandate of the EMRIRB is to screen development projects to determine whether an impact review is necessary and recommend whether a project should go forward and under what circumstances.

[2] During the Wemindji Annual General Meeting in 2015, I met representatives of the EMRWB. During a conversation they mentioned that they were still getting organized and their offices were not ready yet.
[3] The coastal tour is another component to the tourism strategy in James Bay as proposed by COTA. Visitors will be taken on the boat along the coast of eastern James Bay.

1.3 Research Objective

The purposes of this research is to contribute information on the tourism proposal by addressing two different aspects of the project: (1) it avails of geospatial technology to provide a preliminary population survey of the polar bears that can inform an assessment of the economic viability and likely wildlife impact of the project: (2) it uses semi-structured interviews with community members to document local perspectives on the project, including local assessments of potential benefits but also local concerns.

This research addresses four main areas 1) a review of three main bodies of literature: tourism in a community context; wildlife viewing tourism; and polar bear populations and behavior; 2) a preliminary assessment of the abundance and location of polar bears on North and South Twin Islands; 3) documentation of different perspectives on the proposed project, including local community members, local and regional businesses, and scientists; and 4) consideration of factors that should be considered in response to concerns and opportunities identified through the literature review, population survey, and consultations with interested parties.

The implications of these findings are significant not only to Wemindji, but potentially other communities that are considering tourism, especially wildlife viewing. While communities and community members are heterogeneous the factors and considerations in similar tourism projects may resonate with the Wemindji context. This thesis project will contribute to the existing literature providing factors and considerations for a sustainable polar bear viewing project in the Wemindji context.

1.4 Context of the research

The reason for choosing to conduct research in the field of tourism in a community context was based initially on a personal interest. Born and raised in Suriname, I have observed the local ecotourism industry grow throughout the years. With limited to no studies conducted on ecotourism in Suriname, my interest was to inform and build awareness of the degree to which local communities benefit (or not) from this arrangement from an economic perspective and the

social impacts that followed. Due to a change in my personal situation, the opportunity to conduct this research in Suriname as originally intended fell through.

At the same time, a tourism project was receiving growing attention in the James Bay context. My supervisor, aware of my interest in tourism and some parallels between James Bay and the Suriname context, suggested the Wemindji polar bear project as an alternative case study. With a development history resembling that of Suriname, notably the construction of a hydro dam without the prior consent of local communities, followed by the degradation and loss of ancestral lands, James Bay provided an excellent alternative field site. Furthermore Dr. Mulrennan has strong research connections in the region and was already involved in conversations with the Wemindji leadership about local interest in the proposed project.

1.5 Organization of the thesis

This thesis follows a manuscript-based format and in comprised of 4 chapters and an appendix. Based on the format of the thesis, the manuscripts (chapter 3 and 4) borrow from other parts of the thesis, hence some duplication is unavoidable. Chapter 2 covers the literature review examining tourism including ecotourism, wildlife viewing and community based tourism, and polar bear population and behavior. Chapter 3 follows, the first manuscript, which is focused on methods for conducting a preliminary polar bear population assessment availing of satellite imagery and an unmanned aerial vehicle (UAV) or drone on North and South Twin Islands. This manuscript will be submitted to the Polar Biology journal for review. Chapter 4 (manuscript 2) also intended for publication, will be submitted to The Northern Review, and is the results chapter from the semi-structured interviews with Wemindji community members regarding the polar bear tourism venture. The Wemindji community council and COTA are notified about our intentions to publish and their feedback is solicited.

Chapter 2: Literature Review

2.1 Polar Bear

Major uncertainties exist concerning the overall population size (Dowsley, 2007; Tyrrell, 2006) and projected population trend (Obbard, 2008) of the polar bear. It is estimated that the worldwide population is between 20,000 and 25,000 (Obbard et al. 2010); approximately 970 bears are estimated for the Southern Hudson Bay sub-population (SH) which is one of the 19 distinct subpopulations of polar bears in the world (Thielmann et al, 2008; see figure 1 in appendix). According to the International Union for Conservation of Nature (IUCN), 3 of these sub-populations are in decline (Baffin Bay, Kane Basin, S. Beaufort Sea), 6 are stable (Davis Strait, Foxe Basin, Gulf of Boothia, N. Beaufort Sea, S. Hudson Bay, Western Hudson Bay) and 1 is increasing (M'Clintock Channel). There is insufficient data for the remaining 9 sub-populations (IUCN Polar Bear Status Report, 2015). A defining characteristic of the SH bears is that they are forced to go onshore during ice-break up period and remain there for 4 to 5 months until the ice freezes (Stirling, Lunn, Iacozza, Elliott, & Obbard, 2004).

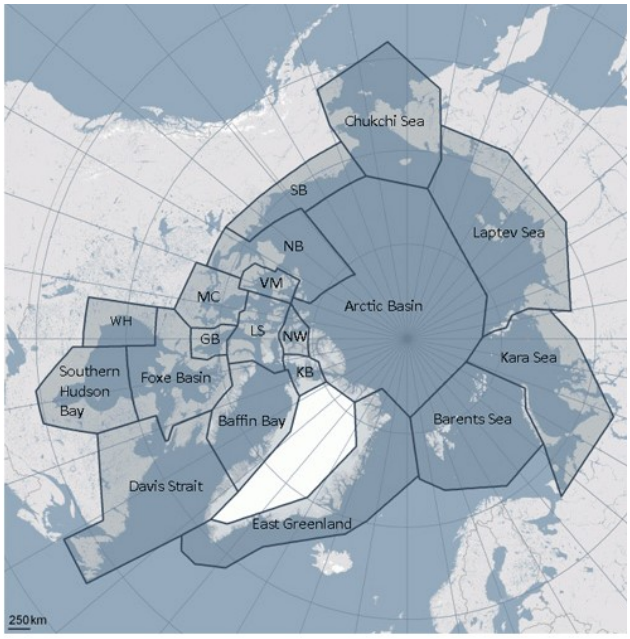

Figure 2.1: Polar Bear sub populations map
Source: IUCN website (http://pbsg.npolar.no/en/status/population-map.html)

The islands of James Bay, with a polar bear population estimated between 70 – 110 (Obbard, 2008), fall under the Southern Hudson Bay subpopulation and are home to a lesser known, quite distinctive sub-population of bears that comprise the most southerly population in the world. This subpopulation shows some degree of genetic difference. Studies conducted on the genetic structure of the SH polar bears have revealed that one genetic structure exists in the northern part of the Hudson Bay (Foxe Basin and Davis Strait) and three in the southern part (Crompton, Obbard, Petersen, & Wilson, 2008). Based on the latter, southern Hudson Bay is considered to have three breeding groups; one in the south west of the Hudson, another in the East and one in James Bay (ibid). According to Crompton et al. (2008), although the James Bay breeding group could be included as a separate management unit in in Hudson Bay(in addition to SH, FB & WH), based on a high gene flow of polar bears between the different breeding groups, the current structure should remain but the James Bay subpopulation should be monitored closely.

Although the polar bears of James Bay exhibit many commonalities with those of Southern Hudson Bay as a whole, including a significant terrestrial phase during the annual cycle (Obbard, 2008), terrestrial maternity dens (Jonkel, Kolenosky, Robertson, & Russell, 1972), and an opportunistic foraging pattern (Russell, 1975), there are distinct characteristics inherent in James Bay polar bears. They are opportunistic feeders with a diet consisting of marine algae, vegetation (grass, mosses, lichen, and berries), beluga carcasses, and birds and eggs from waterfowl (Obbard, 2008; Rockwell & Gormezano, 2009; Russell, 1975). Bear scat revealed that over half of their diet consists of bird remains (Russell, 1975). Scavenging alone cannot explain this concentration of bird consumption in the polar bear diet. Several studies and direct observations have revealed that polar bears actively prey on birds (Russell, 1975; Stempniewicz, 1993). Noteworthy is that James Bay's Twin Islands are a migratory habitat for birds (Latour et al., 2008). In addition to preying on birds, polar bears on the islands of James Bay consume crowberries, juniper berries and cranberries, an amount that is more significant in the diet of polar bears who visit the islands than those on the mainland (Russell, 1975).

Currently, the polar bears on North and South Twin Islands are undisturbed due to their distant location from the mainland, and a lack of interest from the Cree community historically in harvesting polar bears. However, polar bears have recently been observed closer to the inshore islands of James Bay increasing the potential for encounters with humans. Human disturbance could have potential adverse effects ranging from a slight increase in body temperature to

metabolic rate increase of 80%; even the slight increase in body temperature could potentially cause energy and weight loss (Linnell, Swenson, Andersen, & Barnes, 2000). Female polar bears are more sensitive to disturbances during the fall period resulting in abandonment of their denning area (ibid.). Averaged distances traversed by female polar bears that have abandoned their dens in Hudson Bay have been documented between <20 km to just over 60 km (Lunn, Stirling, Andriashek, & Richardson, 2004) demanding significant energy and reducing the chances of survival of unborn cubs (Linnell et al., 2000).

2.2 Tourism

According to the United Nations World Tourism Organization (UNWTO), tourism is the fastest growing industry in the world with an annual revenue of US$1030 billion and 990 million visitors in 2011 (Newsome, Moore, & Dowling, 2012). Visitors are opting for less traditional destinations and often the natural environment is the main attraction (ibid.). Natural area tourism, as defined by Weaver (2008), takes place in the natural environment with the focus on conservation. This type of tourism accounted for about 20% of total tourism receipts in 2011 (ibid.) Natural area tourism encompasses (1) geotourism; (2) adventure tourism; (3) ecotourism; and (4) wildlife tourism (Newsome et al., 2012). Geotourism involves visiting geo-sites for appreciation and education (ibid.). Some examples include viewing of volcanic eruptions or a walk in a nature park to view certain rock formations. Adventure tourism is centered on activities that cater to thrill seekers in the wild and consists of a wide spectrum of activities labeled either as “soft” or “hard”: “Soft” activities refer to those activities where the risks to the visitors are minimal while “hard” refers to activities with a higher level of risk to the participants (ibid.). This includes activities such as mountain climbing and rafting. For the purpose of this paper, the focus is on ecotourism and wildlife tourism.

2.2.1 Ecotourism

According to Weaver (2008), although the term “ecotourism” started to appear in the 1980s, this form of tourism had already been practiced prior to this date. Donohoe and Needham (2006) argue that the lack of consensus in definitions of ecotourism has led to confusion among managers and planners in the operations of such ventures. Harrison (1997:75) has argued that ecotourism has gradually become a buzzword for tourism activities involving nature. Newsome et

al. (2012) note that invoking the ecotourism label is more often a marketing tool. In their work analyzing the many ecotourism definitions, Donohoe and Needham (2006, p. 204) contends there should be key elements present in order to qualify as ecotourism: “nature-based product”, “preservation or conservation”, “environmental education”, “sustainability”, “distribution of benefits”, and “ethics and responsibility”. Critics of ecotourism argue that it has not provided the benefits to the host community it claims: instead inequitable benefit sharing where only a few elite or external stakeholders benefit is common (Pretty & Smith, 2004), and too often the community has no saying in making decisions and conservation results are reduced by too many visitors (Coria & Calfucura, 2012).

Weaver (2008) explains that ecotourism has moved from a "form or type" of tourism to an "approach" to tourism (Weaver, 2008 p6). He further mentions that the approach could be either a "minimalist to a comprehensive" approach. A minimalist approach would encompass tourism activities where there is minimal education whereas the latter would mean there is a more in depth learning experience for the visitors (Weaver, 2008). According to Weaver (2008) there are key characteristics which are necessary for a tourism activity to be considered an ecotourism venture. This includes being a financially sustainable nature-based activity where the outcome fosters learning and protection of the environment and at the same time is socio-culturally beneficial to the host community.

2.2.2 Wildlife Viewing Tourism

Wildlife viewing tourism is defined as tourism involving the observation of wildlife whether by only passively viewing, feeding or touching wildlife in a captive or semi captive environment or in the wild (Higginbottom, 2004; Newsome, Dowling, & Moore, 2005). Wildlife tourism covers a wide spectrum from insects, crustaceans, fish, reptiles, birds to mammals. It is recognized to be one of the most rapidly growing outdoor activities in the world (Higham & Luck, 2007; Newsome, Dowling, & Moore, 2005, Reynolds & Braithwaite, 2001). Wildlife tourism can be further classified as wildlife hunting (consumptive) and wildlife viewing (non-consumptive). There is a dichotomy between consumptive and non-consumptive tourism. Tremblay (2001) in a reaction to the general literature on wildlife tourism argues that labelling an activity to be “consumptive” creates a perception that these activities typically involve the removal or killing of wildlife whereas non-consumptive activities refer to encounters where humans engage with

wildlife without affecting it permanently or without purposeful removals. The focus of this thesis is on wildlife viewing from a non-consumptive perspective. Non-consumptive use of wildlife tourism has expanded dramatically since the 1970s and is now a major contributor to tourism revenues (Duffus & Dearden, 1990).

Lemelin and Dyck (2008), in a review on polar bear tourism in Canada, US, Norway and Russia suggest there is a global acceptance of bear viewing, resulting in a demand for this type of wildlife viewing tourism. Viewing occurs in various ways throughout the world: from large tundra buggies or helicopters in Churchill Manitoba; from cruise ships in the archipelago of Svalbard, Norway (Maher & Lemelin, 2011); from tour buses in Denali National Park; and from boats in Kermode in British Columbia (Lemelin & Maher, 2009). Churchill, Manitoba known as the "polar bear capital of the world" is renowned for polar bear viewing activities (Lemelin, 2006). Viewing occurs in the Churchill Wildlife Management Area (CWMA) and the Wapusk National Park where large tundra vehicles traverse the sub-arctic environment transporting tourists to view the bears (ibid). However, a study by Linnel et al. (2000) conducted on black, brown and polar bears in North America and Europe concludes that the disturbance from recreational vehicles (i.e. snowmobiles) can impact the bears resulting in the permanent abandonment of the denning area and increased cub mortality. A study by Dyck and Baydack (2004) in Churchill, Manitoba counters this finding. Instead they found that the vigilance of sub-adult polar bears slightly increases with the presence of humans. In Churchill, tundra vehicles with a seating capacity of 20 to 25 carry about 18 tourists at a time on seven hour trips, encountering 5 to 10 polar bears and passing 10 to 15 other tundra transporters (ibid). According to Tyrrell (2006) these vehicles have caused damage to the local environment and habituated the polar bears to human presence.

2.3 Community Based Tourism (CBT)

Community based tourism (CBT) is defined as a community participation process where all interested parties are involved in the decision-making process (Okazaki, 2008). Koster (2007) suggests that CBT is a bottom-up approach in the planning and development of a tourism venture which includes locals in the planning process in a meaningful way. Haywood (1988, p. 106) further states that community participation is the process of involving all interested parties including local government, community members, architects, developers, business community and planners whereby decision making is shared. CBT includes the local community that controls the

development. When community is involved in the planning, there is likely to be a fairer flow of benefits, and the inclusion of resident values (Tosun, 2000).

The Cree Village Eco Lodge (CVEL) in Ontario and the Spirit Bear Lodge in British Columbia are two examples of indigenous developed and managed businesses in Canada. The lodges were established in a community based context (Lemelin, Koster, & Youroukos, 2015). CVEL, a 20-room lodge styled as the traditional long teepee, is located on the shores of the Moose River. This project, which was initiated by the MoCreebec Council, opened its doors in the summer of 2000 (ibid.). A local non-profit organization is responsible for managing the lodge and the profits generated from this venture are re-invested into local projects (ibid.). While the focus is on hospitality and food, cultural interpretation and guiding services are provided by local Cree tour operators (Cree Village Ecolodge, 2017). CVEL has won several awards and designations for their success and their commitment to the environment (Lemelin et al., 2015). The second example is the Spirit Bear Lodge, a 12-room lodge with high ocean-view windows providing a view of the waterfront and forest. The Kitasoo Development Corporation (KDC), the economic arm of the Kitasoo/Xai'xais community, completed construction in 2006 with funding from the Kitasoo Band Council (ibid.). With an operational budget of $1 million, the lodge is now managed by the Kitasoo/Xai'xais First Nation (ibid). Community members are hired through a training and placement program (ibid.). The Spirit Bear Lodge has been featured in various magazines, including National Geographic

In applying CBT theory against practice in Marathon, Ontario, Koster (2007) argues that although there is a strong demand for tourism in rural areas, traditional tourism planning should not be viewed as a panacea for communities since much criticism have been levelled against this approach (i.e. planning issues, seasonality of the tourism industry and low paying jobs). Community participation is not without criticism. In applying the community based tourism model on a local community in Palawan Philippines, Okazaki (2008) argues that community based tourism is time consuming. Addison (1996) argues that barriers need to be broken down concerning the lack of education, business know-how, financial resources and conflicting interests of communities. In their discussion of ways to resolve community-related issues in tourism, Jamal and Getz (1999) argue that although a person has the right to participate, he or she must also have the capacity to take part. Being a member of a committee, requires that participants have an agenda and contribute to negotiations as well as raise issues of concern. Someone with no exposure to

these demands may feel intimated and lose out on negotiations Often times it's the government that hold this power and may not consider local residents as their equal partner in a project (Gray, 1985). This problem is compounded when residents don't have an expectation of what is required regarding participation (Joppe, 1996).

Okazaki (2008) argues that although the aforementioned barriers exist, CBT is still the best approach. The author further notes that disapproval from local residents could potentially create an unwelcome environment for tourists (Pearce, 1994). The image of the host community is important to tourists which includes that of the people, infrastructure, cultural events and natural environment (Wahab & Pigram, 1997). When the community is involved, the public will protect assets that contribute to the tourism industry (Felstead, 2000). Koster (2007) further suggests that communities must focus on a product-led approach rather than a market-led approach in terms of providing attractions to visitors since the former is focused on developing attractions, activities and services that will be "better integrated with minimal impact to the development process and society" (Inskeep, 1991 in Koster, 2007, p. 78). A market-led approach is based on providing attractions, facilities and services for which the tourism market may show an interest (Inskeep, 1991 in Koster, 2007).

2.4. Human and Non-Human Interaction

Wildlife has played an important part in the life of humans; from domestication of wildlife to a need for close contact to keeping pets that are more exotic wildlife (lizards, snakes, large invertebrates). According to Newsome et al. (2005, p. 2) our interest in animals has broadened over time. The human and non-human relationship takes on many different forms: a source of food, clothing and shelter, companionship, scientific and medical research, entertainment and sport, and connection with the spiritual world (Newsome et al., 2005, p. 1). Bentrupperbaumer (2005) suggests that many factors informing the human-wildlife relationship are psychological in nature and notes that many authors (e.g. Kaplan and Kaplan, 1989; Kellert and Wilson, 1993; Ulrich, 1993) agree that it is an innate instinct of humans to enhance their chances of survival. Bentrupperbaumer (2005, p. 84) argues that the term "biophelia", coined by socio-biologist Edward Wilson (1984), confirms the notion that the "human had a particular characteristic to pay attention to, affiliate with, and respond positively to nature". He further notes that this notion has many supporters as well as critics and proposes another view based on the idea that humans

respond to nature by innate and experiential forces: “human perceptual and cognitive tendencies are innately prescribed” whereas “affective tendencies are experientially prescribed”.

According to Newsome et al. (2005), research shows that mammals rank at the top of the list of human preferences, followed by birds with reptiles being much lower. Different types of animals are viewed in different ways by humans with different responses: these animals are seen either as dangerous, large, cuddly or harmless; anthropomorphic in their behavior or being intelligent (Newsome et al., 2005). Duffus & Dearden (1990, p. 218) argue that the demand for human wildlife contact has been influenced by the influence humans have on wildlife and their habitat of domesticating them as well as the “cultural conditioning of perceptions” over the centuries. According to Bentrupperbaumer (2005) the universally accepted classification of the different interactions between humans and non-humans is as follows: domination (animals are inferior to human); utilitarian (animals are viewed as a benefit to human); moralistic (there is consideration for animal welfare); and protectionist (humans are aware of the value of animals and have a responsibility to protect their survival) views.

Chapter 3. Manuscript 1[4]

A view from afar: Applying geospatial technology to assess polar bear abundance on North and South Twin Islands in James Bay, Quebec

Abstract

Geospatial technologies hold significant promise for improving wildlife monitoring, particularly in the context of northern latitudes experiencing impacts from climate change. To assess their utility, we conducted a preliminary survey of the polar bear population of North and South Twin Islands in James Bay, northern Quebec, using two approaches: (1) satellite imagery; and (2) an unmanned aerial vehicle (UAV). The first approach used image differencing to identify polar bears against a darker background. The results provided a useful snapshot of the population. The second approach, involving a feasibility study of UAV technology at the southern tip of South Twin Island, found that operating a UAV in an exposed high wind setting such as James Bay is challenging. The UAV data did however show that there were no polar bears within a radius of 200 m from the shore. On the basis of this study, satellite imagery was found to be an effective approach to quickly and easily establish a preliminary population count. However, the accuracy of this approach depends on the topology of the landscape and image quality (i.e. cloud coverage). Smaller UAVs, such as the one used in this study, are unstable and unreliable in extreme weather conditions. However, a larger and more robust UAV seems likely to be able to handle such conditions and provide accurate data at relatively low cost and with minimal disturbance to wildlife.

Keywords: Unmanned aerial vehicle (UAV), satellite imagery, polar bear, geospatial technology, James Bay, North and South Twin Island.

[4] This manuscript will be submitted for review to Polar Biology

1. Introduction

Arctic sea ice loss has accelerated during the last decade (Comiso, Parkinson, Gersten, & Stock, 2008; Stroeve et al., 2012; Stroeve, Holland, Meier, Scambos, & Serreze, 2007) with the most rapid periods of ice melt in September (Serreze & Stroeve, 2015). This has opened up economic opportunities tied to year-round maritime passage, tourism and increased access to natural environments and resources (Melia, Haines, & Hawkins, 2016; Serreze & Stroeve, 2015). However, longer ice-free months and increased commercial and industrial activities could have major deleterious impacts, especially to ice obligate species in the region (Laidre et al., 2008, 2015). Understanding the responses of wildlife to these various threats is essential to their effective management and protection, and this understanding depends on the availability of reliable information based on monitoring and survey data.

Arctic wildlife are typically monitored using aerial-based surveys and capture-recapture programs (Eberhardt, Chapman, & Gilbert, 1979; Garner, Amsrup, Laake, Manly, & McDonald, 1999). The challenges with these methods are the high cost and lack of precision in the data to accurately detect a trend in abundance (B. L. Taylor, Martinez, Gerrodette, Barlow, & Hrovat, 2007), compounded by the inaccessibility and remoteness of the Arctic. The lack of accurate data has at times resulted in debates and uncertainty about the status of wildlife populations, including assessments of population decline that are not consistent with the knowledge and observations of northern indigenous hunters (Dowsley 2007). Hence methods that can improve the accuracy and availability of wildlife population data are much needed.

This paper addresses the potential of geospatial technologies to contribute to improved wildlife monitoring in northern contexts. It focuses on an assessment of two methods which involved relatively low investments of time and resources, compared to more conventional methods of aerial survey and capture-recapture survey. The first approach involved the use of satellite imagery while the second availed of a UAV. The assessments were conducted on a small sub-population of polar bears, representing the most southerly population of polar bears in the world, that inhabit North and South Twin Islands in James Bay, northern Quebec. Although recent studies (Obbard et al., 2015) have estimated the regional population count of these bears, there is limited data available for these particular islands during the ice-free season. Our goals for this assessment were modest. In the first study, we availed of satellite imagery to obtain a snapshot, including population count and location (inland or shoreline) of the polar bear population on the

Twin Islands during the ice-free season. In the second study, we assessed the feasibility of a UAV for monitoring polar bears, specifically the number and location of bears, on South Twin Island. Our findings confirm the utility of satellite imagery for a preliminary assessment of the presence/absence of polar bears whereas the UAV feasibility study demonstrated that small lightweight drones are not suitable for research in areas with high winds.

We begin with a brief overview of the current status of the polar bear population in James Bay. This is followed by an account of the various surveying methods used to assess wildlife populations, including conventional aerial survey and capture-recapture techniques as well as very high resolution (VHR) imagery and surveys using UAV technology. A description of the study area and the methods used in the two studies conducted as part of this research project follows. The results of both studies are then provided, followed by a discussion and conclusion.

2. Polar bear population status

Polar bears are currently listed by the International Union for Conservation of Nature (IUCN) as a vulnerable species (IUCN 2015). It is estimated that the worldwide polar bear population is between 20,000 and 25,000 (Obbard, Thiemann, Peacock, & DeBruyn, 2010). While the distribution of polar bears is international in scale, the population is divided into 19 subpopulations (See Figure 2.1 for polar bear subpopulation map). Subpopulations are defined as "spatial units where population dynamics are mainly influenced by intrinsic vital rates" (M. K. Taylor et al., 2001, p. 691). Major uncertainties exist concerning the population size in most of the 19 subpopulations (Dowsley, 2007; Laidre et al., 2015; Tyrrell, 2006) and projections of population trends of polar bears are contested (Obbard, 2008).

Polar bears that inhabit North and South Twin Islands in James Bay are part of the Southern Hudson Bay (SH) subpopulation. Although the SH number has stayed relatively stable since the mid-1980's, a decline in body condition and survival rate has occurred in the same period which could potentially affect polar bear abundance in the long term (ibid.). Obbard et al. (2015) conducted a line transect aerial survey of the SH polar bear subpopulation during the ice-free season (late September) of 2011 and 2012. The survey included inland areas of Ontario (extending up to 60 km inland), Akimiski Island, and large offshore islands in 2011; the 2012 survey included small islands, James Bay and Eastern Hudson Bay. An estimated 943 polar bears were identified as part of the SH subpopulation (ibid.). A supplementary survey conducted of the polar bear

population within James Bay (including North and South Twin Islands) and along the Eastern Hudson Bay coast resulted in an estimate of 83 polar bears (ibid.). This is consistent with a previous study (using a capture-recapture method) which estimated the population as being between 70 -110 bears (Obbard, 2008). A major polar bear survey of the SH subpopulation was carried out in September 2016, led by polar bear scientist Dr. Martyn Obbard (Ontario Ministry of Natural Resources and Forestry). There were 29 polar bears observed on and near the Twin Islands (9 bears on South Twin Island and 15 on North Twin Island) (Obbard, unpublished).

While sea ice loss is expected to continue at an accelerated pace, there is some uncertainty about the response of polar bears to that change. For example, there is speculation that the SH population as a result of being forced to remain on land longer waiting for the ice to freeze will experience a more drastic loss of body condition and population decline than more northern populations (Derocher, Lunn, & Stirling, 2004; Stirling & Derocher, 2012). Others suggest that a marked difference in depth of water and hence ice conditions between eastern and western James Bay could result in healthier individuals and populations on North and South Twin Islands (Colin Scott, personal communication). There is consensus that the response of this southern-most population of bears to climate change and other factors should be closely monitored.

3. Polar bear surveying methods

Surveying of polar bears has traditionally been undertaken by field and aerial survey. In field surveys, the capture-recapture method is a two-step sample method. In the first step a sample of bears are captured, counted, tagged and released. The second step involves bears being captured again and based on the number of reoccurring individuals in the sample, an estimation of the population is obtained. The capture-recapture method provides accurate data on individual bears (e.g. weight, sex, age) that is important for researchers to understand certain trends related to polar bear condition and behaviors. Unfortunately, this method also has its challenges; it is time consuming, costly, and dangerous.

Aerial survey allows researchers to count polar bears, and provides an opportunity for a quick snapshot of the population over an extensive area. This method is also costly, time consuming, and involves complex logistical arrangements. It also does not provide the same level of detail as field surveys.

In recent years, satellite imagery has been used to conduct polar bear population counts. Availing of very high resolution (VHR) satellite imagery to support image differencing, Stapleton et al. (2014) conducted a polar bear population survey in Foxe Basin, Nunavut. The accuracy of his method was subsequently verified by ground-truthing using aerial survey, which confirmed that the satellite imagery was as accurate as the latter (Stapleton et al., 2014). This increased accuracy of satellite imagery has been made possible through advances in VHR imagery (GeoEye at .41m panchromatic and Worldview at .31m panchromatic). Previous studies availing of satellite imagery to assess wildlife population abundance include assessments of penguins (Barber-Meyer, Kooyman, & Ponganis, 2007; Fretwell & Trathan, 2009; Witharana & Lynch, 2016) and seals (M. LaRue et al., 2011). These studies indicate that VHR imagery is cost effective and allows access to remote areas without disturbing wildlife. However, cloud coverage and the presence of certain topographical features can affect the results. Additionally, VHR imagery does not provide any wildlife vital data (see table 1 for a comparison of the different population survey methods).

As UAV or drone technology has become more cost effective and technologically more advanced (including the reduced noise of the motors and increased range achieved) it has become more attractive to use than manned aircrafts (fixed wing or helicopter) (Christie, Gilbert, Brown, Hatfield, & Hanson, 2016). The low operating costs and reduced noise level allow for repeat surveys with minimal or no impact to wildlife (Anderson K & Gaston K.J, 2013). Applications of UAV include: terrestrial wildlife count-based estimates of abundance (e.g. water birds and wildlife refuges, white pelican breeding colonies, snow goose and Canada goose) and monitoring of marine mammals (e.g. birthing, haul-out areas) (Chrétien, Théau, & Ménard, 2016; Christie, Gilbert, Brown, Hatfield, & Hanson, 2016; Getzin, Wiegand, & Schöning, 2012; Gonzalez et al., 2016). Stapleton (2014) experimented with drone technology to monitor polar bears in Churchill, Manitoba. The results were heralded as promising for future applications (ibid.). However, UAV application is currently limited by its flight range and regulatory framework (Christie et al., 2016). State flight regulations demand that UAVs stay within line of sight when in operation. Additionally, UAV are susceptible to extreme weather conditions i.e. high winds and rain (see table 1).

METHOD	COST	ACCURACY	WILDLIFE DISTUR-BANCE	RISK	CHALLENGES	TIME	REFERENCES
Capture-recapture	Very costly	Accurate (provides vital information i.e. year, weight, sex).	Yes	Yes: wildlife & researcher	Susceptible to bad weather; accessibility to remote locations	Intensive	(Eberhardt et al., 1979; Garner et al., 1999)
Aerial survey	Very costly	Accurate, however vital information is limited	Yes	Yes: researcher	Susceptible to bad weather	Less intensive compared to capture-recapture	(Eberhardt et al., 1979)
Analyzing satellite imagery	Cost effective	Accurate, however no information on vital statistics	None	None	Cloud coverage or topographical features could potentially affect analysis	Less time needed to analyze imagery	(M. A. LaRue et al., 2015; Stapleton et al., 2014)
Unmanned Aerial Vehicle (UAV) or drone	Different price ranges. High initial investment; logistical cost. Less resources needed.	Accurate, however vital information is limited	Limited to no disturbance	Yes: researcher	Susceptible to extreme weather conditions; government regulation.	Time consuming, ideal for small areas and repeat research.	(Chrétien et al., 2016; Christie et al., 2016; Getzin et al., 2012; Gonzalez et al., 2016)

Table 3.1: Comparison of wildlife population surveying methods

4. Study Area

North and South Twin Islands are located about 60 km offshore from Wemindji in the central east coast of James Bay and separated from each other by 10 km of open water. The two islands have a total surface area of 301 km² and a combined coastline of 93 km. They are recognized as an important breeding and denning site for polar bears, and an internationally significant waterfowl nesting site (ibid.). Several important designations have been conferred on North and South Twin Islands: they are an Important Bird Area (IBA) site (NU034) (IBA Canada, n.d.); a Category IV protected area under the IUCN; a key migratory bird terrestrial habitat site of the Canadian Wildlife Service; and an International Biological Program (IBP) site. The islands were declared a wildlife sanctuary in 1939 under the North West Territories (NWT) Wildlife Act. Administrative responsibility for the sanctuary was transferred in 2003 to Nunavut (M. Mulrennan, Bussières, & Scott, 2009). Since 2010, the islands have fallen within the jurisdiction of the Eeyou Marine Region (EMR) offshore agreement, which includes provisions for the governance and protection of the islands. The signing of the EMR agreement has triggered the interest in establishing a marine protected area (MPA) in James Bay led by the Cree Nation of Wemindji in collaboration with two other James Bay Cree communities (Chisasibi and Eastmain); the regional government body, the Grand Council of the Crees; and in partnership with university researchers at McGill University, Concordia University, and the University of Manitoba (Mulrennan, Bussières, and Scott 2009:).

Figure 3.1 Location of North and South Twin Island, James Bay

5. Material and Methods

This study was conducted as part of the requirements of a thesis-based MSc research project undertaken by the first author, under the supervision of the second author. The population assessments reported here were carried out in response to a request from the Wemindji Cree First Nation for information that would assist the community in a decision regarding approval of a proposed tourism project that would center on tourists being taken by marine vessel from Wemindji to the Twin Islands to view polar bears during the ice-free months of July to September. The population assessments were undertaken by the first author in collaboration with the Cree Outfitting and Tourism Association (COTA), the regional Cree tourism entity responsible for developing the proposed project. Since polar bear viewing is proposed to take place from aboard a marine vessel, the population assessment was focused on the number of bears as well as their location (distance inland), since their potential for viewing depended on their proximity to the shoreline. The analysis of the satellite imagery was carried out between February and March 2016. The UAV feasibility study was conducted in July, 2016.

5.1 Satellite Imagery Analysis

VHR satellite imagery (0.5m resolution) was purchased through a grant provided by the DigitalGlobe Foundation. Archival imagery of North and South Twin Islands was chosen based on the time during which: (1) snow or ice was not present; and (2) cloud coverage was minimal (<10%). Based on the available archival footage and the above criteria, images of North Twin Island (August 2009 and September 2013) and South Twin Island (July 2012, and June and October 2015) were analyzed.

Following Stapleton et al (2014), a technique referred to as image differencing was applied. According to this technique if a dot is present in both the target and reference image, it is considered a permanent physical feature. A white dot of about 2 m (when measured using the ArcGIS[5] "measure" tool) is considered a polar bear if it is present in the target image but absent (at the same location) from the reference image. Preparation of the images consisted of applying a histogram stretch to brighten the dark areas to allow easier recognition of lighter dots. Each set of images (target and reference) was divided by a grid where each cell of about 7.5 x 7.5 cm in

[5] ArcGis Desktop Map 10 software was used to view imagery

size was analyzed separately. This process was then inversed where the target became the reference image and vice versa. This resulted in receiving a reading from both images. For example, in image A below (the target image) there is a white object (about 2 m in size) present that is absent in image B (the reference image). Additionally, since there is no evidence of foam or ice in the image it is concluded that the white object is not a permanent feature of this landscape, hence this object is assumed to be a polar bear. Yellow arrows represent permanent features.

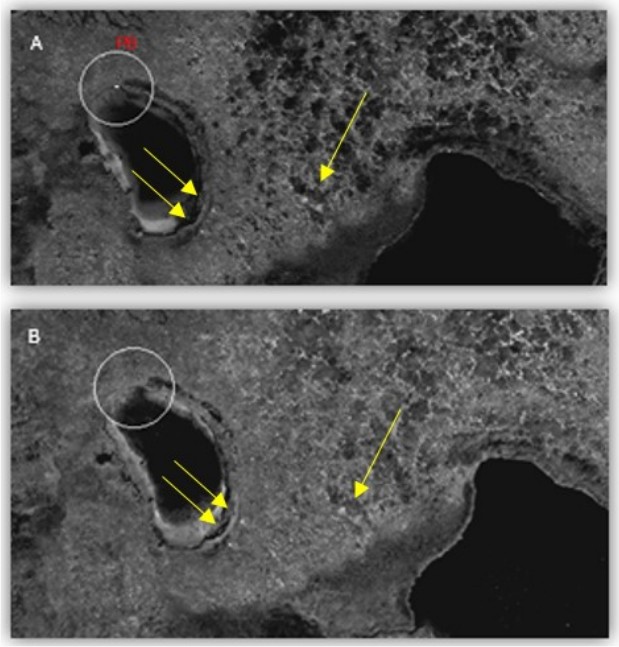

Figure 3.2
Example of high resolution satellite imagery used to detect polar bears. Imagery provided by DigitalGlobe Foundation The images are of North Twin Island, James Bay, Quebec during late summer 2013 (A) and 2009 (B), where (A) is the target and (B) the reference and vice versa. White dot in image A represents a polar bear since a dot is absent in the reference image.

5.2 UAV

A DJI Inspire 1 UAV was purchased with funding provided by COTA[6]. The UAV was chosen based on: (1) usability; (2) cost; (3) camera capability; and (4) stability (see Table 5 in appendix for UAV specifications). Purchased items included: the UAV and remote control, 11 battery packs, charging hub, two sets of additional rotors and an iPad mini. A fishing boat with a length of about 10 meters long with 2 outboard motors was used to transport the team. On July

[6] COTA is the regional Indigenous Cree tourism organization, which has developed a tourism strategy for the eastern James Bay Cree communities.

15th, 2016, the research team consisting of Ernie Hughboy (captain), Chuck Matches (guide), Charlene Wawatie (Wemindji Tourism, representative) and Tariq Hossein (researcher) set out for South Twin Island.

The intended method involved launching the UAV aboard a marine vessel and following it while circumnavigating North and South Twin Islands. According to this plan, the UAV would have been launched and directed up to 100 m inland and subsequently retrieved onboard the vessel, at strategic points to recharge the UAV by changing the battery. The onboard launch and retrieval of the UAV was intended to limit the need for landing on the islands and potentially disturbing the bears. However, the proposed method fell through because of choppy seas that compromised the stability of the boat making it impossible to launch the UAV from onboard.

This prompted a decision to launch the UAV on the shore at the most southern point of South Twin Island (53.065882, -79.924687). The UAV was successfully launched to a height of 60 m and a distance of 100 m inland. The quality of the camera resolution provided an additional 100 m of viewable distance through live video stream from 60 m height, resulting in a total viewable distance of 200 m from the launch point (see Figure 3). Rotating the camera 360 degrees horizontally (panning) provided a viewable range with a radius of 200 m through the live video stream. The UAV was directed at various points with a radius of 100 m from the launch point. Manipulating the camera and operating the UAV in windy conditions resulted in the battery charge lasting about 30% less than when operated in favorable weather conditions. Two (2) batteries were used which provided a total flight time of 25 minutes. Towards the end of the second launch, the UAV system activated the auto recall landing function[7] to return to the launch point when it landed abruptly, likely due to the force of the high winds. This resulted in the camera platform dislodging from the UAV. Due to time constraints and deteriorating weather conditions, the UAV could not be repaired on site forcing the research team to abandon the operation.

[7] This function is activated when the battery has just about enough charge to return to the launch point. The guiding system returns the UAV via autopilot to the launch point.

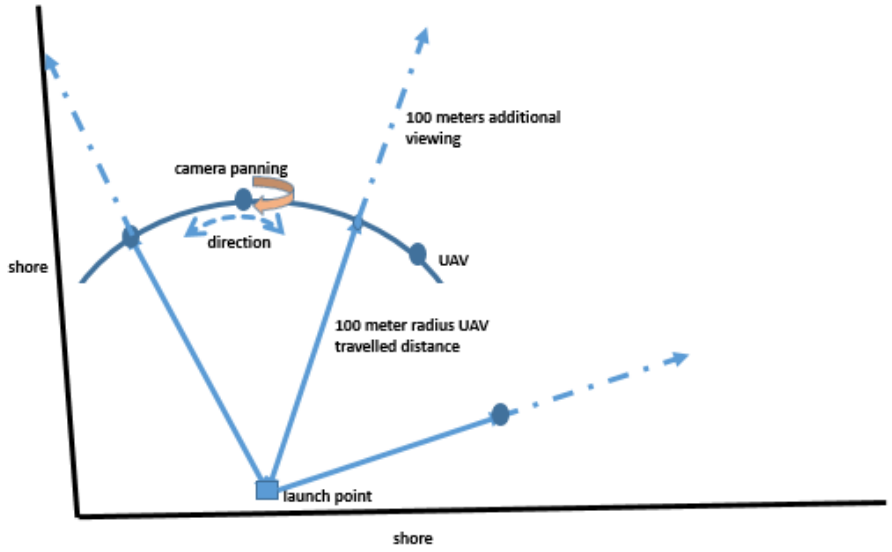

Figure 3.3: Illustration of UAV distance and direction travelled, additional viewing area, and camera panning.

6. Results

6.1 Satellite Imagery Analysis

An estimated equivalent total surface area of 750 km² was analyzed. Although the majority of the images provided almost full land coverage of the islands (see Table 1 in appendix), cloud coverage and topographical features rendered certain parts unavailable for analysis. Some parts of the imagery contained white sand or white rocks on the shore, which made it challenging to distinguish between a polar bear or a physical feature (see Table 2 in appendix). The total time to analyze and confirm the analysis took approximately 30 hours. The following results were obtained (see Table 3.5 below). All the images analyzed indicate that polar bears were present on North and South Twin Islands on the dates the images were taken. As explained above, particular attention was given to the relative location of bears as COTA was interested to assess the extent to which polar bears are potentially "viewable" for tourists.

North Twin Island

[06-Aug-2009] Five (5) polar bears were identified during this time snapshot. All the bears were inland in the southern half of the island. Three (3) polar bears were identified meters apart from each other on the south-western coast about 1 km from the edge of the island.

[27-Sep-2013] Seven (7) polar bears were identified during this snapshot of the island. An adult and cub (~ 1 m in length) were identified on the southern edge of the island. Four (4) other polar bears were identified at the southern part of the island of which two (2) were together. One (1) polar bear was identified on the west side of the island.

South Twin Island

[31-Jul-12] Seven (7) polar bears were identified: three (3) polar bears were identified on the eastern edge. The other four (4) bears were located inland (two (2) in the south: one (1) in the middle; and one (1) in the north-west of the island).

[7-Jun-15] Again, seven (7) polar bears were identified; all polar bears were inland spread across the island with one (1) in the south; two (2) in the middle; and three (3) in the north).

[26-Oct-15] Four (4) polar bears were identified, all were inland on the northern half of the island.

Extensive sections of the shoreline were not taken into consideration during analysis due to the areas being covered by rocks and lighter colored sand. These made it challenging to distinguish a white dot potentially representing a polar bear. Since these areas are likely to be favorable habitat for bears to congregate, this limitation potentially resulted in an underestimate of the numbers of bears present

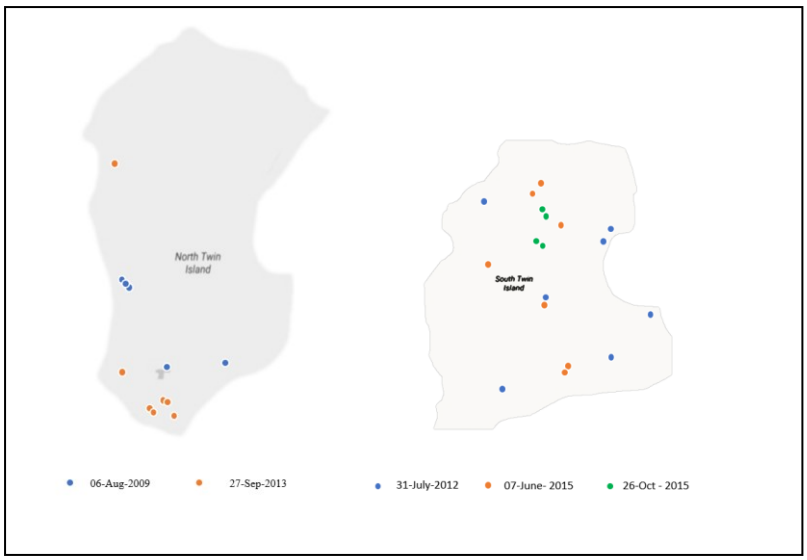

Figure 3.4 Location of identified polar bears on the North and South Twin Island

LOCATION	*DATE*	*POLAR BEAR COUNT*
North Twin Island	6-Aug-09	5
	27-Sep-13	7
South Twin Island	31-Jul-12	7
	7-Jun-15	7
	26-Oct-15	4

Table 3.2 Results of polar bear count on both Twin Islands of all images analyzed

6.2 UAV

The total flight time of the UAV was about 25 minutes. The UAV camera provided live video stream during operation which was used to locate any polar bear in real time. Pictures of an area of about 31400 m² were taken, which included the shore and inland parts. No polar bears were identified from the live video stream (through the iPad) or from the pictures taken. After about 30 minutes on South Twin Island, the research team decided to abandon the operation since the weather had changed for the worse.

7. Discussion

Our findings support the potential for enhanced use of geospatial technologies in wildlife population monitoring. Preliminary results from our analysis of VHR satellite imagery confirmed the presence of polar bears on Twin Islands during the ice-free summer months of 2009, 2012, 2013, and 2015. Since the images provide a limited number of snapshots of the Twin Islands, no particular pattern could be established in terms of the number and/or location of the polar bears. Furthermore, while the satellite imagery provided easy and quick access to polar bear data, there are limitations to this method. Since these were archival images, the authors had no control over the quality of the available images. As a result, cloud coverage in certain images made some areas unsuitable for analysis, a limiting factor in VHR imagery that could alter the

results LaRue et al., 2015; Witharana & Lynch, 2016). Additionally, topographical features (e.g. areas covered by light colored sand and rocks along the shore) also excluded some areas from the analysis further limiting its value (LaRue et al., 2015). Despite these shortcomings, VHR imagery provided an opportunity for the authors to conduct a quick and cost effective preliminary population assessment. An additional advantage was the option of acquiring archival imagery to generate polar bear population snapshots for earlier years.

The particular UAV used in this study was unstable and challenging to operate in the field, confirming the observations of others regarding the limitations of small UAVs when operating in severe weather conditions (Christie et al., 2016). Additionally, the battery rapidly ran out of charge while the UAV attempted to stay stable and operational. It seems likely that a higher-end, more robust UAV would withstand the conditions encountered (Christie et al., 2016), and these are quickly becoming available at more affordable prices. While the UAV has a flight range of 2 km, it was operated within line of sight (~100 m), hence reducing its potential. A high-end UAV could potentially be a viable tool for more comprehensive wildlife population assessment, however current regulations severely limit the optimal use of drones in this field (Christie et al., 2016; Smith et al., 2016).

8. Conclusion

Access to VHR satellite imagery will potentially increase its applications in the wildlife research field. VHR imagery allows researchers to safely and cost effectively conduct research in extensive and remote areas. Image differencing (LaRue et al., 2015; Stapleton et al., 2014) can be used to identify large mammals other than polar bears that have a distinguishing color from their surroundings i.e. a black dot (i.e. moose, reindeer) on a white background i.e. snow. However, currently VHR imagery is not at the stage where it can be used as the only method for monitoring or assessing wildlife populations (LaRue et al., 2015). Topographical inconsistencies and cloud coverage could potentially affect the results. Hence, for polar bear population assessment, the application of VHR satellite imagery is suitable for the more southern areas of the polar bear habitat where the snow melts during the summer season. Additionally, manual processing time can be high and semi-automated processing may result in too many false positives which ultimately compromises the quality of the results (LaRue et al., 2015).

On the other hand, the use of UAVs is potentially valuable for smaller areas and for repeated survey. UAV technology has advanced in recent years. As the cost continues to decrease it is likely that it will be more and more widely applied in research. For research in harsh weather conditions, high end drones are potentially more capable of withstanding such conditions. Although capable of covering larger areas, current state regulations are an impediment to fully benefit from the technological advances in UAV. The modification of regulations applied in remote and restricted research contexts would allow researchers to optimally benefit from the potential of UAV technology. As wildlife populations come under increasing pressure, particularly in the context of climate change in northern settings, the value and urgency of rapid population survey techniques will surely increase.

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Chapter 4. Manuscript 2[8]

Local Cree Perspectives on Polar Bear Wildlife Viewing in Wemindji

Abstract

Wildlife tourism may hold promise as an economic development opportunity for northern indigenous communities. In addition to providing a much needed supplementary source of revenue, potential benefits include the employment of community members in land-based activities that enhance cultural identity and social well-being, support inter-generational knowledge transmission and facilitate cross-cultural exchange. The extent to which wildlife tourism delivers on its promise is not well documented and tends to privilege the perspective of external experts over those of community members. Furthermore, a fuller appreciation of community expectations, concerns, and (mis)understandings is often lacking at the outset of a project with implications for its long-term success and acceptance. In this paper we examine a proposed tourism project centered on polar bear viewing and involving the eastern James Bay Cree community of Wemindji, northern Quebec. The proposal, as put forward in 2013 by the Cree Outfitting and Tourism Association (COTA) – a non-profit organization tied to the Cree Nation Government – characterizes the project as a "sustainable tourism project". At the invitation of the Wemindji leadership, we documented the perspectives of community members on the proposed project, in addition to soliciting input from polar bear biologists, particularly regarding the likely impact of the project on the polar bears. Semi structured interviews, conducted over the summer of 2015, revealed that while community members anticipated some project benefits, they also had concerns, some of which were countered by the biologists, but all of which should be fully acknowledged and considered before a final decision at the community level is taken on whether this project should proceed.

[8] This chapter will be submitted to The

1. Introduction

Many rural and indigenous communities are actively seeking alternative economic development opportunities to replace or supplement their reliance on resource extractive industries. Tourism offers a potentially attractive option because of the range of socio-economic benefits it can provide, particularly to remote Indigenous communities. The benefits from tourism include the development of businesses (Reggers, Grabowski, Wearing, Chatterton, & Schweinsberg, 2016); creation of job opportunities (Buultjens and Gale 2013; Coria and Calfucura 2012; Zeppel 2006; Zapata et al. 2011); an alternative to extractive industry employment and infrastructure creation and/or improvement (Butler & Hinch, 2007); empowerment (Shikida A et al., 2010); conservation of the environment (Lepp & Holland, 2006); and tourism as a reconciliation platform (Higgins-Desbiolles, 2003). Benefits attributed to land-based activities (i.e. hunting, fishing, harvesting, natural resource management, ceremony) include the enhancement of capacity, and improvement of the relationship between the youth and the elders (Hunt, Altman, & May, 2009); transmission of knowledge from the elders to youth and an "increased sense of confidence and identity" (Altman 2010).

Although tourism holds promise in terms of the benefits to the host community, in reality these don't necessarily materialize or at least not for the whole community i.e. inequitable benefit sharing where a small elite group or external stakeholders benefits from tourism (Coria & Calfucura, 2012); a dependence on visitors, shift from communal values to individualism and disparities within and between communities (Reggers et al., 2016); low wages and employment opportunities mostly during the tourism season (Jamal & Getz, 1999); and limited participation from communities (Wellings, 2007).

A project premised on the inclusion of all relevant interested parties in the development of tourism could potentially increase the likelihood of success. Such approach is commonly known as community based tourism (CBT). It is predicated on a bottom-up approach, involvement of the local community, equitable benefit sharing and the inclusion of community values (Blackstock, 2005; Tosun, 2006). CBT enterprises have provided benefits in the form of income diversification and empowerment of local communities (Shikida A et al., 2010; Zapata et al., 2011). According to Dodds et al. (2016), a successful tourism project depends on the presence of several key elements including the cohesiveness of community members at the outset

of the project. CBT is an approach that can apply to a range of different forms of tourism, including wildlife viewing tourism. Wildlife viewing tourism is defined as a tourism carried out to observe wildlife whether by only passively viewing, feeding or touching wildlife in a captive or semi captive environment or in the wild (Higginbottom, 2004; Newsome, Dowling, & Moore, 2005).

The extent to which community-based wildlife tourism delivers on its promise of benefitting host communities is not well documented and tends to privilege the perspective of external experts over those of community members. Additionally, a fuller appreciation of community expectations, concerns, and (mis)understandings is often lacking at the outset of a project (step zero) with implications for its long-term success and acceptance. In this paper, we examine the experience of the James Bay Cree community of Wemindji with a proposed polar bear viewing project. Our case pays particular attention to the documentation of local perspectives, especially at the early stages of project development. Our involvement was in response to an invitation from the Wemindji leadership to contribute information to assist their understanding and ultimately their decision to support or block the project. As such our role is to document the perspectives of community members rather than to present an argument in support or against the proposed project. Our findings reveal that while many of the community members interviewed recognized the socio-economic benefits of this wildlife tourism project, they also have concerns about its viability. While some of their concerns are countered by scientific experts, opportunities for a sharing of perspectives are needed as well as a commitment by the project proponent to hear local concerns and take them seriously before a decision on whether this project should proceed is taken.

We begin by providing a description of the study area, followed by an account of the methods used. An overview of the proposed polar bear viewing project is then presented. The next section documents the perspectives of community members on the project, followed by a discussion which connects the findings to gaps in the literature concerning wildlife viewing from a community perspective. We conclude by providing recommendations.

2. Study area: Cree Nation of Wemindji

The Cree Nation of Wemindji is one of ten Cree communities in Eeyou Istchee (James Bay), northern Quebec. The village of Wemindji is located on the central east coast of James Bay and has a population of about 1400 (Statistics Canada, 2011), 965 of whom are over the age of 15 (INAC, 2011). Community members engage in a hybrid economy characterized by a mix of traditional and contemporary livelihoods. A limited number are fully engaged in fishing, hunting, and trapping, while others alternate between wage-labor employment and the pursuit to land-based activities during weekends and free time (Sayles and Mulrennan, 2010). The maintenance of this connection to the land is regarded as a crucial to intergenerational knowledge transmission, Cree cultural identity, and the overall health and wellbeing of Cree people (Grand Council of the Crees, 2012).

Within Eeyou Istchee, multi-family hunting territories (traplines) are overseen by a senior hunting boss or tallyman ("*uuchimaau*" in Cree) who is responsible for the sustainable and productive use of the land (Scott, 1986). Values of respect, reciprocity and sharing underpin a system of resource use and environmental stewardship. Along the coast these hunting territories extend to encompass the waters, islands and shoals of the nearshore area.

Wemindji is served by an elected Band Council which is the official representative and decision-making body of the Cree Nation of Wemindji. However, the approval of the *uuchimaau* and community elders is sought by the community on all significant matters, particularly those relating to land, development and community well-being. Wemindji territory falls within the terms of the James Bay and Northern Quebec Agreement (JBNQA), signed in 1975, as part of a land claim settlement between the Government of Canada, and three Quebec Crown Corporations, the Grand Council of the Crees, the Northern Quebec Inuit Association, and the Government of Quebec. The agreement was closely tied to the development of hydroelectric energy on the traditional territory of the Crees. A subsequent agreement, the Eeyou Marine Region Land Claims Agreement, signed in 2010 addresses Crees rights and interests in the offshore area of Eeyou Istchee, known as the Eeyou Marine Region (EMR). This agreement acknowledges Cree ownership and of the marine territory where the Crees have traditionally occupied and used.

Wemindji has been subjected to numerous social and environmental changes in recent decades, many of them tied to large scale hydroelectric development, mining and expansion of

the regional infrastructure. The James Bay Project ("Project de la Baie-James"), the first phase of which began in the 1970s, resulted in the rerouting of major rivers within Eeyou Istchee and the flooding of traditional hunting lands and ancestral burial grounds (Chevalier, Dumont, Langlois, & Penn, 1997). The discovery of gold in more recent years has spurred further interest in resource extraction in the region as reflected in the large number of exploration permits issued by the government of Quebec (Mulrennan, Mark, and Scott 2012). Goldcorp Inc. currently operates the Eleonore Mine located 200 km south east of Wemindji. This development is a source of income and opportunity in the form royalty fees and employment but also of concern, particularly in relation to contamination of local waterways.

Cree apprehension about further expansion of industrial scale development, linked in part to Québec's Plan Nord (Plan Nord Action Plan 2015 - 2020, n.d.), have prompted a number of regional and local conservation initiatives. These include a Cree Regional Conservation Strategy launched in October 2015 by the Cree Nation Government (Cree Nation Government, 2015). At the local level, the Wemindji Cree Nation has led the successful establishment of a biodiversity reserve on two important watersheds in the southern part of the territory, and is behind a proposal under consideration by the Grand Council of the Crees and Parks Canada to establish a National Marine Conservation Area in adjacent offshore (Mulrennan et al., 2009; 2012). These initiatives are intended to block large scale development and protect the cultural and ecological heritage of these areas while offering opportunities for sustainable tourism development. It is in this context that a polar bear viewing project has been proposed by the COTA.

3. Methods

This study was conducted as part of the requirements of a thesis-based MSc research project undertaken by the first author, under the supervision of the second author. Semi-structured interviews were conducted by the first author with 16 members of the Wemindji community during a two-week visit in August 2015. Following the field research, 3 additional community members were interviewed (2 in Montreal; 1 via phone). Community members were initially identified by the second author who has a close working relationship with the Wemindji community. Others were then recruited using a snowball sampling method (Goodman, 1961). Community members were chosen based on their potential business ties, knowledge of polar

bears and interest in the proposed project. Several of those interviewed had overlapping roles and expertise within the community; for example, Henry Stewart is a director at the Wemindji Public Works department, a hunter and also a part-time guide; Elmer Georgekish is a band councilor and hunter; George Kudlu, is an Inuit hunter and long-term resident of Wemindji. He is also a holder of much knowledge of and experience with polar bears. Community members were interviewed for their perspectives on the potential socio-economic and ecological impacts of the proposed tourism project. With a few exceptions, community members consented to their names being used in the study.

Following the interviews with Wemindji community members, 2 prominent scientific experts were asked for their perspectives on the potential impacts of the proposed project on the polar bears and also on the viability of the proposed project in terms of the bears being present in sufficient numbers and close enough to the shore to be viewable from a marine vessel. A phone interview was conducted with Dr. Martyn Obbard, a research scientist with the Ontario Ministry of Natural Resources and an adjunct professor at Trent University in the department of Environmental and Life Sciences. His research focus is on population dynamics and effects of climate change on polar bears. A questionnaire survey was completed by, Dr. Ian Stirling, an Adjunct Professor in the Department of Biological Sciences at the University of Alberta. With over 37 years of experience with the Canadian Wildlife Service, Dr. Stirling has studied the effects of climate change on polar bears of Western Hudson Bay.

4. Polar Bear Viewing Project

A tourism project centered on polar bear viewing was formally proposed to the Wemindji Community Council in June 2013. The proposal was submitted by the Cree Outfitting and Tourism Association (COTA), a non-profit organization, incorporated in December 2000 under Part II of the Canadian Corporations Act. COTA's origins extend back over four decades to the negotiation of the James Bay and Northern Quebec Agreement (JBNQA) which was signed in 1975. Since its incorporation, COTA has been active in the development of tourism in Eeyou Istchee. Its mandate, in accordance with Sections 28.4 and 28.6 of the JBNQA, is to: "(1) Provide marketing, booking, and promotion services, for Cree outfitting and tourism operations; (2) Provide business, management, accounting and professional services to Cree outfitters and

tourist businesses; and (3) Conduct feasibility studies related to the establishment of individual outfitting or tourism facilities or a network of outfitting or tourism facilities (COTA, 2016, p. 6). In fulfillment of this mandate, COTA is committed to targeted action in three specific areas: (1) Fostering air access to Eeyou Istchee; (2) Helping operators create market-ready tourism products; and (3) Marketing and promoting the region and facilitating bookings with the establishment of a destination management company" (COTA, n.d.).

The idea of the polar bear viewing project were three or four years in the making. For example, in the fall of 2010, COTA organized a meeting with a tourism operator (Arctic Kingdom), Cree outfitters, managers, and Dr. Harvey Lemelin, a tourism researcher with the School of Outdoor Recreation, Parks & Tourism at Lakehead University, to discuss plans for a polar bear tourism site assessment in Eeyou Istchee (James Bay) (Lemelin and Dickson 2012). Following that meeting, an exploratory 6-day trip was organized in early spring 2011, which included two international tourists accompanied by the tourism operator and Dr. Lemelin. The objective of the trip was to "assess and determine" the viability of a polar bear viewing tourism project in James Bay (Ibid.,186). During 4 days of aerial viewing along the coast of James Bay and Southern Hudson Bay, only 1 polar bear was spotted. A subsequent 2-day trip on snow mobiles revealed fresh polar bear tracks near Wemindji, however no polar bears were observed. Lemelin et al. (2012) therefore concluded that winter polar bear viewing is not viable in James Bay. In the summer of 2012, COTA hired local Cree guides to visit South Twin and Cape Hope Islands, with the aim of assessing the number of polar bears available for viewing at that time. While we were unable to get details of that site assessment, the results led to a decision by COTA to avoid focusing exclusively on polar bear viewing; instead this would be one component of a broader tourism strategy (COTA-ArcticNet Meetings, 2014).

A strategic business plan commissioned by COTA for the development of a "Coastal Route Project" in Eeyou Istchee focused on the tourism potential of the coastal area between Waskaganish and Whapmagoostui in James Bay and actions required to achieve its tourism potential (Perron, 2013). The report identified several potential tourism products, including coastal tours, a fur trade route, beluga viewing and polar bear wildlife viewing. In June of 2013 COTA presented this tourism strategy to the Eeyou Marine Region (EMR) boards[9], Wildlife

[9] EMRWB is mandated "to manage and regulate wildlife of the offshore and harvesting." (EMR, n.d., p. 2);

Board (EMRWB), Planning Commission (EMRPC) and Impact Review Board (EMRIRB), with the objective of starting a conversation about how to align their strategy with the boards (personal communication with COTA in 2016). Since the boards at that time had just been established and the James Bay tourism project was the first project proposed for Eeyou Istchee, the EMR boards recommended that COTA defer their presentation of the project to a later time. This would allow the EMR Boards time to have the processes in place to adequately address this proposal.

In a letter addressed to COTA on June 12th 2013, the Band Council of the Cree Nation of Wemindji, under former Chief Rodney Mark, acknowledged that the wildlife viewing project was only at the feasibility stage. However the former Chief Mark raised several issues concerning the project as proposed. These included: 1) a need for the existing proposal to take account of all available scientific studies on the status and behavior of polar bears; 2) any efforts to monitor and evaluate the impact of this tourism project on the polar should be informed by best practices and expert knowledge; 3) realistic financial targets should be set for the proposed project informed by certain basic information about the status of the polar bear population and/or the viability of the project in terms of the number of bears available to support a polar bear viewing excursion; and 4) community investments in and/or commitments to the supporting infrastructure for this project should be delayed until the sustainability of the project is confirmed. Former Chief Mark suggested that a comprehensive review of the project, informed by local and science-based knowledge, was needed to fully evaluate the sustainability of the project on environmental as well as social and economic terms. Until this was completed, he recommended that any decision on the project, as well as any related field-based activities that could impact the bears, be postponed.

In recent weeks, Wemindji Tourism, an organization under Tawich Development Corporation which is the economic arm of the Cree Nation of Wemindji was in the process of submitting an application for funding from the Wemindji Band Council and Tourism Quebec (the provincial ministry of tourism) to purchase a 36-foot Zodiac boat with a covered deck and seating capacity for 8-12 persons (personal communication with Wemindji Tourism, 2017). This

EMRPC is mandated to "guide the development of planning policies, priorities and objectives" (EMR, n.d., p. 2)
EMRIRB reviews project proposal from an "eco systemic and socio-economic impacts" perspectives (EMR, n.d., p. 2)

vessel is to be used for the coastal tours[10], as part of the James Bay tourism strategy, providing visitors with opportunities to visit the shores of James Bay and the near shore islands. Marine captain trainings were completed in August 2016 and involved 2 Wemindji residents. According to Charlene Wawatie, a representative of Wemindji Tourism, community members have been informed of the tourism project and the Elders have been consulted on at least three occasions about the proposed tourism project. Wemindji Tourism further noted that the Elders did not voice any objections. Since Twin Islands are part of the Eeyou Marine Region, an impact assessment is required (personal communication with Eeyou Marine Wildlife Board) and ultimately permission is needed from the Eeyou Marine Region Impact Review Board (EMRIRB) to carry out commercial activities in eastern James Bay. The mandate of the EMRIRB is to screen development projects to determine whether an impact review is necessary and recommend whether a project should go forward and under what circumstances. At the time of writing the EMRIRB was awaiting a formal proposal from COTA about the tourism project; this step would formally initiate the process of project approval under the guidelines established by the EMRLCA (personal communication with EMR representatives, 2016)[11].

5. Results: Community Perspectives on polar bear viewing tourism in Wemindji

A majority of community members interviewed anticipated that tourism would bring benefits to the community, including a supplementary source of employment income, a boost to the local economy, and a way of showcasing Cree culture.

- Twin islands are not regularly visited – indeed few of the people interviewed had ever been out to the Twin Islands; not significant places for hunting
- polar bears are not well known to Crees – limited quota of 3 bears for all of the coastal communities and these are generally only used if a polar bear becomes a threat or nuisance

[10] The coastal tour is another component to the tourism strategy in James Bay as proposed by COTA. Visitors will be taken on the boat along the coast of eastern James Bay.
[11] During the Wemindji Annual General Meeting in 2015, I met representatives of the EMRWB. During a conversation they mentioned that they were still getting organized and their offices were not ready yet.

- in the last 5 years, there have been 2-3 bears seen closer to the coast which seems to have raised local concerns about safety.
- There has been talk of tourism for more than a decade and some small scale tourism projects, specifically by the Danyluk family. Important in preparing community for this project

Many had concerns about the project, specifically a lack of infrastructure to support the venture; the risks and logistical problems associated with unpredictable weather; concerns about polar bears following the boats back to the village; and impacts on the polar bear and other wildlife

A majority of community members mentioned that tourism would provide a much needed source of supplementary income, particularly for young people in the community. "[Tourism] will be nice, create jobs" (Natawapaneskum). Job opportunities as a sea captain for the tour boats and tourist guides were mentioned. One participant, Abraham Matches, also mentioned that the tallymen could be employed to teach the tour guides about the territory since they have extensive knowledge about the area. He explained with respect to the tallymen, "they know the islands more than anyone here. The tourists would have questions about the islands. The tourist guides would work with the tallymen, [they would] ask them about the islands. The tallymen being guides to the tour guides because not all tallymen are comfortable being around tourists".

Others expected that there would be a boost to the local economy through tourists using the grocery store, hotel and restaurants. "Well it will help the economy with people staying at the hotel and, buying at the grocery, the gas station. Other tourist attractions probably will benefit for other people that want to stay a bit longer (Henry Stewart). Several residents mentioned that revenue can also be generated by selling local arts and crafts. Brigitte Kakabat, who makes lamps in the form of a teepee, mentioned that she looks forward to selling these to visitors.

In addition to these benefits, several community members anticipated that tourism would be a mechanism to support Cree culture since ceremonies could be enacted that are no longer being performed or are only performed at a reduced scale. One participant noted that the youth is not exposed enough to the Cree culture: "They [youth] have two hours of Cree culture and then have a goose break". Meaning they don't spend enough time outdoors. Offering a cultural

experience to visitors would provide more opportunities for the youth to be out on the land. Additionally, this could be an opportunity for the elders to teach the youth about their culture. The same participant mentioned that: "A lot of people think that the draw of tourism is polar bears…the draw of tourism is us as a culture, as traditional people of this land here…that's the sell. Having people together interested showcasing that. It's a promotion locally. One of the things we want to sell is our culture. Go hunt geese, trap beaver, sleep in the teepee". Fred Blackned, an elder and former Chief also mentioned that he would like to see the project go through "so that the people know more about James Bay, and the polar bear. If someday tourist can make it here, they will think it's an amazing trip. You will here clicks from the cameras".

Several community members were concerned about focusing the tourism project on polar bear viewing. According to George Kudlu, a long-term Inuit resident and hunter, mentioned that "the way I see it, tourism is not ready. Need to have things for the people to look at. Teepee is not enough". Elder Nancy Danyluk, proposed that "In addition to polar bear tourism there should be other activities". Elmer Georgekish, also an elder, holds a similar opinion. He believes that the community could provide activities such as paddling to the islands and perform "the walking out ceremony" to attract tourists. Others identified additional natural attractions that are likely to be of interest: "It will be good especially for tourists that would like to go sightseeing. Even the Asians want to come. They want to see the Northern lights. It would be nice to have tourism in the community…even people from down south they love to go out on the islands for sunset, birds". (anon) Fred Blackned mentioned "the plants that grow there [in the south] are different from the ones that grow here".

In addition to benefits identified above, the community members interviewed also had concerns. Eight out of the 19 Wemindji residents noted that the overall infrastructure required for tourism in Wemindji is currently not in place. Two community members mentioned that the current capacity of the local hotel is limited and that if there is a community event, such as a wedding or funeral, the hotel would be stretched to its limits. Henry Stewart was concerned that if the project is successful and more tourists come, "Will [we] be able to keep up? … The restaurant won't hold so many people. So in that area we will need to multiply fast". Another resident mentioned "no, we are not ready …we have limited space here for visitors…during the summer this place here is full with construction workers. The development that is happening I

don't think we will be close to capable of housing that many people…" (Earl Danyluk, Jr). Regarding the strain on the services in the community, Henry Stewart was concerned about the impact on public services, "it will affect the garbage and the water usage. People will want to take a shower. We had a shortage with water. Our garbage pickup. Can we withstand another 700 people in the community during the summer months?". He further mentions that "we need a bigger store".

According to the Wemindji Tourism Plan 2015 – 2020, the average occupancy rate in 2014 was 58% with major fluctuations over time due to the seasonality of the construction work in the community. A report by Wawatie and Perron (2015) indicates the majority of hotel clients are construction workers. They further noted in the report that based on the visitor projection for the coastal tours and in the eventuality of polar bear viewing, the capacity of hotel accommodation will be insufficient. The hotel and the restaurant are housed in the same building. Some residents mentioned that the menu which is currently dominated by sausages, bacon, burgers and French fries needs to reflect traditional Cree food. Another resident mentioned that the hours are limited and many times coming to Wemindji around 8 pm at night, no food is available.

The absence of a proper dock was mentioned as an additional infrastructure issue by George Kudlu. According to Kudlu the current dock is not suitable for a passenger boat because there is no easy access to and from the vessel. Another concern was how visitors will reach Wemindji. "How will they be travelling? Travelling by vehicle or flying in? Those are the things that we have to look at. Is there any means of transportation to bring them here and there" (Henry Stewart). The issue of roads was also raised: "people will come if we have the roads. They will be interested in seeing our way of life. You have to build the roads. They don't like the gravel roads. It's not good for the cars". The local leadership is well aware of these issues. Chief Dennis Georgekish acknowledged that there are limits to what the existing infrastructure can cope with. "When you look at economic development of bringing tourism. There is a question of numbers. How many people are we talking about here. How big is it? It's a small community". Another set of concerns related to the viability of the polar bear tourism project. Several community members have concerns about the polar bear population and the chances of viewing the bears. Elmer Georgekish stated that "we don't know how many [bears] are on the islands. I haven't

seen a report saying what amount of polar bears are on these islands". Blackned also underscored the lack of information available concerning the bears: "There has to be a feasibility study to see how many [polar bears] would stay on the island. Where do they go? If they are not there, where are they?" Like many others, he believes . Henry Stewart was more confident about the presence of the bears "sure enough the bear is there". But he also mentioned the uncertainties: "How many bears we have out there we don't know. I don't know if the bear will be there each time. There will be times that the bear will not to be found. The bear will be there on the island". George Kudlu is well acquainted with the behavior of polar nears: "The polar bear can be there today and move next week. They can swim very good. They could follow the boat and swim to Wemindji".

There was also discussion about the likelihood of tourists seeing polar bears once they got to Twin Islands. Georgekish mentioned that "you have to make sure when you take people out there that the visitors get to see them [polar bears]. Kudlu mentioned that "it's not easy to see the polar bears. Sometimes it's easy to see and other times they are not. Polar bears have their territory on the islands". Assuming visitors will set foot on the islands, Kudlu further noted that "polar bear is not easy to look at, a lot danger. It's easy to get there, however you need a guide. There is danger. Sometimes people try to get close and take picture which can pose danger". According to Dr. Obbard, on cooler days it is likely that polar bears will be foraging for food inland, whereas on hot days they will be in the water (personal communication with Dr. Obbard, 2016). Stewart mentioned that every time he visits the Twin Islands, he sees polar bears on the beaches. However, he also mentioned that "the polar bear is camouflaged with the surroundings…he looks like the boulders… you look you don't notice him and you look for 30 mins you don't see anything. He stays there".

Six community members mentioned that the weather is unpredictable in the Bay. Fred Blackned, a local hunter who is very knowledgeable about polar bears and who has taken many trips to Twin Islands, mentioned that "those who run the boats must always be alert on the weather". Another hunter mentioned that "one moment the weather is beautiful and then it turns sour". Talking to others in town, many have mentioned that the weather is always uncertain. The people will look at the river and say, "oh the water must be rough in the bay".

Safety issues were raised as an additional concern by community members. A particular concern was whether the polar bears would follow the tourist boats back to the village. Three participants of which 2 are regarded as local polar bear experts, mentioned this as a concern. George Kudlu, the Inuit hunter, mentioned that "they are hungry…more open sea … more bears will be coming into the communities… I saw 7 bears and about 2 to 3 more… this is not supposed to happen …this is unbelievable". Kudlu was referring to the bears being hungry due to them not being able to hunt for seals in the open water. Polar bears are now seen closer to the coast, which was not common in the past. "They are hungry ... If they are hungry, polar bears will attack. If they have cubs, they will attack as well (Blackned). He also mentioned that "polar bears are coming closer to the coast, because they are hunting. Looking for food. They are destroying camps. More polar bears are coming closer to the main land". Whether this increase in sightings closer to the community is an increase in the population, he responded with "I don't know, I didn't count the polar bear. Nobody knows" (Blackned). Another participant mentioned that sometimes he is very concerned for those hunters and trappers that go alone to their camps and doesn't want to think about the consequences if a polar bear is near their camp. He further mentioned that "when you start tourism maybe the polar bear will follow the boat and come to the islands. The bears come to the Solomon Islands, they can smell and can come into the community. They are very hungry polar bears and not afraid to come in the community. Last summer I was very afraid and didn't want to walk there [around his camp]. I don't think the polar bear will get scared easily. They are curious. If they see or hear something they will go check it out. It they smell food they will come" (anon).

Dr. Obbard claims that polar bears are unlikely to follow boats back to the village unless they are fed as an enticement for their viewing; if not, they will not associate boats or people with food. He also mentioned that given that the tourism activities will take place during summer months, the polar bears will likely prefer to hunt locally rather than swim long distances. In addition to refraining from feeding polar bears, he suggested that care must be taken not to disturb them.

Concern about the impact of the proposed project on the bears was mentioned by several community members. According to Ernest Tomatuk, while the project is likely to be good for the community, "it's hard to say for the polar bear. It will disturb them. It is a whole different

subject. If we wanna go there [Twin Islands], the first thing is we don't wanna disturb them". Dr. Obbard explained that if done right, the wildlife viewing could have only limited impacts on the bears. However, he cautioned that tour operators may be tempted by visitors to get closer to polar bears which could cause distress for the animals to the point of them getting defensive (personal communication with Dr. Obbard, 2016). Distress can result in an increase in body temperature and/or metabolic rate (Linnell, Swenson, Andersen, & Barnes, 2000; Lunn, Stirling, Andriashek, & Richardson, 2004) which can have detrimental effects on the polar bears, especially during the summer when food sources are scarce.

Dr. Obbard further mentioned that getting close to the polar bears could endanger the visitors if a polar bear attempts to jump in the boat. Blackned mentioned that "before the polar bears were shy when around people because they had a lot to eat. Now polar bear are not shy because maybe they are hungry. The snow is melting fast. Anybody that is watching polar bears, they shouldn't get close". AECO guidelines state that a safe distance of 30 meters must be maintained at all times between the vessel and the bear (AECO Operational Guidelines, 2016). Keeping a safe and tolerable distance, no feeding or antagonizing (AECO Operational Guidelines, 2016) can support a good viewing experience and minimize the impact on the polar bears (personal communication with Dr. Obbard, 2016).

Beyond the safety issues related to the polar bears, some community members expressed safety concerns related to an increase in visitors in the community. Henry Stewart mentioned "the kids they have freedom ..and the vehicle will stop. They play on the streets. If we increase the traffic in here what's going to happen. I don't know if these things were brought up? Angela Stewart's concern was that "a lot of people come into our community. I am sometimes scared seeing strangers in the community. Sometimes we wonder what the people are doing here". One community member mentioned that "I don't mind as long as they [visitors] say hi to me. As long as they don't bring drugs and send the Hells Angels here, bikers. As long as they follow the rules of the community".

Concerns about effects of the project on wildlife and on hunting were mentioned by several community members, particularly those that are hunters. Four participants noted that the depending on the amount of boat traffic generated by the project, the boats carrying passengers to view polar bears could disturb the wildlife (i.e. waterfowl, goose, arctic loon)

and hunting conditions. One participant mentioned that "now in August people start hunting … the [bird] migration is taking place earlier due to climate change". He also mentioned the presence and noise of the boats may affect local goose hunting if the birds' migration path is similar to that taken by the boats. A primary concern for tallymen, according to Abraham Matches, "is to always bring your garbage" and not to disturb hunting activities. "The tallymen when they see the geese start to fly they don't want people to come and go. Sometimes the geese fly to the islands to eat berries and fly back and forth. If tourists are going back and forth, then I'm sure the hunters won't like it". However he added "but I'm sure we can find something" to solve or address this. Stewart mentioned that only if the boats travel along the coast could they potentially have adverse effects on waterfowl hunting. A community member in response to whether the tourism activities will affect hunting mentioned "I don't think so, no one goes that far to hunt. I think it will affect the birds, arctic loons. There are birds that nest in the summer".

Stewart noted that the boats could also affect local fishing: "probably in some areas that the boat travels during the fishing season. People harvest with fishnet during the hunting season in the fall with the birds they won't like the boats running back and forth by their hunting area and where they put their nets. Maybe the nets will be empty with the boats running back and forth". However, he was not sure whether the boat traffic would affect the fishing. Four community members were concerned that the tourism project could potentially impact fishing and hunting. However, Earl and Nancy Danyluk who actively hunt and fish mentioned that fishing is not likely to be affected since nobody goes out in the channel to set their nets. Also several members of the community stated that the boats could potentially disturb the hunt if the path of the boat is the same as that of the migrating water fowls.

Environmental impacts were also mentioned by several community members. Tomatuk mentioned that "the tourism can also affect the water. To get there…let's say the big motor, the 150 hp. You have to spend 10 – 15 gallons. Wemindji to Twins Islands is about 50 km. you will spend almost a drum to go around the Twin Islands. About 45 gallons. That's the big blue drums. For that trip the amount of gas you spend it will go in the water to see the polar bears. Pollution is a concern. It depends how many tourists want to see the polar bear". Another concern is the effects on the birds: "the other thing is it will really affect the wildfowl. We don't know how

many are there at the Twin island". Mark mentioned "there are environmental concerns, however if this is done in small steps, then this should be ok. Overall - bringing tourists in small groups in a very sustainable way. Start the offerings first in the summer. If all is well, then fall, winter".

Many people interviewed spoke of both the positives and negatives and weighted one against the other. Tomatuk mentioned "I guess it will be good for tourism aspect for the community. It will create jobs. Probably it will be very good for the jobs. It's hard to say for the polar bear. It will disturb them. It is a whole different subject. Matches further notes that "it [tourism] may change the way of life. Not everyone is comfortable with visitors, especially the elders. They prefer to be hunting. They'd rather be out there in peace with the land and practice their way of life. But the younger generation, they understand that it will bring opportunities to the community. It will open more doors.". There is also uncertainty in allowing tourism in Wemindji: "I am trying to find out the pros and cons of what they are trying to do" (Tomatuk). Furthermore, there is some confusion where some elders think that the tourists are interested in hunting the polar bears: "tourism is conservation and that's what we're telling them" But many still think we are bringing the tourists to go hunting the polar bears. For this reason many of the elders are not in favor of polar bear tourism (Danyluk Sr.). One participant mentioned that "although not all elders agree with the tourism in Wemindji, the majority of the elders do agree". Blackned, also an elder, mentioned that "I would like to see the project go through so that the people know more about James Bay, the polar bears. If someday tourist can make it here, they will think it's an amazing trip. You will hear clicks from the cameras". Mark notes that "It has to be done in a sustainable manner. We have to make sure visitors have a good reception when they come into the community. As well, we have to make sure that the community is comfortable with the visitors. He is also satisfied with the steps that COTA is taking. "It's going slow, but progress is being made".

6. Discussion

The findings of this study indicate that community members anticipate that the polar bear tourism project will provide economic benefits, however they also have some concerns. They mentioned the potential for new employment opportunities, an expectation that is aligned with the economic benefits mentioned in literature including the development or expansion of existing

businesses, such as food or catering services, to supply goods and services to visitors (Reggers et al., 2016). These benefits could potentially help to dissuade some people from leaving the community to find work outside the community, a trend referred to in the Australian context as 'the emptying out of country' (Altman 2010). Some Wemindji residents have availed of the opportunity to work in the Eleonore Mines (owned by Goldcorp Inc.), about 200 km east of the village. However, residents complain that this takes them away from their families and the community for 10 days – 2 weeks at a time (personal communication with Fred Blackned, 2015). Job opportunities within the community, and particularly those that involve being on the land are highly desired. Land-based practices also have benefits in enhancing local capacity, and improving the relationship between the youth and the elders (Mulrennan 2014).

Hunt, Altman, and May (2009) identified cultural benefits from land-based activities that include the inter-generational transmission of knowledge, increase of confidence levels and higher awareness of identity. Cree participants similarly anticipated that the polar bear project would be an opportunity to offer visitors a cultural experience that could help rekindle the culture within the community in terms of providing and practicing ceremonies that have been forgotten or are no longer practiced.

According to Bennett e al. (2012, 763), infrastructure is an essential physical or built capital asset that supports the ability of "communities to engage in tourism development". Tourism tends to improve existing infrastructure (Butler & Hinch, 2007) but can also place pressure on existing resources, such as during the summer season when the construction workers already use most of the hotel rooms (Wawatie & Perron, 2015). A suitable dock for loading and unloading of passengers is also an essential piece of infrastructure if the project is to go ahead.

Recent population studies of the polar bears on North Twin Island indicate between 5 and 15 (satellite imagery study from previous chapter, Obbard unpublished data respectively); South Twin Island between 4 and 9 (satellite imagery study from previous chapter, Obbard, unpublished data respectively). Although some polar bears were identified closer to the shore, based on the data there is no indication of a preferred location on the island. With a total area of over 300 km² and a shoreline totaling about 93 km, it's challenging to determine where the polar bears will be located at the time of viewing. In a survey conducted by Lemelin (2006) during polar bear viewing trips in Churchill, Manitoba, visitors mentioned that the number of polar

bears and the viewing distance could diminish their experience. Preliminary survey results indicate that polar bears are present in relatively low numbers on Twin Islands. When foraging inland, the chance of viewing the bears is further reduced because of the topography of Twin Islands. The extent to which tourists will be satisfied by the viewing experience remains uncertain. Tourism can potentially have a more profound impact on local resources in small communities. This includes increased water and sewer treatment, garbage collection, health services and food supplies. In northern communities where resources are limited and logistics of replenishing basic goods are complex, any factor of strain can have a profound impact on the available supplies. Careful planning and coordination is required to satisfy the demand from both host and visitors. Currently access to Wemindji is via air or land travel. Air Creebec services the route with daily flights between Montreal and Wemindji (AirCreebec, n.d.). The flight is about 41/2 hours and the price tag is similar to that of an international flight. For a domestic ticket, it is costly and could potentially be a barrier for Wemindji to become accessible as a tourist destination. Accessible by the James Bay Highway, Wemindji is just over 1300 km from Montreal. There is a gravel road of 100 km that connects Wemindji to the James Bay Highway. For those that prefer to drive, from Montreal to Wemindji is a scenic route and can be completed within 2 days. Extra care should be taken on the James Bay Highway.

The weather in James Bay is unpredictable, with conditions changing rapidly over a few hours. Also the weather in Wemindji is not necessarily the same as in the bay. Although the Zodiac may be better equipped to handle the weather, it adds certain risks going out on the bay during bad weather. In case of a sudden storm, there is no shelter between Twin Islands and Wemindji for at least 50 kilometers. In the event of a rescue, the community is not equipped for a search and rescue operation. The search and rescue (SAR) unit from Trenton, Ontario, about 1000 km away which services the James Bay area will provide support (SAR Trenton, 2016). In addition to the weather, the uncertainty of the presence of polar bears on the shores of the islands is also a more critical factor for the success of the project.

While community members may see benefits to polar bear wildlife viewing, they were concerned about the possibility that bears would follow the boats back to the community. Dr. Obbard (in personal communication) has countered this concern. However an increase in local sightings of polar bears on the inshore islands of Temple Island, Moar Bay, and Paint Hills Island

as well as closer to the village, have residents worried. An increased presence of polar bears closer to communities has also been documented on Baffin Bay and western Hudson Bay (Dowsley, 2005; Tyrrell, 2006). Scientific experts attribute this change in behavior to the bears being hungry and attracted by the smell of food and people. Inuit interpret the change as the bears adapting to the environment and suggest that their numbers have increased (Tyrrell, 2006).

In her review of the effects of noise on birds, Ortega (2012) suggests that one of the impacts to noise on birds is stress and fright, which leads to flight and avoidance. Although noise levels led to flight and avoidance for most bird species, very few were able to tolerate the noise (ibid.). If the boats are travelling on the same path as the migrating waterfowl, the latter might choose a different path. However one community member mentioned that only if the boat runs along the coast it may affect the waterfowl and hunting, which is not the case in the polar bear tourism context. The Twin Islands is a designated wildlife sanctuary since 1939 and an Important Bird Area (IBA) site (Mulrennan et al., 2009). These designations reflect the importance of these sites to the birds. Additionally, since the Twin Islands are under the jurisdiction of the EMRLCA, an impact assessment is required (EMR, n.d.)

7. Conclusion

In conclusion, the Wemindji case study provides an opportunity to gather the perspectives of community members at the outset of a wildlife viewing tourism project. The Wemindji case study allows for a unique opportunity to potentially gauge any relationship with the success of the project. According to Dodds et al. (2016), one of the key elements to a potential successful venture is soliciting the perspectives of community members at the outset of the project. Usually in tourism a limited number of community members benefit, whereas the larger community must bear the strain on the local resources. Their expectations, concerns and (mis)understandings should be documented and where possible addressed at this early stage allowing for more buy-in from the community, or at least from most members thereby limiting or avoiding resentment.

Communities may not have the necessary infrastructure in place to host visitors, however, tourism development provides an opportunity to improve on the current infrastructure. Additionally, affordable access to the host community is a factor for the economic viability of such venture. Additionally, access to relevant information is essential for the community to make decisions whether a project will be sustainable given the large investments and potential impacts involved.

Studies have shown that tourism can cause changes in the lives of the host community (Reggers et al., 2016), however being aware of the possible cause and effects could limit undesired outcomes.

Although the community members interviewed are positive about tourism in the community. there are some concerns. The expectations and concerns of the Wemindji community as documented in this paper will need to be taken into consideration before moving forward with the project. Failure to address these points could create misunderstandings and lead to many not supporting tourism in the community.

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Chapter 5. Conclusion

Indigenous peoples are availing of international human and indigenous rights discourses, legislative and regulatory measures, direct action, alliances with other indigenous groups, and a variety of other strategies to assert control of their own affairs for the future well-being of their communities. This is increasingly reflected within Canada in shifts in nation-to-nation governance arrangements, more favorable outcomes from negotiations related to large-scale development, and an openness among some indigenous communities to engaging in new economic enterprises (Mulrennan, 2014). The latter is evidenced by a rise in the number of new Indigenous run businesses in a range of industry sectors across Canada (CCAB, 2016). This includes tourism, a sector touted by the Canadian government since the 1980s to hold the potential to alleviate some of the adverse socio-economic conditions currently experienced by Indigenous communities (Whitford & Ruhanen, 2016).

Delivering on the potential of tourism requires attention to certain key elements and considerations. According to Dodds et al. (2016), soliciting the perspectives of community members at the outset of the project is essential to success. Community members must be consulted in meaningful ways and be active participants in decision-making processes. This requires an understanding of, and respect for, how decisions are taken at the community-level. Within indigenous communities this usually means going beyond formal State sanctioned Band Councils to ensure that the perspectives of elders are heard and privileged. In the James Bay case it also includes the hunting boss or tallyman, since he/she is responsible for the decisions affecting certain land and sea territories. An understanding of intra-community and inter-community dynamics is also needed, particularly as tourism often tends to directly benefit (e.g. provide jobs and supplementary income) a relatively small group of people while the costs (e.g. additional strain on local services) is shared among the wider community. Broader regional level policies and politics are also relevant, including an understanding of the approvals process required under the often complex political and jurisdictional arrangements negotiated between federal, provincial and indigenous governments. In the case of James Bay, this involves navigating the terms defined under the JBNQA, the EMRLCA and various other governance agreements. Since the proposed polar bear project is closely tied to the provisions

of the recently ratified EMRLCA there is the additional challenge of operating in a newly established governance regime where the processes are not yet clearly developed and few precedents for project approval are available.

Support for decision-making also requires that relevant information is available and accessible. In the Wemindji context, this included access to polar bear population data at spatial and temporal scales relevant to determining the economic viability and likely impact on wildlife of the proposed project.

The availability of skilled personnel and adequate infrastructure within the host community are also key elements for a successful tourism project (Bennett et al., 2012). A comprehensive inventory of the available skillset and a commitment to training are essential. A detailed understanding of capacity issues is also required; this is linked to tourist expectations and demands as well as the tolerance and interest of community members. The quality and availability of basic services (i.e. food supply, sanitary services, water etc.) must be carefully documented and monitored. A comprehensive assessment of the required investments and funding opportunities should also be analyzed, and revisited frequently.

In conclusion, tourism can offer an attractive option for economic diversification, particularly in remote northern indigenous communities where limited alternatives to large-scale resource extraction exist. Tourism in such contexts can be a welcome alternative that provides much needed employment and supplementary income for community members. It can also support local aspirations for environmental and cultural heritage protection, such as in the Wemindji case when tourism is an offshoot of protected area creation.[Despite these advantages and perhaps a general willingness among community members to accept tourism as an option, it is essential that communities have a meaningful decision-making role from the earliest stage to any proposed project. This requires attention to three components: 1) that the community is recognized as having a decision-making role rather than simply being another stakeholder consulted for input; 2) that decision-making should be informed by accurate and accessible information on the key components of a project; and 3) that the long-term success and sustainability of a tourism project depends to a large extent on a commitment to the other two components.

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APPENDICES

LOCATION	*DATE*	*LAND COVERAGE*	*AREA CLOUD COVERAGE*	*SATELLITE*	*BAND IMAGING*
NORTH TWIN	6-Aug-09	~90%	0%	WorldView-1	Panchromatic
	17-Jul-13	~40%	7%	GeoEye-1	Panchromatic and Multiband
	27-Sep-13	~80%	0%	GeoEye-1	Panchromatic and Multiband
	26-Oct-15	~75%	2%	WorldView-1	Panchromatic and Multiband
SOUTH TWIN	31-Jul-12	~75%	0%	QuickBird-2	Panchromatic and Multiband
	7-Jun-15	100%	0%	WorldView-2	Panchromatic and Multiband
	26-Oct-15	~95%	2%	WorldView-2	Panchromatic and Multiband

Table 1 Land, cloud coverage and technical specifics of images

LOCATION	*DATE*	*STATE*	*ANALYSIS COMPLETED*
NORTH TWIN	6-Aug-09	No cloud or snow coverage. Good contrast. Beach covered by white sand, rocks making it challenging to analyze this area.	YES
	17-Jul-13	Since this image was not complete and represented about 40% of the island, it was not used.	NO

	27-Sep-13	No cloud or snow coverage. Good contrast. Beach covered by white sand, rocks making it challenging to analyze.	YES
	26-Oct-15	The beach area is challenging to analyze since there is a lot of white spots and the area is clearer than other images. Image is covered by snow making this not accurate to analyze. This image was not used due to snow coverage.	NO
SOUTH TWIN	31-Jul-12	Some cloud coverage representing about 5% of the island. However the image had good contrast and brightness.	YES
	7-Jun-15	No cloud coverage. There are a few snow patches (5%) covering the island.	YES
	26-Oct-15	Snow coverage of about 40%, which was not analyzed. However the image has good contrast making the rest of the image easy to analyze.	YES

Table 2 Condition of surface area of all obtained images

North Twin Island			
6-Aug-2009	This image has no cloud or snow coverage and provides a good contrast. The edge of the island is covered by white sand, rocks making it challenging to analyze.	All five (5) polar bears found were located in the southern half of the island.	In image 2009, the bears were found inland in contrast to image 2013, where most bears were found on the edge of the island. The majority of the edge area was not included in the analysis since
27-Sep-2013	About 80% of the island surface is represented in this image. Similar to the	Seven (7) polar bears were found, all in the	

	previous image, there is no cloud or snow coverage and the image provided good contrast. Additionally, the edge area is covered by white sand and rocks which made it challenging to analyze.	southern half of the island except for one (1).	the background is light and there are many rocks or similar objects in appearance.
South Twin Island			
31-Jul-2012	This image represented about 75% of the surface area of the island. Although there is some cloud coverage representing about 5% of the island, the image has good contrast and brightness.	A total of seven (7) polar bears were found, all close to the edge except for one (1) which was found inland.	On South Twin Island, polar bears were found close to the edge of the island, but also inland.
07-Jun-2015	This image has no cloud coverage, however there are a few snow patches (5%) covering the island. The shore area could not be analyzed since it was partially covered by snow and the sand in this area was lighter, which as explained earlier could potentially skew the results.	A total of seven (7) polar bears were found spread throughout the island.	
26-Oct-2015	This image had a snow or lighter color of about 40% of the surface area. This part was not analyzed. Apart from the lighter colored area, the image has good contrast.	A total of four (4) polar bears were found central of the island.	

Table 3 This table provides the physical and environmental conditions of the satellite imagery during the time snapshot, and the number of polar bears identified.

UAV SPECIFICATIONS & FEATURES	
Make & Model	DJI Inspire 1
Classification	Lightweight small quad copter
Weight (battery included)	2935 g
Max Descent Speed	4 m/s
Max Speed	22 m/s (ATTI mode, no wind)
Max Height	450 m
Max wind speed resistance	10 m/s | 36 km/h
Max flight time	~18 minutes
Operating Temperature Range	-10° to 40° C
Dimensions	438x451x301 mm
BATTERY SPECIFICATIONS	
Name	Intelligent Flight Battery
Model	TB47
Capacity	4500 mAh
Voltage	22.2 V
Battery Type	LiPo 6S High voltage battery
Energy	99.9 Wh
Net Weight	570 g
Operating Temperature Range	-10° to 40° C
CAMERA SPECIFICATIONS	
Name	X3
Model	FC350
Total Pixels	12.76M
Effective Pixels	12.4M
Image Max Size	4000x3000
CMOS	94°Sony EXMOR 1/2.3”
Still Photography Modes	Sony EXMOR 1/2.3”
Video Recording ModesStill Photography Modes	Single shoot Burst shooting: 3/5/7 frames Auto Exposure Bracketing (AEB): 3/5 bracketed frames at 0.7EV Bias Time-lapse

Video Recording Modes Supported SD Card Types	UHD (4K): 4096x2160p24/25, 3840x2160p24/25/30 FHD: 1920x1080p24/25/30/48/50/60 HD: 1280x720p24/25/30/48/50/60
Supported SD Card Types	Micro SD Max capacity: 64 GB. Class 10 or UHS-1 rating required.

Table 4 Specifications of UAV, battery and camera

# PARTICIPANTS	***ROLES***
5	Band Councilor
3	Business Owner
4	Hunter / Trapper
5	Elders
1	Youth Coordinator
1	School Teacher
3	Local Polar Bear Expert
2	Scientific Polar Bear Expert
2	EMR Officials
2	CTA officers
2	Arts & Crafts maker

Table 5 Provides the number of participants holding several roles and or responsibilities in the community