Effects of tundra vehicle activity on polar bears (*Ursus maritimus*) at Churchill, Manitoba.

By

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A Thesis
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements
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FACULTY OF GRADUATE STUDIES

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EFFECTS OF TUNDRA VEHICLE ACTIVITY ON POLAR BEARS (*URSUS MARITIMUS*) AT CHURCHILL, MANITOBA

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A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirement of the degree

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MASTER OF NATURAL RESOURCE MANAGEMENT

Abstract

Churchill, Manitoba is world-famous for its polar bear (*Ursus maritimus*) viewing activities using tundra vehicles. Churchill is unique in that bears are viewed at close distances relative to any other bear-viewing location. The close proximity of tundra vehicles (TV) and polar bears in the Gordon Point area at Churchill poses a question vital to the bear management and the nature tourism industry: do human activities at Churchill induce behavioural changes in polar bears?

From 7 July to 18 November 2000 a non-invasive study was conducted near Churchill to collect information on the nature tourism activities and polar bear behaviour. Focal animal sampling was used to collect data on daily activity patterns (e.g., resting, traveling, feeding), and vigilance (i.e., visual scanning of the surroundings beyond the immediate vicinity) in the absence versus presence of TV.

An estimated 9,720 visitors came to the Gordon Point area to view polar bears from 10 October to 15 November 2000. There were 15 ± 1 (mean ± SE) TV (an estimated 270 visitors) per day in the viewing area. The mean approach distance between bears and vehicles was estimated to be 24 ± 3 m. The observed average number of TV around a bear was 2.1 ± 0.1 TV, ranging from 1 – 9 TV. The minimum time TV were within 20 – 30 m to bears was estimated to be 3 h. Family groups (5.5 ● 1.2 TV) and subadult males (4.6 ± 1.2) had more TV around them than bears of other sex and age classes. Disturbances in the form of approaching and leaving TV around a bear occurred every 10.2 ± 1.7 min.

Vigilance behaviour in the presence of TV activity was significantly increased, with increased frequencies of head-ups, and decreased time intervals between vigilance bouts. Overall, bears were 2.5 times more vigilant in the presence of TV than without. Female bears showed a significant response to the number of TV, where the frequency of head-ups increased, and the between bout intervals decreased with increasing number of TV.

When resting, feeding, and traveling behaviours of lone bears, females, and all bears were compared to published data, all behaviours differed significantly. Polar bears during this study spent 64.3 % resting, 15.7% feeding, and 20.1% traveling. No significant differential behaviour for sex (males: 58.4% resting, 14.5% feeding, 20.7% traveling; females: resting: 41.2%, 19.7% feeding, 26.5% traveling) and age-classes (adults: 64.0% resting, 10.0% feeding, 19.4% traveling; subadults: 39.9% resting, 38.3% feeding, 18.3% traveling; cubs: 26.7% feeding, 20.8% resting, 35.5% traveling) were detected. Seasonal effects were detected for feeding (summer: 3.3%; fall: 24.0%) and swimming (summer: 16.4%; fall: 0%). Estimates indicated that, if bears feed on terrestrial food sources (e.g., berries or kelp) during the ice-free period, a stable body mass could be maintained. Depending on sex and age of the bear, and the amount of food consumed, body mass could increase and a net energy gain would occur.

Based on the results, the main recommendations were (1) Manitoba Conservation should seek dialogue with stakeholders to develop a protocol for consistent and predictable tundra vehicle and helicopter activities; (2) Manitoba Conservation should encourage more research examining the polar bear viewing

industry; (3) viewing distances of at least 20 m should be maintained; (4) tundra vehicle movement around bears should be minimized; (5) passengers on vehicles should avoid noisy behaviour; (6) bears should not be pursued during viewing activities; and (7) the purpose of two Designated Polar Bear Resting Areas in the Gordon Point area should be re-examined.

Acknowledgements

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The past two years were a journey where I discovered new sides to myself that I did not know existed. Throughout my research, many events occurred, either unexpectedly or more or less determined by intervention of a Supernatural power, or as I call it - fate. Everything in our lives happens for specific reasons! There are purposes in each and every event. Every person we meet fulfills a particular role in the puzzle that we call "our life"! We only have to learn to figure out how to put these pieces into place for them to make sense to us. Two people died that were very close to me, and I re-connected with a very special person after several years. The combination of "good" and "bad" times, the cyclical nature of "ups" and "downs" made me realize who I am, and what I foresee for my future. To me, friends and happiness have become goals that I will keep close to my heart. The past two years made me a more mature person, and opened my eyes to seeing what is important to me and to my life. I hope others will experience this fact with a little less pain and tears! The universe will unfold as it must! Thanks also to all my friends ("you know who you are") who were there for me when I needed someone to talk to because my vision was clouded with frustration, pain, depression, anger, loneliness, and fear. I love you all!

Many individuals assisted me in different phases of the project, particularly when funds were scarce. Without the help of all these great human beings this project never would have taken place. I thank you all! Special "Thanks" to Harvey Lemelin, Kim Daley, Dan Stewart, Ginger Gill, Mitch Campbell, Stacie Stiege, and Malcolm Ramsay for encouraging me to continue when the path ahead of me was covered with "bear shit" and boulders as big as the Rocky Mountains!

The fact, that some students "thank everyone, you know who", or "it would take up too much space to thank everybody" brings my conscience to an uproar. I will take the time and space on this and the following pages to thank all individuals that were instrumental to the success of this research. However, I am not saying that all individuals influenced the work in a positive direction. The underlying principle is that the interactions with the following individuals enriched my world by helping me to:

a) learn social and "hands-on" skills;

b) gain insight in, and appreciation for different perspectives;

c) learn how to compromise and to be diplomatic;

d) respect other people's opinion;

e) learn when to shut up; and

f) learn how to relax in order to prevent insanity.

I intentionally omit the ranks, degree and positions held within any educational, government or non-government organization, as only the person's expertise, personality, views, quality of interaction, guidance, perseverance, tolerance, patience, commitment, and friendship had a tremendous impact on how I conducted myself, and the direction this research took. I consider myself very fortunate to have had this opportunity in my life to meet all of you (in no particular order):

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This project was a-dream-come-true for me! During endless visitations to Churchill beginning in 1992 I became more and more fascinated with these "white fuzzy creatures".

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Dedications

I dedicate this thesis to the following individuals who were very important in my life:

1. On 23 May 2001 my father died after a long and painful battle with cancer. He never had an opportunity to visit and enjoy the Arctic. I hope he is watching down on me, and he may now have opportunities to enjoy it as much as I do!

2. On 21 May 2000 Malcolm Alexander Ramsay died in a helicopter accident in the Canadian High Arctic. He was a great scientist, colleague, and friend who inspired others and myself in all aspects of life. To him I owe this fascination with the Arctic wonderland and most of my experience with polar bears. The world lost a man that was always willing to share his knowledge, wisdom, and experience beyond the call of duty. He was a great human being - an example for everyone. He will be missed by many people. Malcolm and I spent many hours discussing the nature tourism industry at Churchill, and it was he who gave me a lot of encouragement to begin and continue my project. Thank you, Malcolm! Your spirit will live on!

3. On 3 November 1997 my two cats died in a cabin fire at Churchill that was brought upon by an irresponsible, drunken, and "recreationally drugged" individual. "Nanook" and "Napoleon" gave me strength and happiness after a personal crisis. Their playfulness and sense for tense situations saved me from getting off the path of a serene life. Thank you for your companionship, compassion and sympathy! I will always remember what you have done for me!

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Chapter 1

1.1 Introduction

Members of the family Ursidae have fascinated humans (*Homo sapiens*) for thousands of years. Today, people congregate from all over the globe in areas that provide viewing opportunities of this charismatic mega-fauna in its natural environment – whether black (*Ursus americanus*), brown (*U. arctos*), or polar bears (*U. maritimus*). Congregation or staging areas are particularly attractive to tourists as bears reliably gather in these areas in high concentrations. The Gordon Point area near Churchill, Manitoba is such a place, and its discovery by the tourism industry has resulted in a large increase in human traffic since bear enthusiasts first came to watch this large carnivore. The first tour company began carrying tourists into the Gordon Point area in 1974, with other companies following in the early 1980's (Webb 1985).

The Gordon Point area (approximately 58° 45' N to 58° 48' N, and 93° 38' W to 93° 50' W), which is predominantly used for polar bear viewing, and is located along the west-central shore of Hudson Bay, approximately 35 km east of the town of Churchill (Fig. 1), and within the Churchill Wildlife Management Area (CWMA). Polar bears are readily accessible at Gordon Point during the ice-free period (July to November) when they are forced to come ashore (Stirling et al. 1977). While ashore, bears conserve energy and are sustained by their stored fat reserves (Nelson et al. 1983; Ramsay and Stirling 1988). Tour operators at Churchill, Manitoba have been transporting visitors since the early 1980's into areas where bears congregate, using large customized vehicles that travel across tundra (Webb 1985). Human/tundra vehicle/polar bear interactions have been observed in these staging areas resulting in some instances of food conditioning,

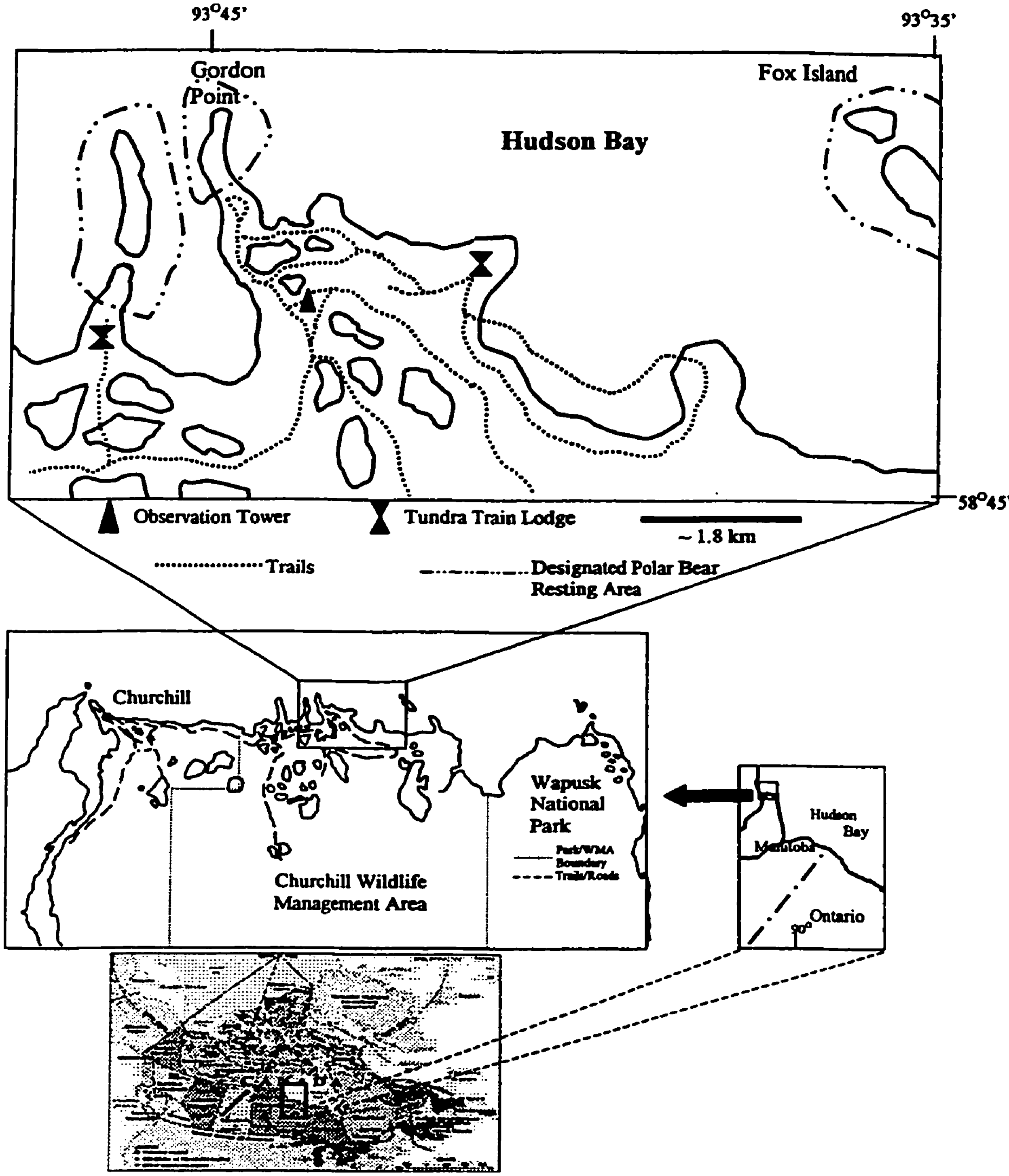


FIG. 1. Location of study area approximately 35 km east of Churchill, Manitoba.

habituation, and harassment (Watts and Ratson 1989; Herrero and Herrero 1997). Some of these interactions may elicit behavioural and physiological responses that could compromise the bears' energy balance (Knight and Gutzwiller 1995).

The close proximity of polar bears and humans during the fall at Gordon Point may pose a question vital to the fitness and effective management of these bears: do ongoing human activities at Gordon Point induce behavioural changes and/or cause physiological stress in the polar bears that rely on the staging areas to conserve energy in order to survive and reproduce? Watts et al. (1991) documented metabolic rates of polar bears after human-controlled disturbances. Metabolic rates of polar bears increased between 4 and 12 times for walking speeds of 1.0 - 2.2 m/sec when compared to basal metabolic rates. While these controlled manipulations are suggestive of the effects of human activities on polar bear behaviour, a quantitative measure of the degree of behavioural changes caused by human activities would provide a noninvasive, readily measurable, and complementary tool. Such data could be utilized by interested parties to design effective management protocols for the bear-viewing industry.

1.2 Purpose of study

The purpose of this study was to collect baseline information on the polar bear viewing industry in the Gordon Point area at Churchill. This included the collection of data on tundra vehicle conduct, behaviour of passengers on tundra vehicles, helicopter activities, and polar bear behaviour. More specifically, polar bear vigilance behaviour (e.g., a visual scanning of the surroundings beyond the immediate vicinity) in the presence and absence of tundra vehicles was examined. This behaviour was used to determine how viewing activities and the current approach regimes of vehicles affect bear behaviour, and possibly bear physiology.

Vigilance is costly, and can lead to a physiological chain-reaction where stress hormones (e.g., cortisol, corticosterone) increase, leading to acute and chronic negative effects (see Chapters 2 and 4). To assess the current situation during bear-viewing activities, to prevent chronic stress symptoms, and to examine whether current viewing regimes are neutral to bears, this comparative approach of vigilance behaviour (e.g., presence versus absence of tundra vehicles) was used.

To provide useful and helpful data to management agencies and tour operators at Churchill, all activities that I believed to influence how polar bears behave during viewing activities were recorded and reported. Having this baseline information, managers and tour operators will be in a position to decide which factors help to maintain or improve the quality of the viewing experience, both for polar bears and visitors.

1.3 Objectives

In this study, I collected baseline information on helicopter and tundra vehicle activity to obtain data on the dimensions of the polar bear viewing industry in the Gordon Point area. In addition, general polar bear behaviour, and vigilance behaviour in the presence and absence of tundra vehicles were examined. The specific objectives of this study were:

(1) to provide quantitative and qualitative information on helicopter and tundra vehicle activity during polar bear viewing activities;

(2) to quantify vigilance behaviour of polar bears in the presence and absence of tundra vehicles;

(3) to quantify daylight activity patterns, such as resting, traveling, and feeding;

(4) to provide an estimate of the contribution of terrestrial food sources to the energy budget of polar bears; and

(5) to provide considerations for management strategies based on the results of the analyses.

1.4 Clarification about time-lines for conducted research

Data for this research were collected between 7 July and 18 November 2000. However, time frames for each chapter differ, and sometimes chapters consist of two time blocks where data were collected. For example, tundra vehicle activity around polar bears (Chapter 3) was recorded from 10 October through 15 November. During the course of these observations, I decided to collect baseline information on helicopter activities in the study area during polar bear viewing season because too little is known on how helicopter activities affect polar bears. Thus, I began to collect data on helicopter activities from 24 October through 12 November. Similarly, while observations on vigilance (Chapter 4) and general bear behaviour (Chapter 5) were conducted, I observed that few bears used the Designated Polar Bear Resting Areas (DPBRA) [Fig. 1]. I therefore examined the tide chart, and compared times for high and low tides to field observations in order to draw inferences about whether the DPBRA designation is useful to bears.

1.5 Thesis format

Chapter 2 is a review of nature tourism in general, its effects on wildlife, and what is known about Churchill's polar bear-viewing industry (CPBVI). In addition, this chapter provides the background for the thesis. Chapter 3 examines the dimensions of

CPBVI from October through November 2000, including tundra vehicle and helicopter activities. Chapter 4 investigates vigilance behaviour of polar bears in the presence and absence of tundra vehicles. General polar bear behaviour (e.g., resting, traveling, and feeding), the effect of sex and season on these behaviours, and habitat preferences for general behaviours are quantified in Chapter 5. A mathematical approach is used in Chapter 6 in order to estimate possible contributions of terrestrial food sources to the overall energy budget of polar bears during the ice-free period. A summary of the thesis and management recommendations are provided in Chapter 7. Chapters 3 – 6 are formatted following guidelines of the Canadian Journal of Zoology.

1.6 Limitations and assumptions

The study was carried out within the context of the following limitations and assumptions:

1. whenever observations on bears were conducted, it was assumed that all bears encountered within the study area were encountered by pure chance, and every single bear had an equal chance of being detected (Chapters 3 – 5).
2. effects on bear behaviour caused radionuclides, tourism activities, helicopters, climate change, habituation, food-conditioning, and local residents would be equally imposed on all bears as not to bias data (Chapters 3 –5).
3. specific experimental designs were not as successful as anticipated because day-to-day operations of the tour operators limited the freedom of experimental manipulations (Chapters 3 – 5).
4. it was assumed that optimal foraging theory would apply to polar bears when calculations on the contributions to the energy budgets were performed (Chapter 6).

Chapter 2

2.1 Nature tourism and associated effects on wildlife

Nature tourism can be defined as a form of tourism that encompasses mass tourism, adventure tourism, and ecotourism (Goodwin 1996). All of these forms of tourism use natural resources in a wild or undeveloped form, including species, habitat, landscape, scenery, and salt and fresh-water features. The purpose of nature tourism is travel in order to enjoy undeveloped natural areas or wildlife (Goodwin 1996). Mass (or industrial) tourism has the additional characteristics of meeting the expectations and demands of visitors at the cost of great development (e.g., hotel, entertainment, and shopping facilities) and displacement of local people from their traditional livelihoods (Fennell 1999). Adventure tourism has a risk factor for the participant, which is the primary reason people engage in these activities (Ewert 1985; Hall 1992). In contrast, tourism that is said to be "true" ecotourism follows generally these six principles (Wallace and Pierce 1996):

(1) minimization of negative impacts to the environment and local people;

(2) increased awareness and understanding of an area's natural and cultural systems involving visitors in issues affecting these systems;

(3) contribution to the conservation and management of legally protected and other natural areas;

(4) maximization of short and long-term participation of local people in the decision-making process regarding the type and amount of tourism that should occur;

(5) economic and other benefits directed towards local people that complement

rather than overwhelm traditional practices; and

(6) provision of special opportunities for local people and nature tourism employees to use and visit areas and learn about the wonders that other visitors come to see.

For the purpose of this thesis, and based on the last definition, Churchill's polar bear-viewing industry using tundra vehicles is defined as nature tourism, and is not considered to be ecotourism.

Wildlife viewing, a form of nature tourism, is a very popular wildlife-dependent recreational activity. Duffus and Dearden (1990) reported that the number of persons participating in this activity increased from 22.9 to 37.5 million between 1980 and 1990 in the United States alone. The projected trends indicate that the numbers of participants will increase between 63% and 142% over the next 50 years (Walsh et al. 1989; Giannecchini 1993).

Wildlife viewing, as part of outdoor recreation, may influence wildlife behaviour and populations (Fig. 2), as well as the diversity of vegetation and soil (Wolcott and Wolcott 1984; Vaske et al. 1992; Camp and Knight 1998; Cole and Spildie 1998), and ultimately the quality of the experience of visitors (Vaske et al. 1995). Boyle and Samson (1985) reviewed 166 scientific papers containing data on the effects of hiking, camping, boating, wildlife observation and photography, and off-road vehicle use on wildlife. In 81% of those papers, the recreational use was considered to have negative effects on wildlife.

Reported negative impacts on wildlife include: (a) physiological responses (increased heart rate and body temperature, elevation of blood sugar, change in blood flow to the skin and digestive organs, increased energetic costs) caused by disturbance or

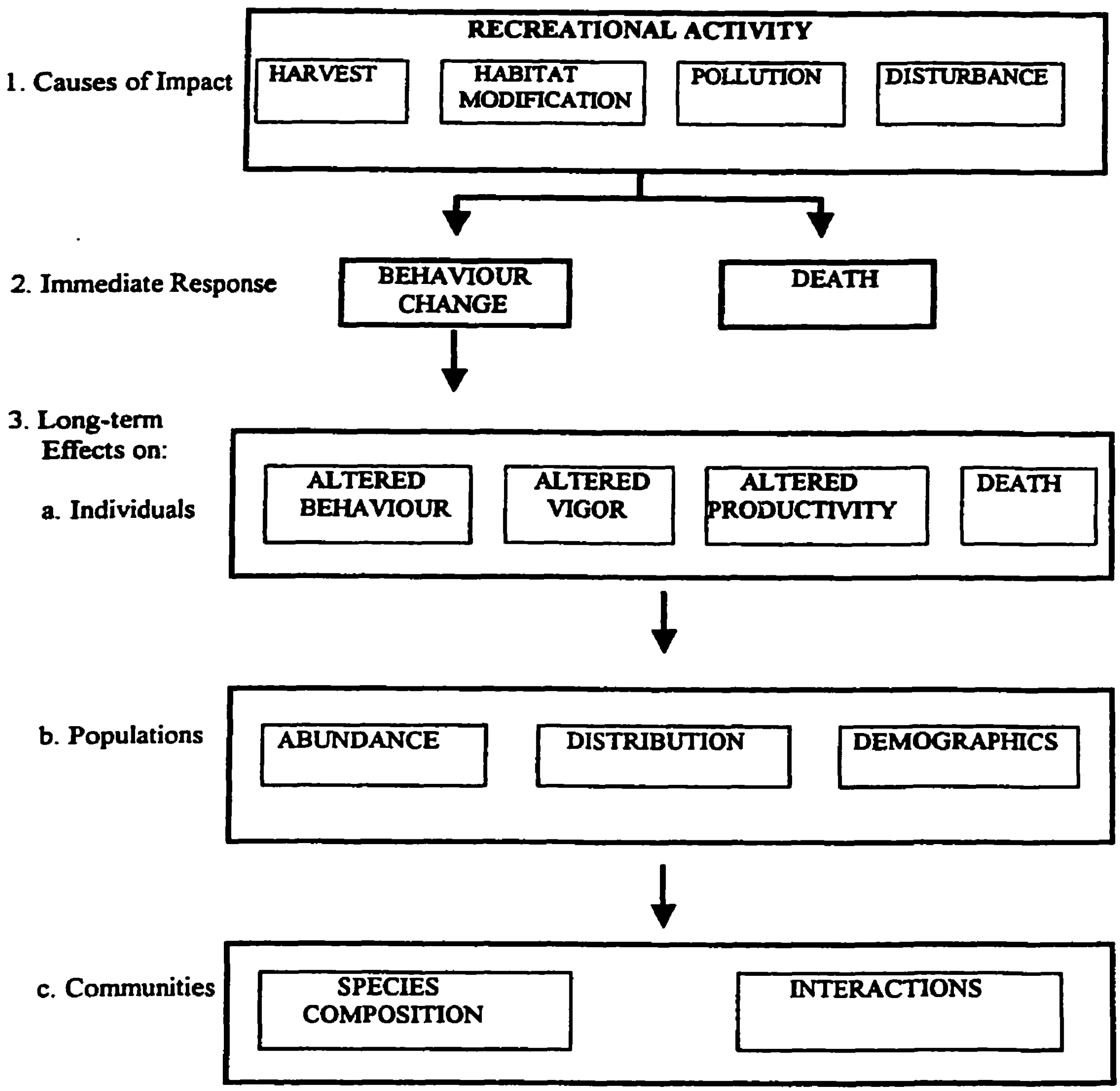


FIG. 2. A conceptual model of wildlife responses to recreational activities (Source: Knight and Cole 1995).

harassment of wildlife, including noise (Bowles 1995; Gabrielsen and Smith 1995); (b) behavioural responses that are either short-term (e.g. displacement from habitat, aggressiveness) or long-term changes (e.g. abandonment of preferred foraging habitat) (Baydack and Hein 1987; Knight and Cole 1995); (c) change in vigor (e.g. due to increased heart rates or decreased food intake) (MacArthur et al. 1982); (d) death or decreased productivity due to alterations in energy budgets (Yarmoloy et al. 1988).

White et al. (1999), for example, demonstrated that mountain climbers in Glacier National Park, Montana, had an effect on brown bear feeding efficiency and aggressiveness. Bears were disturbed at their army cutworm moth (*Euxoa auxiliaris*) feeding sites and subsequently spent 53% less time foraging and behaved 23% more aggressively than when undisturbed. Yarmoloy et al. (1988) disturbed radio-collared mule deer (*Odoceilus hemionus*) with an all-terrain vehicle. The investigators noted that harassed animals altered their feeding and space-use patterns, while undisturbed deer maintained their normal usage. In addition, only disturbed deer experienced a decrease in reproduction the following year. MacArthur et al. (1982) investigated the effects of mountain climbers and aircraft on the physiology of bighorn sheep (*Ovis canadensis*). Sheep had higher heart rates and were more likely to run from the area when approached by humans as compared to when these were disturbed by road traffic or helicopters. Birds [i.e., American goldfinches (*Carduelis tristis*), Red-winged blackbirds (*Agelaius phoeniceus*)] also have a tendency towards higher aggressiveness when disturbed by humans (Knight and Temple 1986a, b).

More recent studies specifically examined the effects of tourists and tourism on wildlife species [Kovacs and Innes 1990: harp seals (*Phoca groenlandica*); Burger and Gochfeld 1993: boobies (*Sula dactylagra* and *S. sula*); Blane and Jaakson 1994: Beluga whales (*Delphinapterus leucas*); Jacobson and Lopez 1994: green sea turtles (*Chelonia mydas*); Burger et al. 1995: various bird species; Lott and McCoy 1995: Asian rhinos (*Rhinoceros unicornis*); Grieser Johns 1996: chimpanzees (*Pan troglodytes*); Russell and Ankenman 1996: orangutans (*Pongo pygmaeus*); Giese 1996, 1998: Adélie penguins (*Pygoscelis adeliae*); Barr and Slooten 1999: dusky dolphins (*Lagenorhynchus obscurus*); Fowler 1999: Magellanic penguins (*Spheniscus magellanicus*)]. In all studies, negative effects of tourists on wildlife were reported. These negative effects included habituation, decrease in feeding time, hormonal changes, decrease of survival in nestlings, increased alertness, decreased nursing time, increased predation and death. Recommendations for the management of the tourism industry to minimize the effects were proposed by Kovacs and Innes (1990), Blane and Jaakson (1994), Jacobson and Lopez (1994), Lott and McCoy (1995), Grieser Johns (1996), Giese (1998), and Fowler (1999). Specific recommendations proposed by some of the authors are listed in Table 1.

2.2 Nature tourism and polar bears at Churchill, Manitoba

Polar bears depend on the sea ice to hunt their primary food source, ringed seals (*Phoca hispida*) (Stirling and Archibald 1977; Smith 1980). Hudson Bay is generally ice-free from mid-July until mid-November, which forces the bears to come ashore (Stirling et al. 1977). During that time, bears feed little and undergo a lengthy fast. Thus, they are sustained by their stored fat reserves during that period (Russell 1975; Knudsen 1978; Nelson et al. 1983; Lunn and Stirling 1985; Watts and Hansen 1987; Ramsay and Stirling 1988; Ramsay and Hobson 1991; Ramsay et al. 1991, 1992; Derocher et al.

Table 1. List of effects on various wildlife species by nature tourism and recommendations to minimize impact on that wildlife species.

Author	Species	Effect	Recommendations
Blane and Jaakson (1994)	Beluga whale (*Delphinapterus leucas*)	1) Feeding and traveling behaviour interrupted 2) Boat and location avoidance	1) Limited number of licensed boats 2) No further development 3) Speed limit 4) Policing 5) Interpretive programmes
Lott and McCoy (1995)	Asian rhino (*Rhinocerus unicornis*)	During elephant-borne visits rhinos are more alert and feed less	1) Keep visits short 2) Increase viewing distance > 12 m
Grieser Johns (1996)	Chimpanzees (*Pan troglodytes*)	Increased vocalization when habituated chimpanzees were approached by > 10 visitors	Reduce size of tourist groups to maximum of 10 visitors
Giese (1998)	Adélie penguins (*Pygoscelis adeliae*)	1) Increased heart rate without behavioural response at distances of 15 m 2) Interrupted incubation behaviour and increased heart rate at 5 m	1) Increase distance to at least 15 m 2) Approach quietly 3) Photograph kneeling 4) Visitors should be briefed about signs of disturbance
Fowler (1998)	Magellanic penguins (*Spheniscus magellanicus*)	Increased corticosterone levels at less visited sites as compared to sites with higher visitations	Visitations should be concentrated in a small portion of breeding colony; the remaining colony should have restricted access
Kovacs and Innes (1990)	Harp seals (*Phoca groenlandica*)	Behavioural changes for females and pups	Tourists should maintain distance (e.g., > 10 m) and remain calm
Jacobson and Lopez (1994)	Green sea turtles (*Chelonia mydas*)	Nests, false-nesting, and non-nesting emergence occurred more often on weekday nights than on weekends	Trained tour guides are used and flashlights are prohibited

1993). Once on land, polar bears segregate by sex and age class along the western shore of Hudson Bay, where adult males remain on the coast, family groups move farther inland, pregnant females travel toward denning areas in Wapusk National Park, and subadults can be found in coastal and inland areas (Derocher 1987; Derocher and Stirling 1990a, b).

While on shore, bears are readily accessible to view from tundra vehicles (customized vehicles or buses that have been modified by the tour companies to travel across tundra) and tundra train lodges within the Churchill Wildlife Management Area (CWMA), 30 – 35km east of the town of Churchill (Fig. 1). This type of nature tourism, as related to polar bear viewing in the Gordon Point area along the Hudson Bay coast, has been practiced since the early 1980's (Webb 1985; Herrero and Herrero 1997), but has increased mainly in recent years.

Tundra vehicle activity may impose an energetic cost on bears, energy that could otherwise be utilized for growth (e.g., cubs), maintenance, (Belkhou et al. 1990; Castellini and Rea 1992), reproduction and lactation (Atkinson and Ramsay 1995), or for different activities such as male play fighting (Clutton-Brock et al. 1979). Polar bears are easily affected by hyperthermia (Øritsland 1970; Best 1982), therefore, reduction of unnecessary movement may be important for the conservation of energy. The rate of depletion of energy reserves will influence an animal's condition when it returns to the sea ice and may affect reproductive success or subsequent survival (Øritsland 1970; Best 1982; Derocher and Stirling 1990a).

Watts et al. (1991) examined basal metabolic rates of stationary subadult male polar bears at rest relative to metabolic rates after human-controlled disturbances and at four rates of locomotion. The human-controlled disturbance (e.g., tundra vehicle noise or other noise) was simulated by using a snow machine, which was run for 30 s/trial. The authors concluded that the disturbance factors were only significant if they occurred over extended periods of time. Metabolic rates increased between 4 and 12 times for walking speeds of 1.0 - 2.2m/sec (Watts et al. 1991). However, these data suggest that the energetic costs could be quite substantial for male polar bears during imposed stresses by tundra vehicles, especially if bears are forced to move, or if disturbance of stationary bears persists for longer than 30 – 60 min. Energetic costs could be even higher for females with cubs due to additional energetic constraints, such as lactation or protection of the offspring. In a study on male adult and subadult polar bears, Atkinson et al. (1996) documented losses of body mass between 42 and 121 kg over 66 to 88 d during the ice-free period, which amounted to a loss of approximately 286 kJ / (kg of body mass$^{0.75}$ /d). Eighty-six percent of this loss was accounted for by the loss of body fat. Body-size in male bears, and therefore body fat, may be an important factor in the social play-fights that male bears exhibit, for example as a tool to assess an opponent (Maynard Smith and Parker 1976).

Nutritional deficiencies in mammals can result in the impairment of all reproductive processes including conception, gestation and lactation (Bauman and Currie 1980; Loudon and Kay 1984; Albon et al. 1986; Ramsay and Dunbrack 1986; Oftedal 1993). Atkinson and Ramsay (1995) demonstrated that body composition (i.e., body fat) of female polar bears is significantly related to litter weight, and may be indirectly related to a litter's probability of surviving the first year. If females with cubs at Gordon Point are diverting energy due to bear-human interactions, cubs may ultimately suffer the consequences.

Climatologists and other scientists believe that increasing concentrations of greenhouse gases in the atmosphere are causing the climate of the Earth to warm (Etkin 1990). The possible impacts of climatic warming on polar bears are described by Stirling and Derocher (1993) and Stirling et al. (1999). For example, Stirling and Derocher (1993) examined whether polar bears came ashore with greater body mass by comparing years of early versus late ice break-up and freezing. No significant differences in body mass between early versus late ice break-up years were detected. According to the authors, this result is consistent with a density-dependent response that is exhibited by the bears of western Hudson Bay (Derocher and Stirling 1992), indicating that the polar bear population may be at the maximum size that can be supported by the existing ringed seal population (Stirling and Derocher 1993). The ringed seal population was estimated to be 140,880 seals and able to support a polar bear population of western Hudson Bay of up to 1,300 polar bears (Lunn et al. 1997a). The latest estimate of the bear population was 1,200 ± 250 animals in autumn of 1995 (Lunn et al. 1997b). However, detailed information about the sex ratio, reproductive status, mortality and survival rates for adult seals and pups were not recorded during this study, and inferences about whether the seal population is stable can only be made cautiously.

Aside from a suggested density-dependent response, bioaccumulation of environmental contaminants such as polychlorinated biphenyls, chlordanes, chlorobenzenes, and other halogenated organic compounds has been reported for polar bears (Norstrom et al. 1990; Muir et al. 1992; Norheim et al. 1992; Polischuk et al. 1995; Bernhoft et al. 1997). These contaminants are transferred from mothers to offspring, increase in concentration during the fasting period, and could adversely affect survival and growth of cubs in the early phase of development (Polischuk et al. 1995). Other possible effects of these contaminants are currently unknown (e.g., possible weight loss), but it was suggested that they may cause hermaphroditism in polar bears (Wiig et al. 1998), and could therefore affect reproductive potential of polar bears.

If a prolonged hunting season does not enable the bears to store more fat, and the trend is pointing toward an increased ice-free period, then the results could be reflected by reduced rates of reproduction and cub survival (Stirling and Derocher 1993). This fact, in conjunction with possible alterations in behaviour by human activity, may make polar bears more susceptible to other stress factors or diseases (McDonald et al. 1988).

During summer and early autumn, polar bears frequent the Gordon Point area in low numbers, and tundra vehicle activity is consequently low as well. Bear viewing during that time is offered as half-day trips (12:00 h – 16:30 h), about three times per week, by one tour company. As ambient temperatures drop and more polar bears migrate through and congregate in the Gordon Point area, tundra vehicle activity increases. Full-day trips (9:00 h – 16:30 h) are offered by two local tour companies, beginning on or about 1 October. Tundra vehicle activity is at its peak, with a maximum of 18 permitted vehicles from 1 October through 15 – 18 November, depending on freeze-up of Hudson Bay.

In addition to viewing bears from tundra vehicles (Plate 1), two stationary tundra train lodges provide accommodation and viewing options (Plate 2). These lodges consist of two sleeper trailers, one lounge trailer, one cafeteria/kitchen trailer and one utility trailer, all built in a tundra vehicle-style. Both lodges are situated on the coast in the Gordon Point area at the origin of gravel spits, approximately 4 km apart from each other (Fig. 1).

Tundra vehicles use a trail system consisting of established trails, eskers, and foreshore flats to transport visitors into the Gordon Point area. Two inland and one

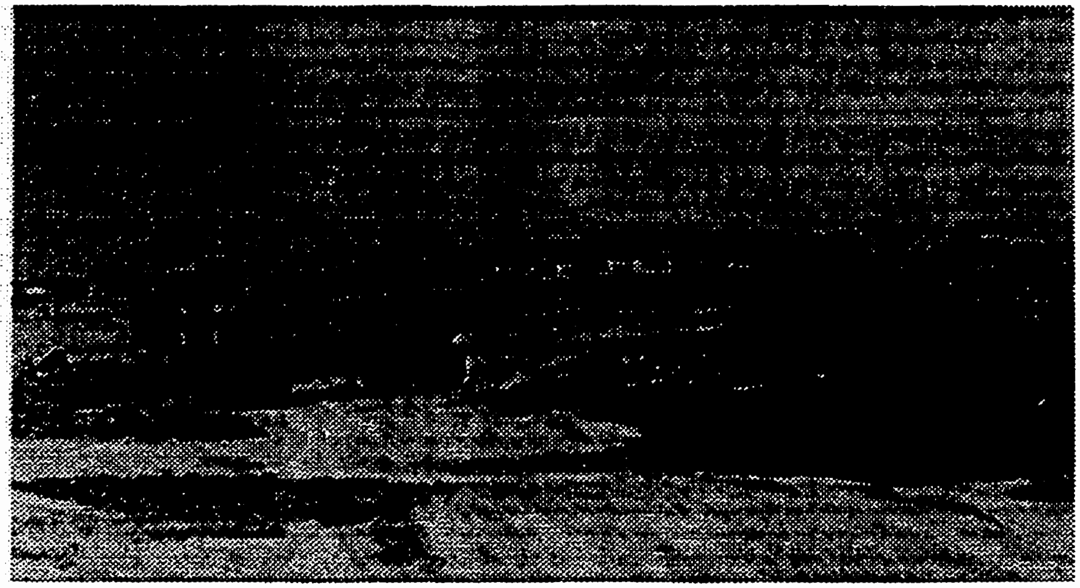


Plate 1. Tundra vehicles (foreground) and tundra train lodge (background) in the study area during polar bear viewing season (Photo credit: K. Daley).

Plate 2. Example of a tundra train lodge in the study area near Gordon Point at Churchill (Photo credit: K. Daley).

coastal trail stretch from Gordon Lake toward the Tundra Buggy® Tours Ltd. train lodge. Vehicles also use the foreshore flats to drive along the coast toward the second tower, approximately 3 km east of the Tundra Buggy® Tours Ltd. lodge.

While most visitors engage in bear viewing activities from tundra vehicles, many take advantage of helicopter rides to view bears. These flights usually begin in July and last as long as bears are in the area. Half-hour and hour long tours are flown along the shoreline, over spits, Fox Island, and toward Cape Churchill.

Most of these activities take place in the Churchill Wildlife Management Area, and as such are overseen by Manitoba Conservation. Permits are issued for tundra vehicles, train lodges, and helicopter activities and also include a provision for vehicles to drive on established trails. No special training or ecological/educational background is required to operate tundra vehicles. Manitoba Conservation set certain spits and islands aside as Designated Polar Bear Resting areas (DPBRA). The purpose of these DPBRA is to provide undisturbed resting opportunities for polar bears awaiting the freeze-up of Hudson Bay. Two DPBRA are within the Gordon Point area (Fig. 1).

The industry has evolved immensely since the early 1980's. What started out with one tundra vehicle in a remote sub-Arctic community and a few visitors, has grown into a large mega-fauna industry, attracting over 10,000 visitors annually (Herrero and Herrero 1997). Churchill is known as the "Polar Bear Capital of the World", and its residents have been benefiting tremendously from the annual migration of polar bears. The industry now provides many job opportunities and supports residents and non-residents alike (Newton 2000).

Butler (1980) argued that a tourist destination undergoes changes similar to a natural population. He suggested that increases in visitations to a destination are followed

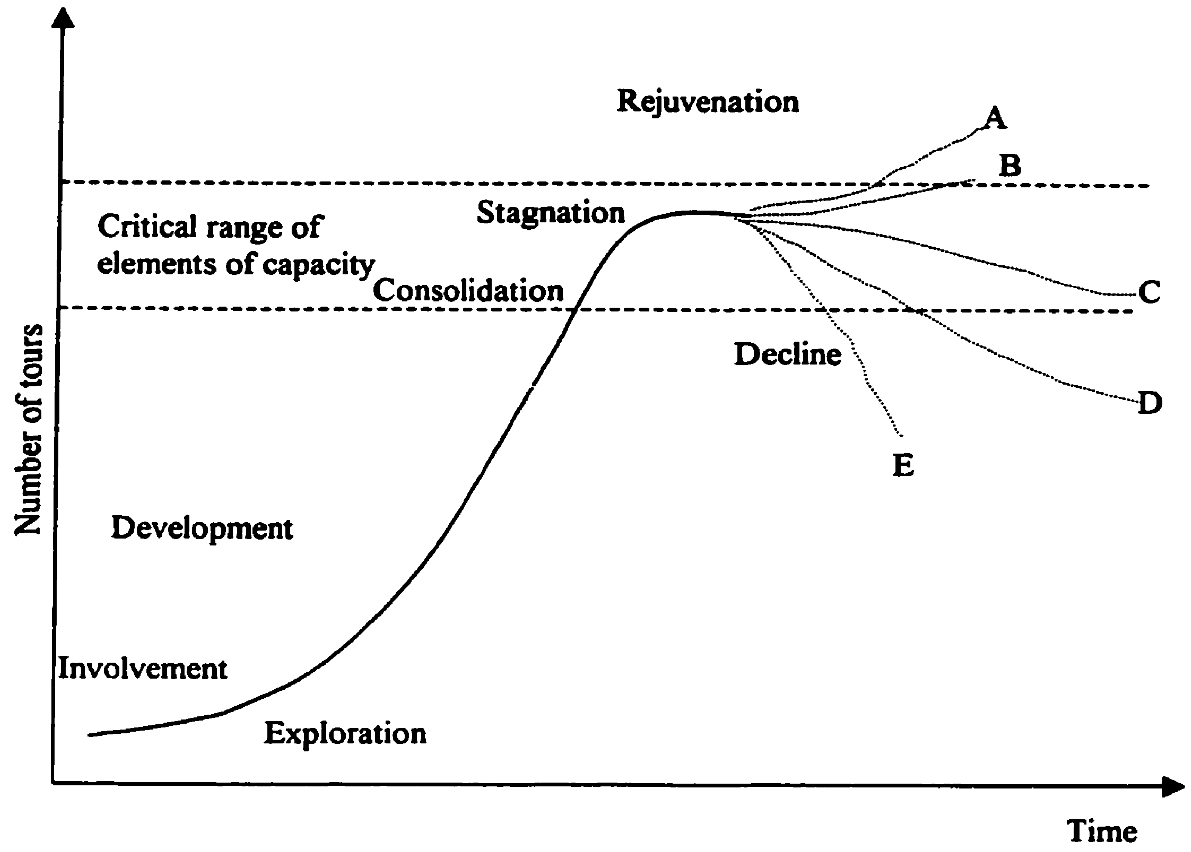


FIG. 3. The tourist area life cycle. (Source: Butler 1980). A tourist destination undergoes changes (i.e., exploration through stagnation), similar to a population of living organisms. Once stagnation has been reached, the destination either becomes rejuvenated (A and B), the number of tours to the destination remains stagnant (C), or visits to this destination decline (E and D). (See also p. 15).

by decreases in visitation as the carrying capacity of the destination has been reached. Moreover, a transformation of the destination area from early exploration and involvement through to consolidation and stagnation are manifested as the industry attempts to accommodate more visitations and competing operations (Fig. 3). As there is a sustained decline in ecological quality of the destination over time, the attractiveness of the destination to the tourist will wane (Fennell 1999). Concerns about the degradation of the ecosystem, in particular the degradation of vegetation by tundra vehicle activity were expressed by Churchill residents (Newton 2000), tourists (World Wildlife Fund Canada 1999), and non-profit organizations (e.g., Great Bear Foundation, Missoula, Montana; C. Jonkel, 2001; pers. comm.). Managers and the industry should be concerned if long-term sustainable tourism is a goal at Churchill.

2.3 Other factors possibly affecting polar bears at Churchill

The western Hudson Bay polar bear population is the most studied polar bear population in the world. This population has been the subject of research on distribution, abundance, and population boundaries since the late 1960's (Stirling et al. 1977; Derocher and Stirling 1995b; Taylor and Lee 1995; Lunn et al. 1996). How these studies and their methods (e.g., darting, marking, attachment of radio collars, etc.) affected the bears is poorly understood. Greater susceptibility to diseases (Lance and Elsey 1986; Greenburg and Wingfield 1987; McDonald et al. 1988; Moore et al. 1991; Bagchi et al. 1999) and reduced reproduction (Ashley and Holcombe 2001) may be the long-term results of those studies due to acute and chronic stress symptoms.

Hunting of polar bears in Manitoba was legal up until the late 1960's, and about 50 – 100 polar bears were harvested annually (Derocher and Stirling 1995a). Military personnel stationed at Fort Churchill during the 1960's and other local residents controlled the population through hunting (Kearney 1989). After the base closed in the early 1970's, the bear population rapidly increased and bears were seen in the garbage dump in Churchill's vicinity (Stirling et al. 1977). The Polar Bear Alert Program (PBAP) was initiated in 1969 by the Department of Natural Resources (now called Manitoba Conservation) to control human-bear interactions at Churchill, and to minimize bear-caused human injury or property damage (Kearney 1989). To accomplish the goals of the PBAP, bears are trapped in baited culvert traps, immobilized, caged at a holding facility, and relocated with helicopters or trucks (Kearney 1989). How these activities affect bears, and whether some of these bears become food conditioned and habituated is also poorly known.

Other activities in the area that may have affected bears over the years are the maneuvers of military personnel throughout the Churchill area; spraying of dichlorodiphenyltrichloro-ethane (DDT) by the military as pest control between 1955 and 1963 (Brown and Brown 1970); feeding, habituating, and food conditioning of bears at a local dog kennel along the coast, as well as by tourists on tundra vehicles and at the tundra train lodges (Herrero and Herrero 1997); and encounters of polar bears with local facilities due to food and other human odours or attractants (C. Jonkel, 2001; pers. comm.). The combined effects on polar bears by these activities are poorly understood.

On 15 November 1973, the International Agreement on the Conservation of Polar Bears and Their Habitat was signed in Oslo, Norway. The five "polar bear countries" of the world (Canada, Denmark, Norway, United States, and the Union of Soviet Socialist Republics) responded to a growing concern about the number of bears being killed or harvested each year (Derocher et al. 1998). Each undersigned party agreed to conduct national research relating to the conservation and the management of the species, and to give females and cubs a special status compared to other sex and age groups. The Polar Bear Specialist Group also recognized that there is a strong public demand for watching polar bears and their behaviour in their natural environment, and that disturbance in polar bear concentration and denning areas should be minimized (Derocher et al. 1998). Studies throughout the circumpolar range of polar bears on radionuclide contaminants are being undertaken, but too little is known about the effects of tourism on polar bears (Calvert et al. 1998; Derocher et al. 1998). More research is needed to understand the impact of such perturbations, especially from a management and conservation perspective. It was suggested that harassment of bears at the time of year when they are fasting, may be particularly stressful (Calvert et al. 1998).

Acute or chronic stress stimulates the release of cortisol or other adrenocorticoids in mammals (Yates and Urquhart 1962). The cumulative effect of potential long and short-term stressors may result in increased serum corticosterone or decreased serum progesterone, leading to either smaller litter sizes (Boonstra et al. 1998) or decreased reproductive success (Ball 1993; Ashley and Holcombe 2001), respectively. Lower reproduction rates were reported for the western Hudson Bay polar bear population (Derocher and Stirling 1995b) between 1966 and 1992. These responses were in part attributed to climatic change and density of the polar bear population (Derocher and Stirling 1992, Stirling and Derocher 1993; Stirling et al. 1999). Consequently, what is being observed in this population may be a result of the combination of multiple stress factors.

2.4 Existing knowledge on polar bear behaviour at Churchill

The western Hudson Bay polar bear population has been studied since 1966. A vast body of literature exists on population distribution, abundance, physiology, and population boundaries, which were the main foci throughout these years (Stirling et al. 1977; Derocher and Stirling 1995a; Taylor and Lee 1995; Lunn et al. 1996). Some indirect studies of polar bear behaviour were conducted where feces were analyzed which allowed inferences to be made about terrestrial feeding behaviour during the ice-free period (Derocher et al. 1993). A few studies at Churchill examined the significance of supplemental food during the ice-free period (Lunn and Stirling 1985) or investigated non-aggressive behaviour at Churchill's garbage dump (Lunn 1986). Various other studies focused on the Cape Churchill to Nelson River area to examine the distribution and social interactions of bears during the ice-free period (Latour 1980, 1981a,b; Stenhouse 1982; Derocher and Stirling 1990b). Other studies focused on polar bear safety (Fleck and Herrero 1988), human - bear conflicts (Herrero and Herrero 1997), and possible harassment of polar bears by tundra vehicles (Watts and Ratson 1989). Safety concerns and human-bear conflicts were either attributed to the baiting of polar bears (Watts and Ratson 1989), or the food conditioning of bears by improper disposal of gray water (e.g., dishwater that is disposed of into the gravel below the tundra train lodge) at tundra train lodges (Herrero and Herrero 1997). A more recent study focused on bear-bear interactions and the evolutionary advantage of male social play-fight in the Gordon Point area (Ramsay and Waterman, unpublished).

Chapter 3

Dimensions of the polar bear tourism industry at Churchill, Manitoba

Abstract

From mid-July to mid-November, polar bears of western Hudson Bay are on shore because the annual ice on the bay melts completely. As the season progresses, polar bears concentrate in staging areas to await freeze-up. This natural phenomenon was recognized and led to the establishment of a polar bear viewing industry by tour operators at Churchill during the 1980's. Quantitative and qualitative data were collected during the October and November of 2000 to provide baseline information on the dimensions of the polar bear viewing industry. An estimated 9,720 visitors came to the study area to view polar bears from 10 October to 15 November, 2000. There were 15 ● 1 (mean ± SE) tundra vehicles [TV] (an estimated 270 visitors) per day in the viewing area. The mean approach distance between bears and vehicles was estimated to be 24 ± 3 m. The average of the maximum number of TV around a bear was 4.6 ± 0.4 vehicles, the average number of TV around a bear was 2.1 ± 0.1 vehicles, ranging from 1 – 9 TV. The minimum time TV were within a close viewing distance to bears was estimated to be 3 h. Family groups (5.5 ± 1.2 TV) and subadult males (4.6 ± 1.2) had more TV around them than did other bears. Disturbances in the form of approaching and leaving TV around a bear occurred every 10.2 ± 1.7 min.

Key words: human dimensions, tourism, bear viewing, Churchill, Manitoba, polar bear, *Ursus maritimus*.

Introduction

Polar bears of the western Hudson Bay population spend from mid-July through mid-November on shore because Hudson Bay ice melts completely (Stirling et al. 1977). During that time, bears feed little and are sustained by their stored body fat (Russell 1975; Knudsen 1978; Nelson et al. 1983; Lunn and Stirling 1985; Ramsay and Hobson 1991; Derocher et al. 1993). Once on land, polar bears segregate by sex and age class along the western shore of Hudson Bay. Adult males remain on the coast, family groups move farther inland, pregnant females travel toward the denning areas, and subadults of both sexes are found throughout the coastal and inland areas (Derocher and Stirling 1990a, b).

The study area at Gordon Point is a major congregation site (~50 km^2), approximately 35 km east of Churchill, where polar bears await the freeze-up of Hudson Bay (Fig. 1). The number of bears in this area increases over the season. Two local tour operators provide bear-viewing and photography opportunities for tourists in this area. Tourism in the study area peaks from 1 October through mid-November when polar bear density in the area is the greatest. Visitors view polar bears either from tundra vehicles (customized vehicles with large tires that travel across tundra) or helicopters. This form of tourism has been practiced since the early 1980s, attracting approximately 4,000 polar bear enthusiasts annually (MacKay et al. 1996).

Very little research and monitoring of this industry has been conducted to examine the dimensions, possible effects on polar bear behaviour and physiology, and whether current management practices by agencies and conduct of tundra vehicle operators are adequate to sustain this industry over the long-term. Watts and Ratson (1989) provided anecdotal information on polar bear behaviour and vehicle conduct at

Cape Churchill, approximately 40 km east of the study area. Their conclusion was that standard codes of conduct or guidelines for tour guides and tundra vehicle operators should be developed that regulate the approach of tundra vehicles to bears.

The objectives of this paper are to provide quantitative and qualitative baseline information on the dimensions of the Churchill polar bear viewing industry at Gordon Point. Tour operators and management agencies could use these data as building blocks for future monitoring programmes, or as key points when assessing Churchill's current bear-viewing tourism industry.

Materials and Methods

Study Area

The study area lies on the southwestern coast of Hudson Bay within the Churchill Wildlife Management Area (CWMA), 30 - 35km east of Churchill, Manitoba (Fig. 1), in the Gordon Point area (approximately 58^{O} 45' N to 58^{O} 48' N, and 93^{O} 38' W to 93^{O} 50' W). The entire area is generally without relief with elevations less than 50m. The coastline is characterized by gravel spits, foreshore flats, post-glacial beach ridges, shallow lakes and ponds surrounded by willows (*Salix* spp.), and is described in more detail by Ritchie (1962), Jonkel et al. (1972), Stirling et al. (1977), Latour (1981b), Dredge and Nixon (1992) and Clark et al. (1997). Plates 3 through 8 provide a general overview of the landscape of the study area at Gordon Point. Hudson Bay's pattern of freezing and thawing are briefly described by Lunn et al. (1997a).

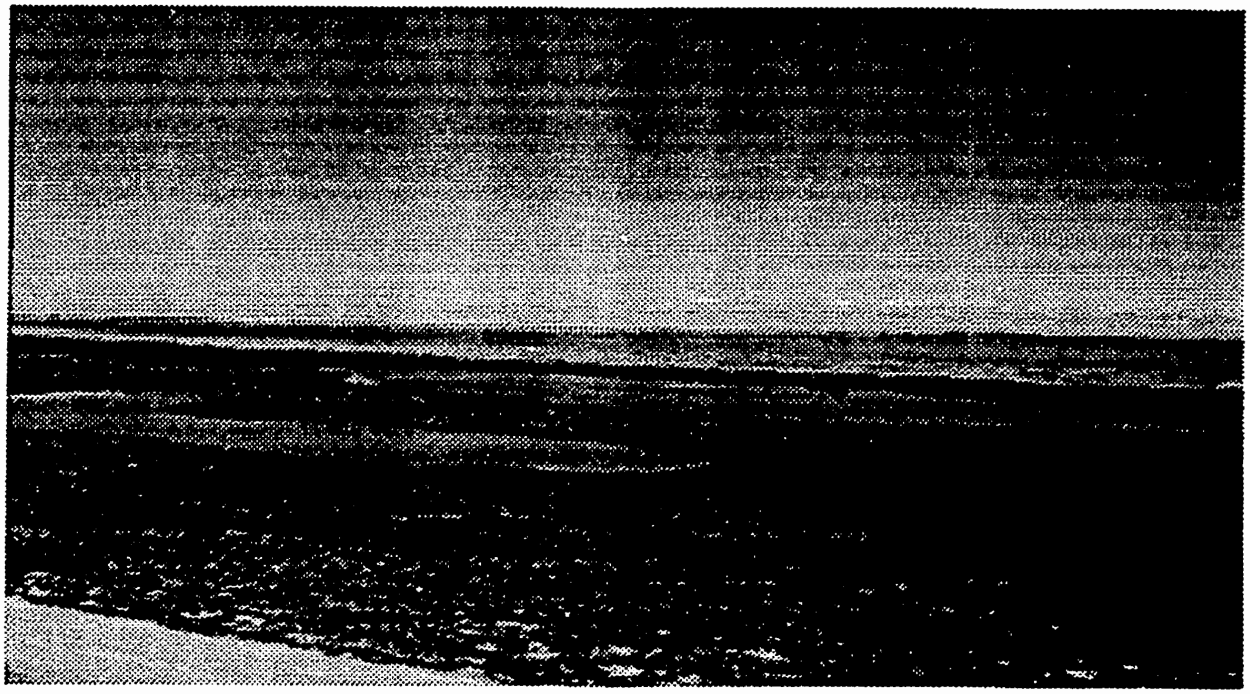


Plate 3. Study area (West-view) as seen from observation tower.

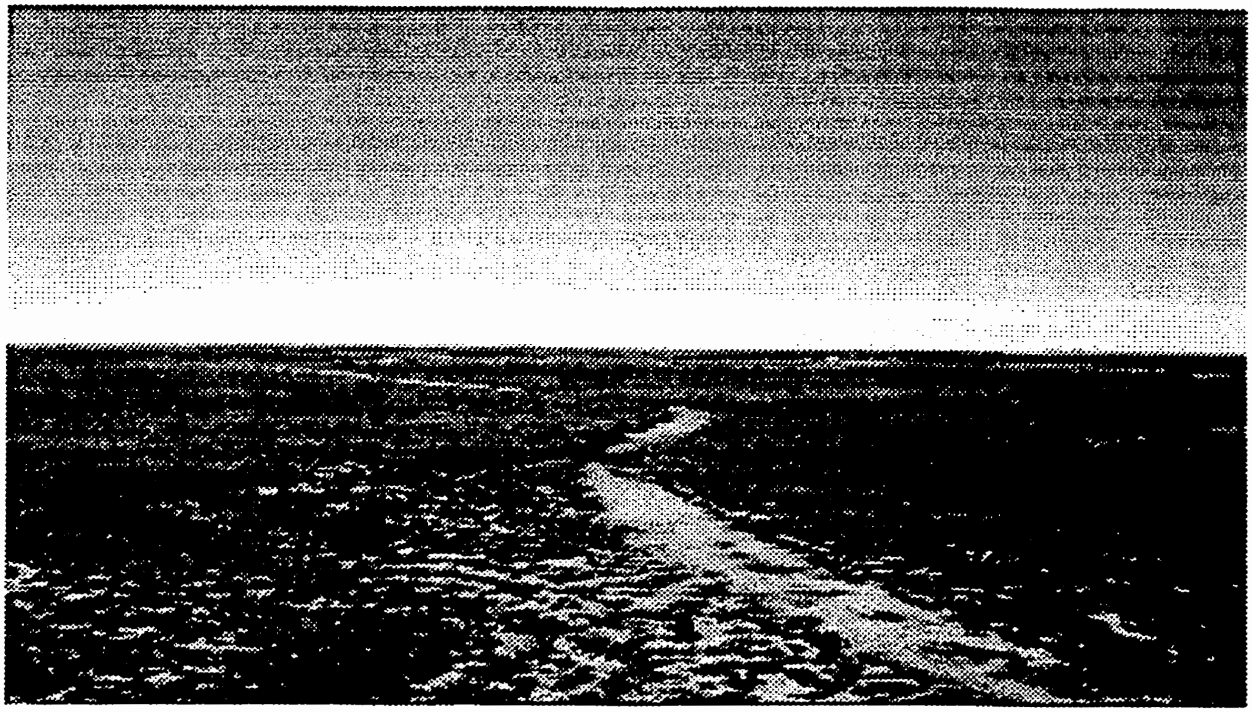


Plate 4. Study area (East-view) as seen from observation tower.

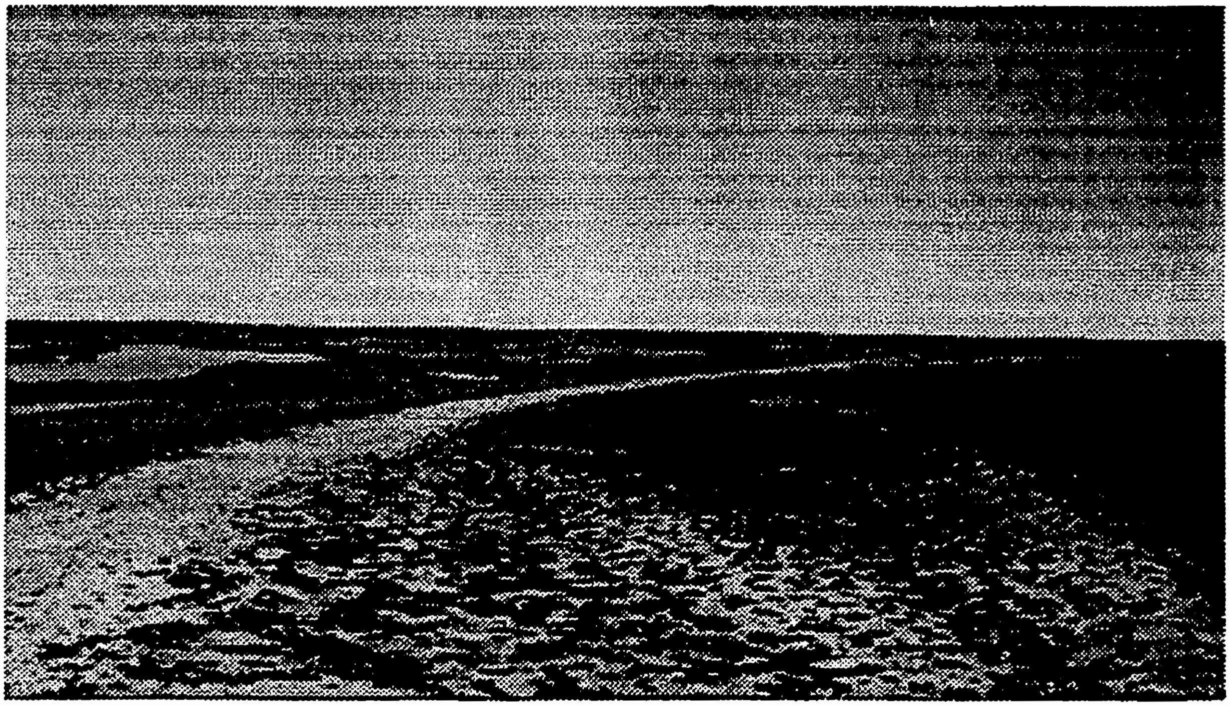


Plate 5. Study area (South-view) as seen from observation tower.

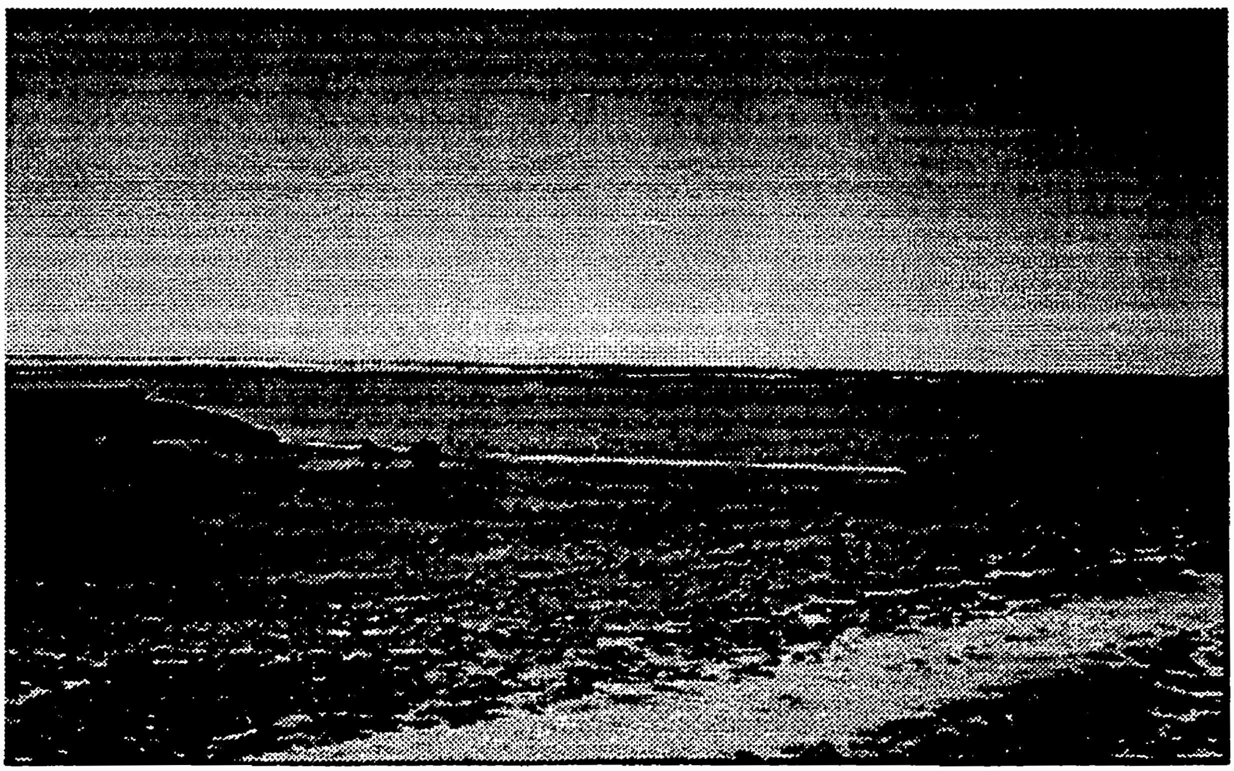


Plate 6. Study area (North-view) as seen from observation tower.

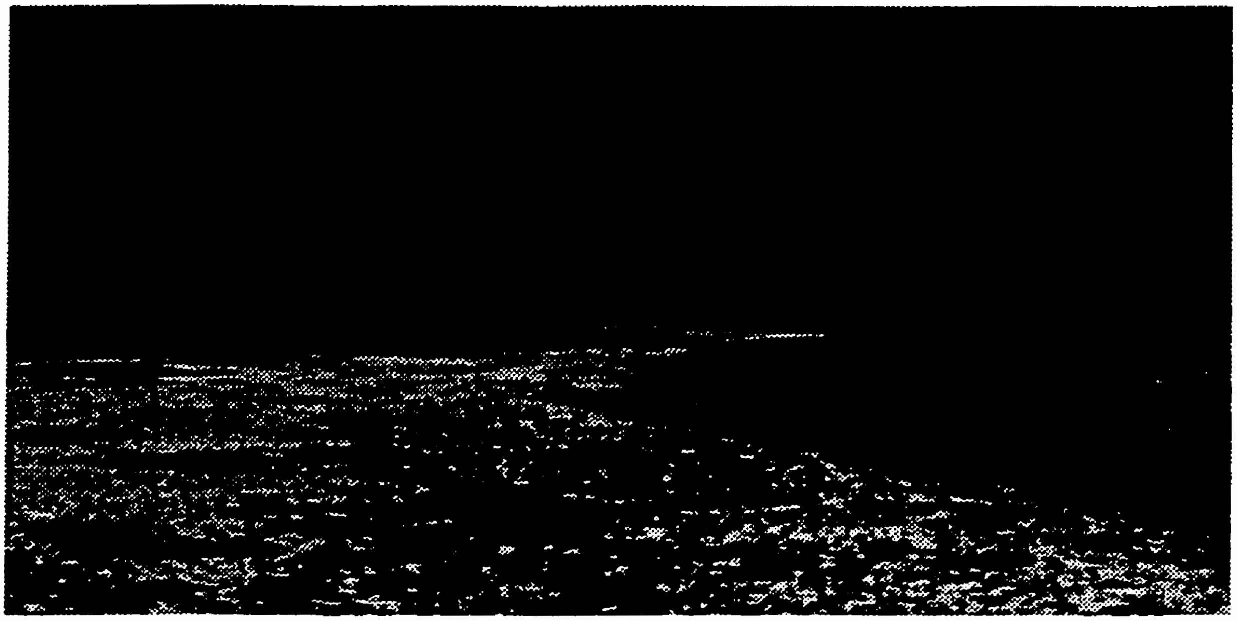


Plate 7. View of study area where Tundra Buggy ® sets up their train lodge.

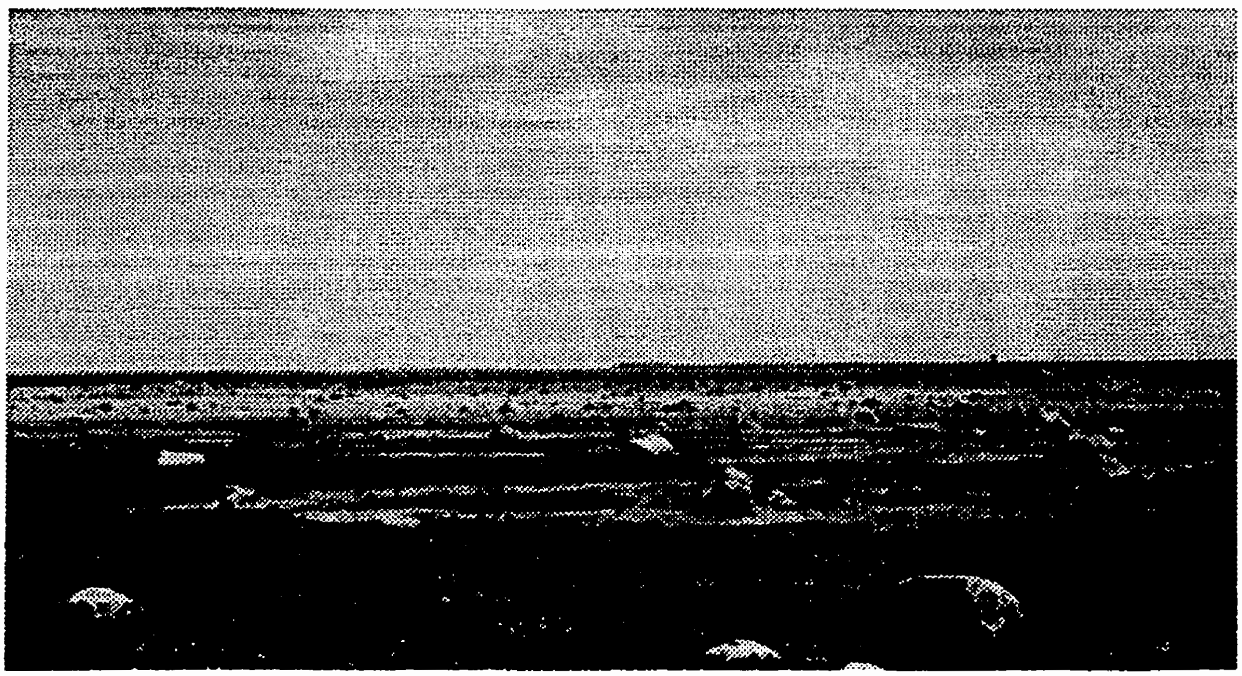


Plate 8. Study area east of Tundra Buggy ® train lodge at low tide.

Observations of the tourism industry activities

This study was carried out from 1 October through 15 November 2000. Observations on tundra vehicle and helicopter activity were conducted from an 8 m high wooden observation tower within the Gordon Point area. All observations on bears, tundra vehicle and helicopter activities were made using a Bushnell 45X spotting scope or a SONY Handycam Video Hi8 camcorder. Observations generally lasted from 0900 to 1700 Central Standard Time. However, data could not be recorded every day because of either reduced visibility (e.g., fog or heavy snow fall) or inaccessibility of the observation tower due to polar bears nearby. Numbers are presented as mean ± SE.

The total number of tundra vehicles per day in the study area was counted as each vehicle passed by the observation tower. All fall tours began at about 0830 h when tundra vehicles left their launch facilities. During scan sampling (Altmann, J. 1974) of the study area, every bear seen, whether it had tundra vehicles in close proximity (e.g., within four to five tundra vehicle lengths, or up to 50 m), the number of tundra vehicles around bears, the estimated distance between tundra vehicles and bear to the nearest meter, and date and time of the scan, were recorded. A 360° scan was conducted from the platform of the tower and lasted for about 2 min. Family groups during scans were recorded as one bear because cubs tended to remain close to their mother. I estimated the maximum number of bears per day in the study area by comparing the number of bears seen during each scan for each observation day, where the scan per day with the most bears was used for analyses. The average of the maximum number of tundra vehicles around bears per day was estimated where the scan with the greatest number of tundra vehicles around a bear was selected for analysis. The maximum number of bears having tundra vehicles around them was estimated using a similar approach. An estimate of the mean number of tundra vehicles around bears was obtained by selecting every event during a scan where a bear had one or more tundra vehicles in close proximity (e.g., within 50 m).

The estimated approach distance between a tundra vehicle and a bear was determined from direct observations or videotapes using the dimensions of a tundra vehicle to provide a scale (e.g., a tundra vehicle is about 10 m long). All individual estimated approach distances were used to calculate an overall mean estimated approach distance. The mean least time where tundra vehicles were around bears was estimated by calculating times from scan samples when the same individual bear was in close contact (e.g., up to 50 m) with tundra vehicles in at least two consecutive scans.

During the course of observations on polar bears and tundra vehicles, I decided to conduct observations on helicopter activities in the Gordon Point area. Helicopter activities occurred every day, and to estimate how extensive those activities were, I quantified these activities from 24 October to 12 November (n = 11 d). I recorded the number of helicopter over-flights, where an over-flight is defined as passing by the observation tower from east to west or vice versa. Other over-flight directions (e.g., north to south) did not occur in the study area as helicopters followed the coastline (i.e., west to east or vice versa) during aerial viewing activities. Time intervals between helicopter over-flights, the mean number of helicopter landings, the mean time on ground were recorded as well. The locations of landings were recorded qualitatively (e.g., close to bears, on an island, off the trail).

The tide chart for Hudson Bay for the period from 15 August to 7 November 2000 was also examined to determine whether the two Designated Polar Bear Resting Areas (DPBRA) within the Gordon Point area would be accessible to bears during tundra vehicle activities throughout the day. It was suggested that DPBRA would be used by polar bears when tourism activities at Gordon Point are at daily peaks (C. Elliott, 1999; pers. comm.).

Qualitative data of tundra vehicle activity (e.g., following a designated trail versus driving off a trail, pursuing bears off trail), behaviour of passengers on tundra vehicles (e.g., passengers are talking loudly, yelling, laughing), and helicopter activity (e.g., landing in Designated Polar Bear Resting Areas) were recorded during the collection of quantitative data (i.e., during scan or focal sampling) as naturalistic observations (Punch 1998). These observations were either directly observed and recorded on paper, or videotaped from the observation tower or tundra vehicles as natural events occurred.

Results

Quantitative observations

The total number of tundra vehicles/day in the Gordon Point area from 10 October to 15 November (n = 22 d) was 15 ± 1 tundra vehicles (Fig. 4). With a conservative estimate of 18 visitors/tundra vehicle (seating capacity ranges from 20 – 44 people), an estimated 9,720 visitors came to the study area to view bears from 10 October to 15 November, 2000, or at least 270 visitors/day.

The overall maximum number of bears seen per day (7.6 ± 0.6 bears), the maximum number of bears seen per day having tundra vehicles around them (4.9 ± 0.4 bears), and the maximum number of tundra vehicles around a bear/family group (4.6 ± 0.4 tundra vehicles) are shown in Figure 5. When broken down by classes of bears, family groups had the highest maximum number of tundra vehicles around them (family groups: 5.5 ± 1.2; Subadults: 4.6 ± 1.2; Adult males: 4.2 ± 0.7; Unidentified: 3.5 ± 0.6).

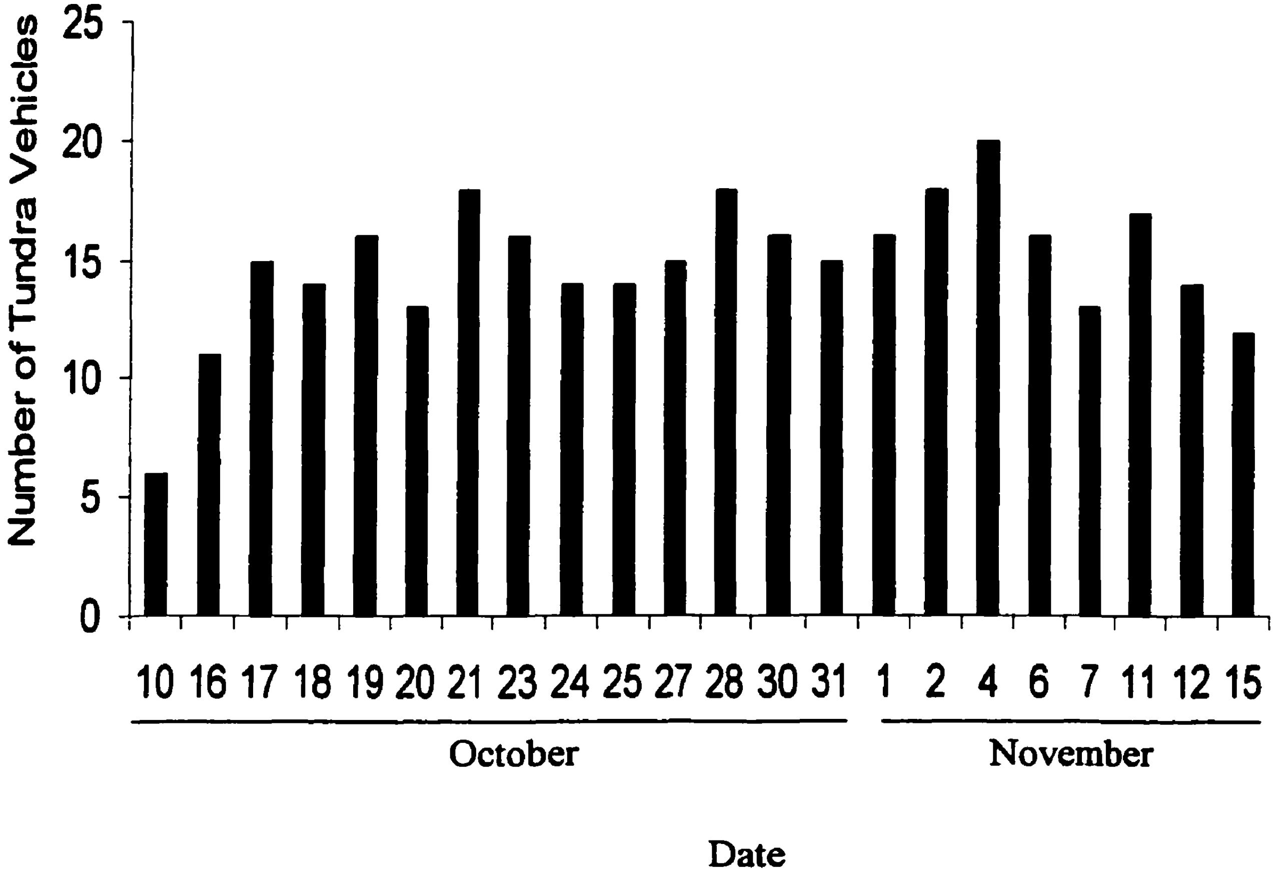


FIG. 4. Total number of tundra vehicles in the study area per day between 10 October and 15 November 2000 (Note: Data for each day were not available due to weather conditions).

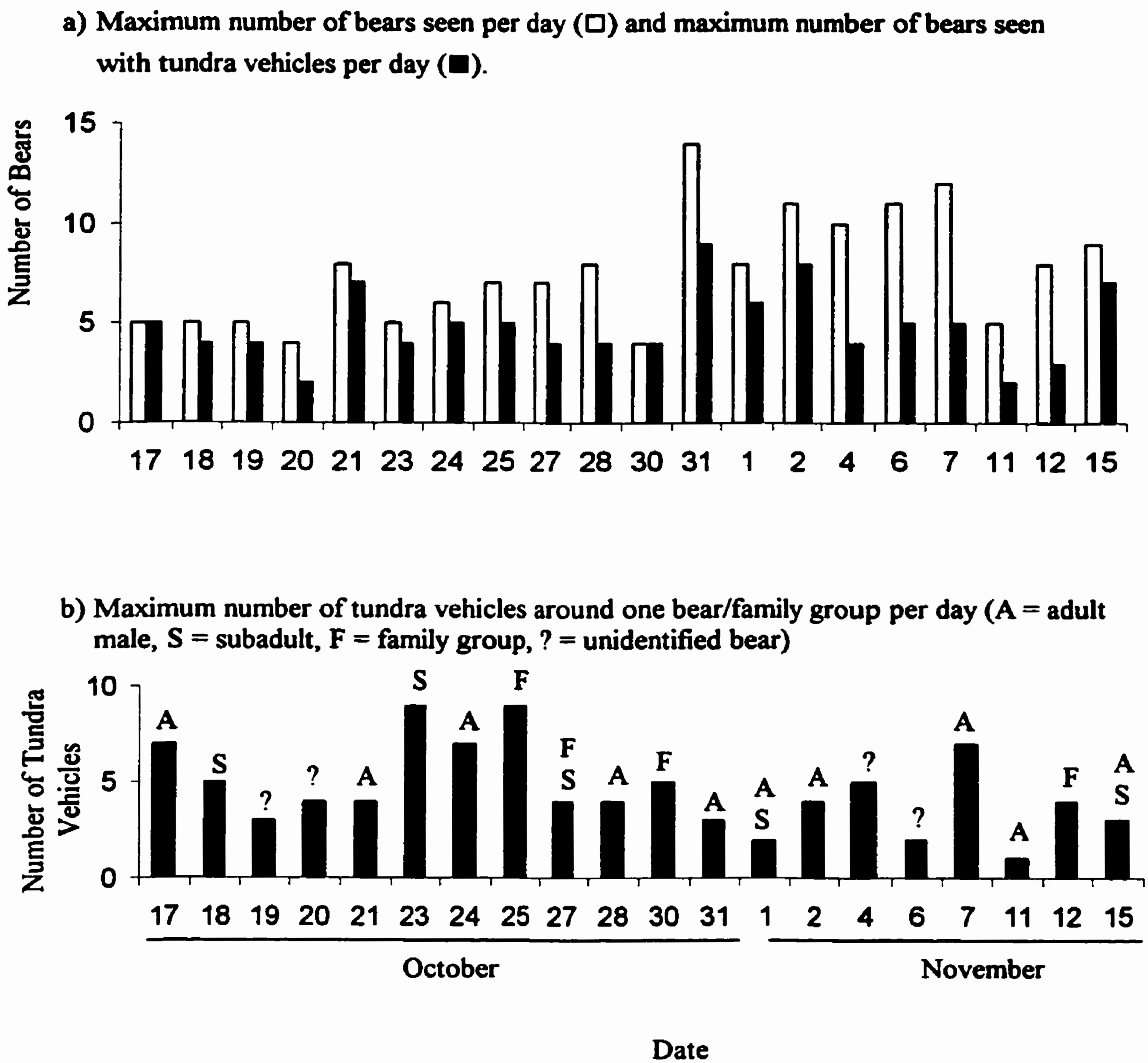


FIG. 5. Maximum number of bears seen per day and maximum number of bears with tundra vehicles (a), and maximum number of tundra vehicles around one bear/family group per day (b), 17 October to 15 November, 2000 at Churchill, Manitoba (Note: Data for each day were not available due to weather conditions).

The mean number of tundra vehicles around a bear was 2.1 ± 0.1 tundra vehicles (n = 216), ranging from 1 to 9 tundra vehicles. As the frequency distribution indicates (Fig. 6), one tundra vehicle around bears occurred more often than two or more tundra vehicles. As the season progressed, more bears were seen in the study area (multiple regression: $t = 2.965$, $P = 0.0091$, n = 20). A breakdown of the frequency and the number of tundra vehicles around polar bears of different sex and age classes is presented in Figure 7.

Using scan samples, the least time that a bear had vehicles within 50 m (n = 31) was 169.5 ± 9.4 min (2.8 hrs). A scan was conducted every 100.7 ± 5.3 min (1.7 hrs). The overall estimated approach distance between tundra vehicles and resting or feeding bears was 24 ± 3 m (n = 66). No significant difference was detected between the estimated approach distance for resting (21 ± 2 m, n = 53) and feeding (33 ± 10 m, n = 13) bears (Mann-Whitney U; $U_{11,53} = 310$, $p = 0.578$). A frequency distribution of all estimated approach distances (n = 66) is shown in Figure 8. Distances of 0 – 30 m represented 88% of all approaches. On average, tundra vehicle activity or commotion around a viewed polar bear occurred every 10.2 ± 1.7 min (Fig. 9).

From 24 October to 12 November (n = 11 d), 367.9 ± 27.3 min (6.1 h) per day were spent to record helicopter activities. The mean number of helicopter over-flights (HOF) per day was 15.8 ± 2.5 HOF, ranging from 7 to 36 HOF, depending on weather conditions. In addition, helicopters landed on average 4.7 ± 1.1 times/day in the Gordon Point area. Intervals between HOF were 29.8 ● 2.4 min, and time on ground was 2.9 ± 0.7 min. Helicopters were landing along the trail system within the Gordon Point area where pick-up and drop-off of passengers occurred next to tundra vehicles.

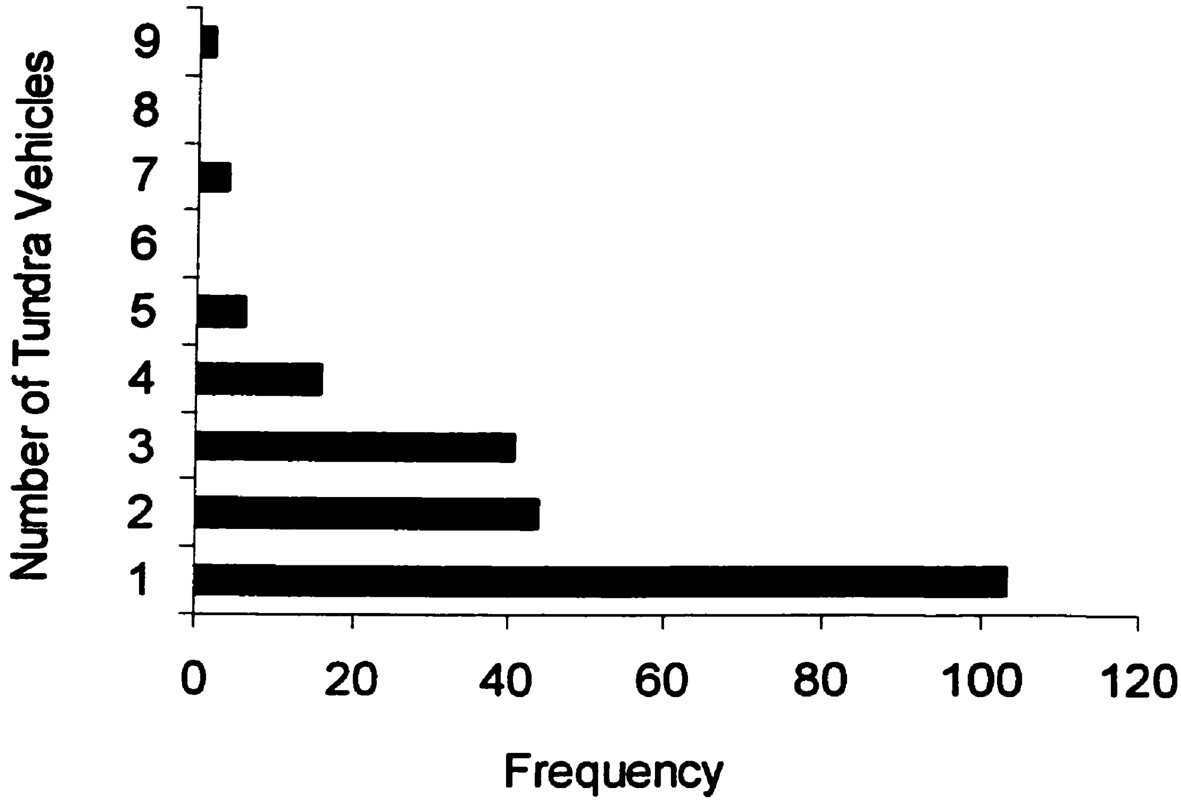


FIG. 6. Frequency distribution of the number of tundra vehicles around polar bears at Churchill from 17 October to 15 November, 2000.

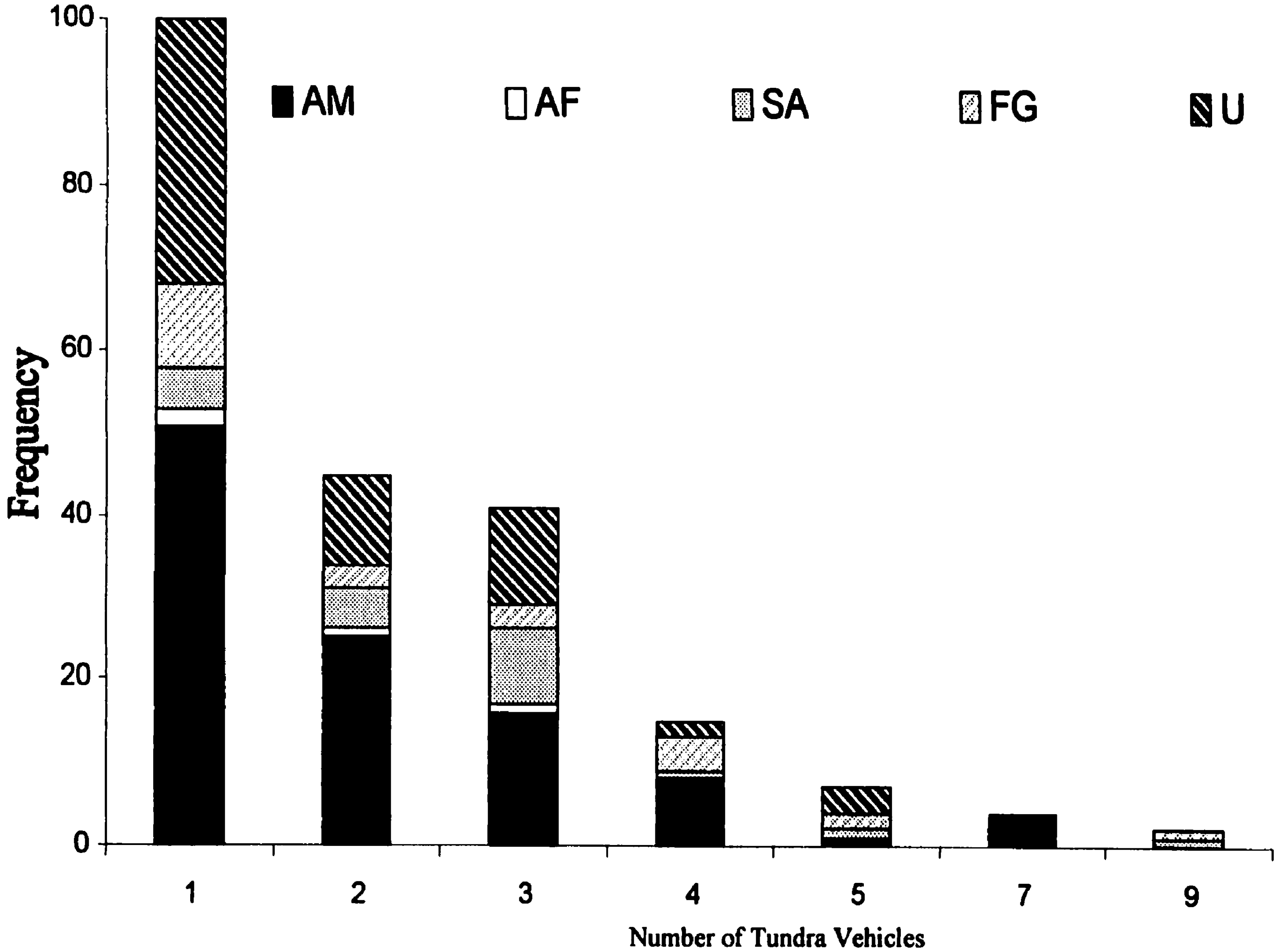


FIG. 7. Distribution of the number of tundra vehicles around sex and age classes of polar bears at Gordon Point, Churchill, (Note: AM = adult male; AF = adult female; SA = subadult; FG = family group; U = unidentified).

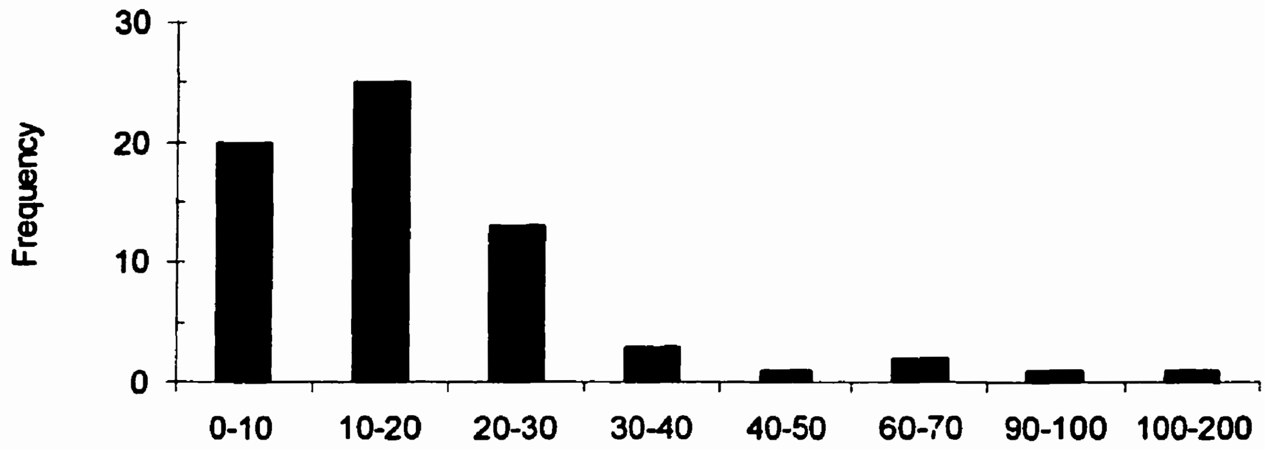


FIG. 8: Frequency distribution for Estimated Approach Distance (EAD) between tundra vehicles and bears at Churchill from 17 October to 15 November, 2000.

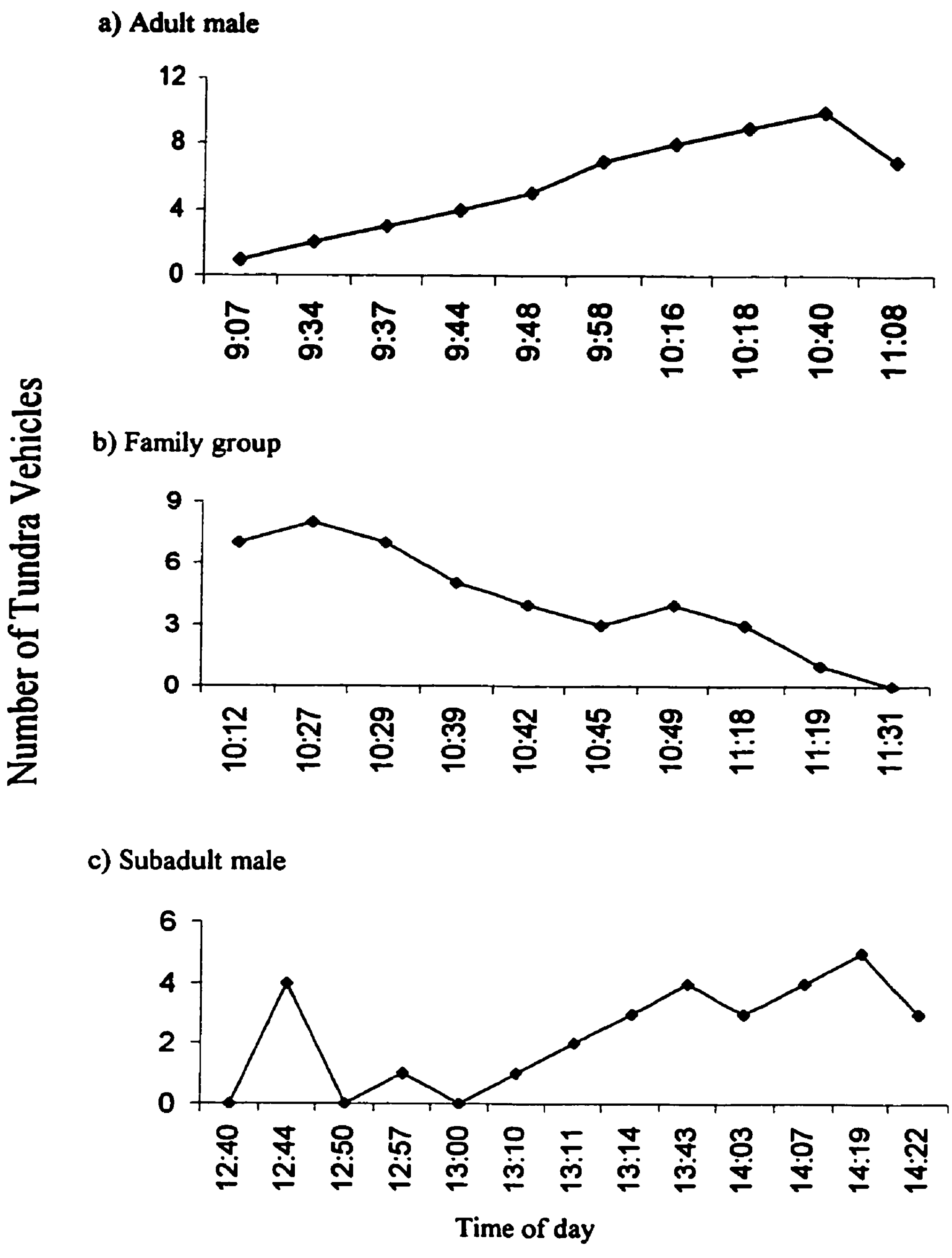


FIG. 9. Examples of the change in the number of tundra vehicles during individual viewing sessions on any day around polar bears at Gordon Point, Churchill for a) Adult male, b) Family group, and c) Subadult male.

Examination of the tide chart for Hudson Bay and comparison with field observations revealed that the Designated Polar Bear Resting Areas (Fig. 1) were either completely or partially covered by water on 40 out of the 84 days (47.6%) while polar bear viewing tours were conducted. These resting areas were considered as inaccessible to polar bears when high tides occurred from 1030 h to 1530 h while tundra vehicle tours were conducted in the Gordon Point area.

Qualitative observations

Qualitative information was recorded on tourist behaviour, helicopter and tundra vehicle activity during polar bear viewing. On several occasions, passengers of tundra vehicles were observed photographing polar bears from the roofs of vehicles. Film crews and regular passengers were observed disembarking tundra vehicles for unknown purposes, but it is assumed for better photo opportunities of specific objects of interest. While on the back deck of the tundra vehicles (Plate 9), passengers were noisy in close proximity to lying bears (i.e., yelling, talking loudly, laughing), and some were banging on the outside of the deck to get the viewed bear's attention. Passengers also leaned over the railing of the deck when the vehicle was stationary. Attempts to get the attention of polar bears included whistling and loud talking by passengers, starting-up of the engine by tundra vehicle drivers, or hissing and chuffing noises by drivers and passengers. When light conditions were not favourable for photography, pictures were taken with flash-supported cameras at relatively short distances to bears (e.g., when bear was rearing on tundra vehicle).

During October and November, it was observed on three occasions that helicopter bear-viewing tours were flown over Designated Polar Bear Resting Areas, and after

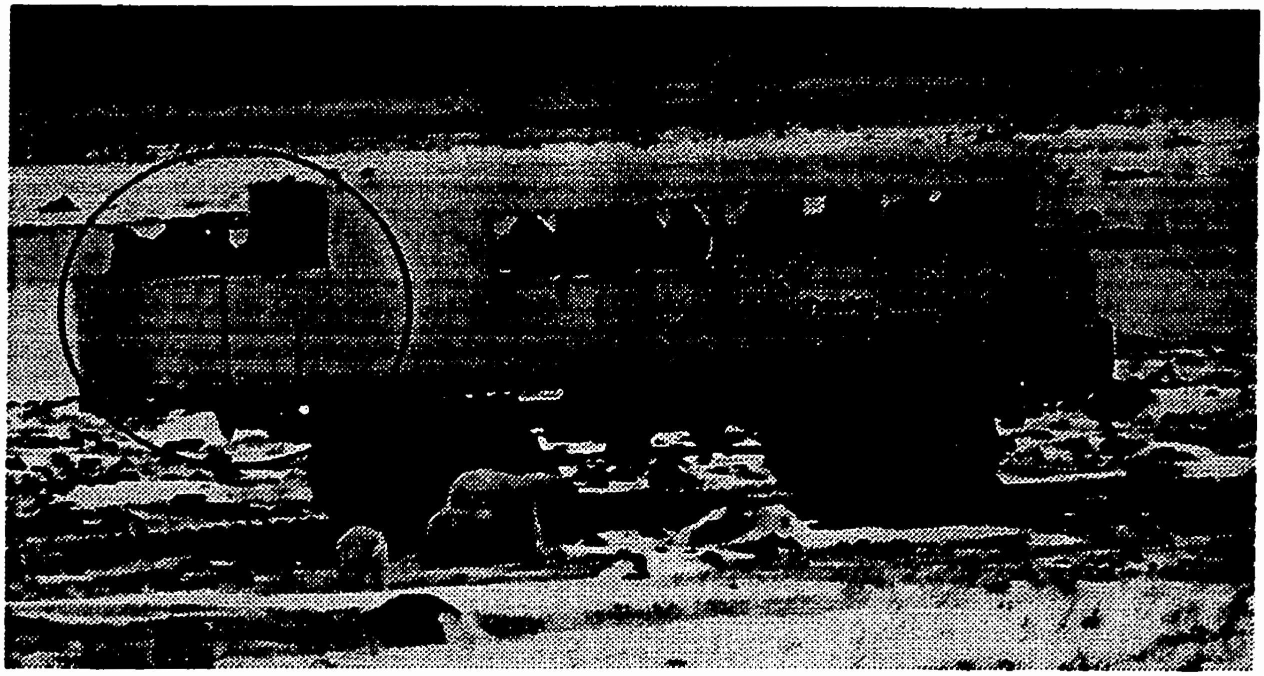


Plate 9. Back deck of a tundra vehicle with visitors (red circle) during a bear-viewing excursion at Gordon Point, Churchill, Manitoba (Note: female and cubs on the lower right of the circle) [Photo credit: Kim Daley].

landing, passengers disembarked. Helicopters landed throughout the Gordon Point area to pick up and drop off passengers. There were at least two instances observed where helicopters displaced bears to allow closer landing to a tundra vehicle. Displacement was achieved by hovering low (e.g., << 50 m) and next to the bear, which resulted in indirectly "pushing" the bear farther away from the tundra vehicle.

Tundra vehicles used any trail that remotely resembled an all-weather road or existing trail, including snowmobile and ATV-trails. Increased speeds were noticed when tundra vehicles were returning to their launch facilities and the day-trips were finished. It was also observed on several occasions that family groups were approached in areas with no existing trail system. These family groups were pursued for up to 4 km and 2 – 4 h to allow professional photographers and film crews unique photo opportunities. This was observed directly and later confirmed through conversations with tundra vehicle drivers.

Discussion

The estimated number of visitors transported to view polar bears in the study area between 10 October and 15 November 2000 was 9,720 visitors, and is more than double of what has previously been estimated by MacKay et al. (1996). This number does not include mid-to-late summer excursions which occurred approximately three times per week from mid-July to the end of September, nor tourists staying overnight at the two tundra train lodges, nor visitors participating in night-time bear-watching tours. The overall number of participants in polar bear-viewing activities is assumed to be greater as visitors participating in bear-viewing activities between 1 – 9 October are not included in this estimate. This difference in visitor numbers may suggest that either previous studies did not accurately record or compute all polar bear viewers, or numbers have in fact been increasing. The reported estimate was also confirmed by the owner of one tour company (M. Gunter 2001; pers. comm.).

Beginning 1 October, operators had reached the maximum number of tundra vehicles permitted by Manitoba Conservation in the study area. Therefore, no relationship between maximum number of bears seen and number of tundra vehicles in the study area was observed. As temperatures got colder and the fast-ice (e.g., ice that forms very early during the cold season and is attached to the shore) formed, more bears congregated in the study area. This was likely because the bears were awaiting freeze-up of the bay. Subjectively, when maximum numbers of bears seen in the study area increased, the maximum number of tundra vehicles around bears decreased. These observations indicate that earlier in the bear-viewing season, when fewer bears are around, "crowding" of bears occurred where each bear was associated with four to five tundra vehicles, or an estimated 72 – 90 visitors. This crowding of polar bears with tundra vehicles was perceived negatively by visitors, who expressed their personal viewing experiences in a 1998 survey (World Wildlife Fund Canada 1999).

Family groups, adult and subadult males had the highest number of maximum tundra vehicles around them. Male bears engage in play-fight activities (Ramsay and Waterman, unpublished). This activity is sought-after by visitors as a photographic collectible, as well as females and their cubs (N. Rosing, 2000; pers. comm.). Adult male bears and subadults seem to be less affected by the number of tundra vehicles than females. Because females are mostly accompanied by their cubs in the Gordon Point area, they may tend to be more cautious of noises and human-made disturbances (e.g., tundra vehicles).

The data did not allow to demonstrate at which maximum number of tundra vehicles bears are affected the most. However, given that visitor experience declined with increased number of tundra vehicles around bears (World Wildlife Fund Canada 1999), a maximum limit of tundra vehicles around bears could be established through conducting a visitor survey that focuses specifically on this issue.

Currently, due to the lack of manipulative studies, no scientific data exist to determine whether the estimated closest distance to resting and feeding polar bears is affecting their behaviour or physiology. From studies on other wildlife species, group size and approach distance of tourists can affect the behaviour of the animals negatively (Kovacs and Innes 1990: harp seals; Burger and Gochfeld 1993: boobies; Burger et al. 1995: various bird species; Lott and McCoy 1995: Asian rhinos; Grieser Johns 1996: chimpanzees; Russell and Ankenman 1996: orangutans; Giese 1996, 1998: Adélie penguins; Fowler 1999: Magellanic penguins). Reported negative effects included habituation, decrease in feeding time, hormonal changes, decreased survival in nestlings, increased alertness, decreased nursing time, increased predation and death.

Stonehouse (1990) suggested a "baseline" distance of 18 m between Antarctic travelers and fur seals. My reported estimated closest distance was greater than Stonehouse's baseline distance. However, polar bears at Churchill are approached in large motorized vehicles, and noise levels are higher than when compared to a traveler on foot. Noise can have a variety of negative effects on wildlife, including hearing loss, increased metabolism, and aggression (Manci et al. 1988; Bowles 1995; Gabrielsen and Smith 1995). No specific requirements regarding noise reduction (i.e., engine noise levels, approach distances of tundra vehicles to bears, and noise levels of visitors on tundra vehicles) are provided by the provincial management agency when permits to operate tundra vehicles are issued (W. Roberts 2000, pers. comm.).

Polar bears spend most of their time resting during the ice-free period to conserve energy (Knudsen 1978). Therefore, more resting bears were approached by tundra vehicles. However, because a bear that does not move away while being approached by a tundra vehicle does not necessarily mean that there are no adverse effects. Fowler (1999) demonstrated that when Magellanic penguins were approached by visitors, the birds' corticosterone levels increased. Similarly, when Adélie penguins were approached from 5 to 30 m by visitors, their heart rate increased significantly (Giese 1998). In both studies, the animals did not move away when approached by visitors. Prolonged adrenocortical stress response can result in cessation of reproduction, cardiovascular and gastrointestinal disease, damage to the immune system, and loss of neurons in the brain (Wingfield 1985; Sapolsky 1987).

Polar bear safety and animal welfare issues become more problematic as monetary incentives are provided to guides and drivers to "relax" approach practices (Herrero and Herrero 1997), and viewing distances between polar bears (i.e., family groups) and tundra vehicles carrying visitors, professional photographers, and film crews diminish. As well, charismatic wildlife, such as polar bears, can often be seen as a photographic collectible (Russell and Ankenman 1996), they are approached closely, and ethics of wildlife photography as outlined by Gabriel (1990) are sometimes compromised. Some of these suggested ethical considerations include a) to move slowly, casually, and not directly at the wildlife; b) to observe wildlife from a distance; c) to use the animal's behaviour as a guide; d) to limit the time around wildlife, and e) not to chase wildlife (Gabriel 1990).

The estimated mean least time that a bear had tundra vehicles within the estimated approach distance (24 ± 3 m) was probably underestimated, and is in fact greater. The total number of scans used was small because fog and snowfall often reduced visibility, causing scans to be aborted or delayed. This number does not reflect the total time that tundra vehicles were in the study area. In general, tundra vehicles arrived in the study area between 0900 h and 1200 h, depending on bear encounters along the trail from the tundra vehicle launch facilities to the study area. Tundra vehicles usually left the study area between 1400 h and 1500 h. However, when the maximum number of bears in the study area was low, up to five tundra vehicles were associated with one bear for at least 3 h. Watts et al. (1991) suggested that prolonged disturbances (e.g., > 60 min) could result in significant increases in metabolic rates of stationary (e.g., resting) bears. While bears are viewed for at least 3 h, resting bears may have elevated metabolic rates that could increase further if bears are engaged in locomotion. The fact that tundra vehicles approached a bear or vacated the vicinity of a bear every 10 min could have an additive or synergistic effect on the metabolic costs of viewed resting bears. "Visitation times" for other wildlife species, such as chimpanzees (Grieser Johns 1996) and Asian rhinos (Lott and McCoy 1995) are limited to one hour and 21 min per day, respectively.

In addition to terrestrial viewing activities, bears were also exposed to viewing from helicopters. The exact number of visitors participating in these activities was unknown because helicopters landed within the study area to pick-up passengers directly from tundra vehicles, or transported passengers directly into the viewing areas and Designated Polar Bear Resting Areas (DPBRA) from the town of Churchill. Intervals for helicopter over-flights (HOF) corresponded to half-hour viewing tours. While viewing-tours are flown, a minimum altitude of 50 m above ground, and a minimum distance of 100 m between wildlife and the helicopter should be maintained (W. Roberts 2000; pers. comm.). Subjectively, these altitudes were rarely maintained during fair weather conditions, and helicopters were much lower during fog and light snowfall. Studies on the effects of noise from helicopters and other aircrafts on wildlife species showed negative effects on behaviour and physiology, even at recommended distances (Manci et al. 1988; Bowles 1995; Gabrielsen and Smith 1995; Knight and Cole 1995). To address whether these distance requirements for helicopters at Churchill are adequate, carefully designed research is needed to evaluate the possible effects of current practices.

While polar bear viewing-tours were conducted, polar bears had only limited access from 15 August to 7 November, 2000 to the two DPBRA within the Gordon Point area because these areas were completely covered by water. The DPBRA were established to provide resting opportunities for bears while on land, and to avoid tourism activities during fall (C. Elliott 1999; pers. comm.). However, it appears that these DPBRA are not fulfilling their intended purpose, and a re-evaluation of their designation seems warranted. The Regional Wildlife Manager at Thompson was informed about the findings and remarked that this issue will be looked into (C. Elliott 2001; pers. comm.).

The primary polar bear viewing season at Churchill lasts 42 to 50 d on average. The potential effects on polar bears by humans and their artifacts in the study area are confined to a short time frame, but it is the quantity of human activity during this period that should be taken into consideration when attempting to manage a nature tourism industry. If climatic changes become more pronounced in the sub-Arctic regions, polar bears could spend a substantially longer period on land during the ice-free period (Stirling et al. 1999). Therefore, their exposure to human activity may increase as tour operators could take advantage of a prolonged fasting season of polar bears (Newton 2000). To avoid cumulative effects on polar bears, management regimes should be designed that take these parameters into consideration and reduce any potential adverse effects on bears.

Conclusions

Churchill's polar bear-viewing industry is world-famous, mostly because visitors get "up-close and personal" with bears as compared to other bear-viewing areas where greater distances are encouraged and enforced (Herrero and Herrero 1997). This study documented that bears are viewed from a distance of about 24 m. How viewing distance affects bears in other ways could not be established, but my impression from observations is that the current minimum distance for resting bears should be at least 24 m. In conjunction with the collected baseline data, monitoring of bears and their behaviour together with a manipulative study where viewing distances are experimentally altered, could help establish proper viewing distances.

Watts et al. (1991) suggested that stationary bears may have increased metabolic rates during prolonged disturbances. Individual "viewing sessions" per bear could be restricted to about 1.5 hour with a maximum of 2 – 3 tundra vehicles. If more tundra vehicles surround bears, the viewing experience of customers decreases (World Wildlife Fund Canada 1999), and the commotion around a bear increases. Tour operators together with Manitoba Conservation could design a schedule for where tundra vehicles can drive within the study area, and where vehicles will stay in a group to engage in bear-viewing activities. Participatory involvement of all interested parties could lead to a better understanding and acceptance of possible implementations to mitigate adverse effects on the bears (Korten 1981; Long 1993; Timothy 1999). Education of tourists regarding specific regulations or codes of conduct can enhance visitor experience as education facilitates the understanding of why these restrictions or codes exist (e.g., protection and conservation of bears), and they allow viewing of polar bears in their natural environment (Frost and McCool 1985). Monitoring of bear behaviour and vehicle activities by either Manitoba Conservation personnel or tour operators may provide information on how to satisfy customer needs with the least disturbance of bears.

Chapter 4

Vigilance behaviour of polar bears in the context of polar bear viewing activities at Churchill, Manitoba.

Abstract

Polar bear viewing tours using tundra vehicles have been offered at Churchill, Manitoba since the 1980's without examining the possible effects on polar bear behaviour. Vigilance behaviour of polar bears in this context was used to examine whether it was affected by tundra vehicle activity during wildlife viewing. I used focal animal sampling where I examined whether a difference in vigilance behaviour existed between presence and absence of tundra vehicles. In general, male bears showed increased vigilance response in the presence of tundra vehicles (i.e., increased frequency of head-ups and decreased between bout intervals). Females/family groups behaved opposite to males, probably because vehicles provided a safety-buffer and decreased risks of infanticide. The vigilance bout lengths did not differ significantly between males and females. Vehicle-threshold for males where an increased response was observed is one vehicle. No magnification in response was observed with increasing number of vehicles. Females showed a response to the number of vehicles where more vehicles resulted in greater vigilance response. Total time spent vigilant was 2.5X greater with tundra vehicles than without. More research is needed to determine which factors (e.g., noise of vehicles and people, distances from vehicles to bears, odours) are responsible for increased vigilance.

Key words: *Ursus maritimus*, polar bear, wildlife-viewing, vigilance, effects, Churchill, tundra vehicle

Introduction

Polar bears depend on the sea ice to hunt their primary food source, ringed seals (Stirling and Archibald 1977; Smith 1980). Hudson Bay is generally ice-free from July until mid-November, which forces the bears to come ashore (Stirling et al. 1977). During that time, bears feed little and they are sustained by their stored fat reserves (Russell 1975; Knudsen 1978; Nelson et al. 1983; Lunn and Stirling 1985; Watts and Hansen 1987; Ramsay and Stirling 1988; Ramsay and Hobson 1991; Ramsay et al. 1991, 1992). Once on land, bears segregate by sex and age class (Derocher and Stirling 1990a, b), and spend the majority of their time resting to conserve energy while awaiting freeze-up (Knudsen 1978).

During October and November, two local tour operators at Churchill offer polar bear viewing tours where visitors are transported on tundra vehicles (large customized vehicles that travel on the tundra) to view polar bears in the Gordon Point area, about 35 km east of the town of Churchill. These activities have been practiced since the early 1980's (Webb 1985; Herrero and Herrero 1997). During these viewing excursions, bears are approached at distances of < 40 m (see Chapter 3), and at times are harassed by tundra vehicles (see Chapter 3; Watts and Ratson 1989).

Certain life-history characteristics of polar bears of the western Hudson Bay population indicate that bears may be responding to changes in the environment and ecosystem (see Chapter 2). Litter sizes and body masses of polar bears of this population have been decreasing, whereas cub mortality has been increasing (Derocher and Stirling 1995a, b). Those manifestations in the life-history characteristics of bears were attributed to possible effects of climatic change (Stirling and Derocher 1993), or were seen as a density-dependent response (Derocher and Stirling 1992, 1993). Other factors that may produce similar results are the presence of organochlorines in polar bears (Korach 1987; Colborn et al. 1993; Rennie 1993; Polischuk et al. 1995). Whether nature tourism activities at Churchill are contributing toward the facts mentioned above, and how these activities affect polar bear behaviour and energetics is poorly understood (Calvert et al. 1998). It was suggested that, while bears are fasting, these perturbations might be particularly stressful (Calvert et al. 1998).

Wildlife-viewing has become a very popular recreational activity with the number of participants steadily increasing (Walsh et al. 1989; Giannecchini 1993). As humans seek recreation and spirituality, wildlife behaviour (Boyle and Samson 1985; Knight and Cole 1995; Knight and Gutzwiller 1995), vegetation and soil (Wolcott and Wolcott 1984; Vaske et al. 1992; Camp and Knight 1998; Cole and Spildie 1998), as well as the quality of the experience of visitors are altered or negatively influenced through these activities (Vaske et al. 1995). Recent studies documented increased habituation, decreased feeding time, changes in hormonal milieu, decreased survivorship, increased predation, death, and increased alertness as effects of tourist activities on wildlife (Kovacs and Innes 1990: harp seals; Burger and Gochfeld 1993: boobies; Blane and Jaakson 1994: Beluga whales; Jacobson and Lopez 1994: green sea turtles; Burger et al. 1995: various bird species; Lott and McCoy 1995: Asian rhinos; Grieser Johns 1996: chimpanzees; Russell and Ankenman 1996: orangutans; Giese 1996, 1998: Adélie penguins; Barr and Slooten 1999: dusky dolphins; Fowler 1999: Magellanic penguins). Data on how tundra vehicle activity affects polar bears at Churchill are particularly important in light of trends that indicate an increase in the length of the ice-free period. As the ice-free period increases, tour operators could benefit from this phenomenon and lengthen the polar bear viewing season at Churchill.

Through an experimental study, Watts et al. (1991) concluded that prolonged disturbance of stationary polar bears could lead to substantial metabolic costs. Observations on behaviour of a species under certain circumstances (e.g., how an animal behaves during wildlife viewing activities) can also lead to contributions to conservation and improved management of that species (Clemmons and Buchholz 1997). Examining "vigilance" behaviour of stationary polar bears in the context of tundra vehicle activities could lead to a better understanding of whether these activities affect polar bears, and in which way.

Vigilance can be defined as "a motor act, which corresponds to a head lift interrupting the ongoing activity" (Quenette 1990), and involves a visual scanning of the surroundings beyond the immediate vicinity (Quenette 1990; Treves 2000). This behaviour has been associated with the detection of predators (see review by Elgar 1989; Lima and Dill 1990; Cowlishaw 1998; Arenz and Leger 1999a, b; Toïgo 1999), reduction of risk by allowing prey to perform evasive or mobbing behaviour (Curio 1978; Lima 1994), detection of mates and competitors (Prins and Iason 1989; Baldellou and Heinzi 1992; Cowlishaw 1998), observation of conspecifics (Roberts 1988; Caine and Marra 1988), and avoidance of infanticide (Steenbeek et al. 1999). Many studies documented that individual vigilance decreases with increasing group size (Quenette 1990; Kildaw 1995; Roberts 1996; but see Bekoff 1995; Rose and Fedigan 1995; Blumstein 1996; Treves 1998), and that differences between sex (Schall and Ropartz 1985; Quenette 1990; Burger and Gochfeld 1994; Rose and Fedigan 1995; Gould et al. 1997; but see Elgar 1989), season, and habitat exist (Quenette 1990).

Polar bears are at the top of the arctic food chain. They are solitary animals that come together only for the purpose of mating, or when land-bound during the ice-free period (Ramsay and Stirling 1988; Derocher and Stirling 1990a, b; Ramsay and Waterman unpublished). How group-size effects are manifested in polar bears is unknown, but risk of infanticide could increase with increased group size.

The only "natural" predators of polar bears are humans and conspecifics. Humans in Nunavut hunt bears of the western Hudson Bay population. Bears in the Gordon Point area may perceive humans and tundra vehicles as possible threats. Also, male-male bear and family group-male bear interactions including cannibalism have been reported from the Gordon Point area (Ramsay and Waterman unpublished; Dyck and Daley *In press*). These interactions could also provide stimuli that elicit a vigilance response in polar bears at Gordon Point. Vigilance behaviour for polar bears in the context of tourism activities can shed light on how bears react to a "perceived threats", either in the form of humans and human artifacts (e.g., tundra vehicle), or conspecifics.

Vigilance behaviour conflicts with other activities, such as sleeping, feeding, grooming, or fighting (Dimond and Lazarus 1974; Caraco 1979; Lendrem 1983, 1984; Cords 1995; Mooring and Hart 1995; Brick 1998; McAdam and Kramer 1998). As such, it is costly because it requires the limited resources of time and visual attention (Altman, S. 1974; Dukas 1998). Continued stimuli that are perceived as threats (e.g., predator avoidance) can elicit a hormonal chain reaction resulting in increased cardiac output, increased levels of "stress hormones" (i.e., glucocorticosteroids and corticosterone), and the formation of glucose at the expense of protein and fat (Axelrod and Reisine 1984; Sapolsky 1987; Chester-Jones et al. 1972; Wingfield 1994; Wingfield et al. 1997). Short-term and chronic effects of stress hormones include increased foraging behaviour, suppressed reproductive behaviour, inhibition of the reproductive system, severe protein loss, suppressed immune system, neuronal cell death, and suppressed growth (Wingfield et al. 1997). An investigation into polar bear vigilance behaviour in the context of tourism activities, and the determination of whether polar bears are affected by these activities, can help to establish a baseline of the current situation, therefore enabling management agencies to prevent chronic effects from taking place.

In this paper, vigilance behaviour of polar bears in the context of wildlife viewing activities at Churchill, Manitoba was examined. The results of this study may provide a tool, or indicator in the form of vigilance, which could be used by management agencies when designing monitoring programmes with the goal to assess possible effects of wildlife viewing in a non-invasive form.

Materials and Methods

The study was conducted in the Gordon Point Area (GPA; 58^{O} 45' N to 58^{O} 48' N, and 93^{O} 38' W to 93^{O} 50' W) which lies on the southwestern coast of Hudson Bay approximately 30 - 35km east of Churchill, Manitoba (Fig. 1). The entire area is generally without relief with elevations less than 50m. The coastline is characterized by gravel spits, foreshore flats, post-glacial beach ridges, and shallow lakes and ponds surrounded by willows (*Salix* spp.). A more detailed description of Churchill's coastal and inland areas is given by Ritchie (1962), Jonkel et al. (1972), Stirling et al. (1977), Latour (1981b), Dredge and Nixon (1992) and Clark et al. (1997). The area of highest tundra vehicle activity in the Gordon Point area is approximately 50 km^2 and encompasses a polar bear staging area. Hudson Bay patterns of freezing and thawing are briefly described by Lunn et al. (1997a).

The Gordon Point area was chosen for this study over a comparative study with multiple locations to avoid confounding effects of pseudo-replication (Hurlbert 1984), to minimize variation within and among locations (e.g., differences in habitat, bear abundance), and to increase the power of statistical tests used for data collected from this location.

Vigilance behaviour of polar bears

Observations of vigilance behaviour of polar bears were conducted during the day-to-day activities of tour companies from 1 October through 12 November 2000. Distances from bears to tundra vehicles, the number of tundra vehicles around a bear during viewing, and visitor behaviour on board of tundra vehicles could not be controlled. I examined whether a difference in vigilance of polar bears could be detected in the presence versus absence of tundra vehicles. Polar bears were observed from an 8 m wooden observation tower (Plate 9) at Gordon Point (Fig. 1) usually at distances of 200 – 1500 m, or videotaped from tundra vehicles using a SONY Handycam Video Hi8 camcorder.

Bears were identified as either males or females by accompanying cubs, body size, scars, and head and neck shape (Knudsen 1978). I focused only on resting bears (e.g., lying prone in one spot, head on ground, legs sprawled out or front legs tucked under body, with flank and hindquarters on ground, or curled up; Øritsland 1970; Caro 1987) because the conservation of energy at this time of year may be critical in the bear's lifecycle (Knudsen 1978; Belkhou et al. 1990; Castellini and Rea 1992; Atkinson and Ramsay 1995; Atkinson et al. 1996). Any disturbance during resting could point toward greater energy expenditures or physiological responses (Watts et al. 1991). In addition, focusing on resting bears provides the same starting point for data recording, it allows comparison of data between bears with and without tundra vehicles, and it seemed practical as most bears approached by tundra vehicles were resting. Vigilance for this purpose was defined as head-up movements where the head of a bear was lifted to shoulder-level or above while lying down (Plate 10).

Observations on vigilance behaviour of polar bears in the Gordon Point area were generally begun between 09:00 h and 16:00 h Central Standard Time. Focal animal sampling was used to record data on vigilance behaviour of polar bears (Altmann, J. 1974). In particular, I recorded the number of head-ups with and without tundra vehicles for a maximum of 30 min, or until the bear stood or sat up, or walked away. The starting point for recording data was the first head-up after the bear took a resting position with the head lowered to the ground. The end point was a head lowered to and resting on the ground, either when the 30 min were over, or before the bear engaged in activities other than resting. Because observation times differed for all bears, each variable was expressed as a proportion of the total observation time. These proportions were used for statistical analyses.

In addition, I recorded the vigilance bout length (i.e., time in seconds from the moment the head was raised to the moment when the head was lowered back to the ground), and the between bout intervals (i.e., the time in seconds that passed between a head-down and the next head-up movement) in the presence and absence of tundra vehicles.

Data were recorded for a "paired" and an "unpaired" experimental design. For the paired design, I randomly selected bears from bears present in the Gordon Point area using a random number table. Once a bear was selected as focal animal, head-up, vigilance bout length, and between bout intervals were recorded in the presence and absence of tundra vehicles on the same individual (e.g., head-up for an individual with

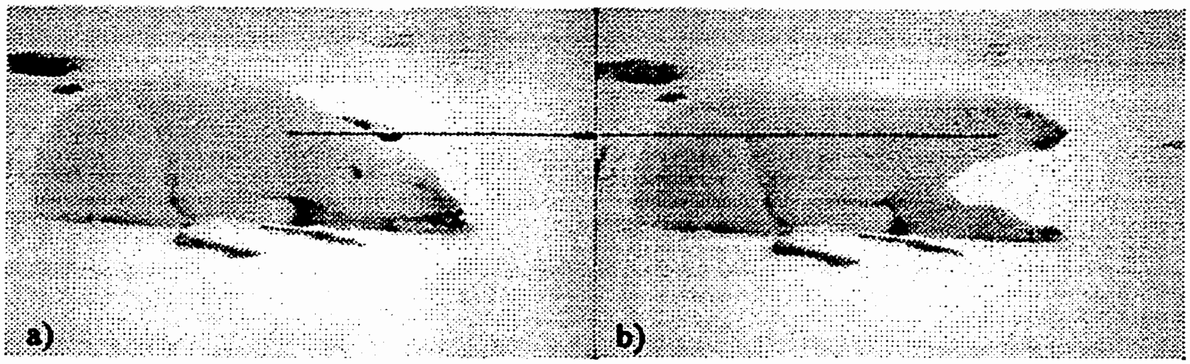


Plate 10. Illustration of vigilance (head-up) behaviour of a polar bear. Initial resting behaviour [a)] with head on ground, and reaction to stimulus [b)] with head at or above shoulder level (dotted line).

and without tundra vehicles) on the same day. For example, observations with tundra vehicles were taken early during the day, and without in the afternoon, or vice versa. For the unpaired design, I randomly selected bears either with or without tundra vehicles to record the variables in question. Hence, all variables for this design were recorded on different animals either with or without tundra vehicles (e.g., head-up for an individual with tundra vehicles, or head-up for an individual without tundra vehicles). However, bad weather (e.g., dense fog, heavy snow fall), tundra vehicles along the trail, and safety precautions prohibited travel to the observation tower on several occasions. Therefore, vigilance behaviour was recorded either after tundra vehicles vacated the study area, or were at least 2 km away from the focal animal, and the bear was undisturbed for at least 30 min. To examine whether time of day influenced vigilance behaviour, the daily observation time was divided into three blocks of 33 percentiles each. I therefore compared vigilance behaviour of bears within the first 33 percentiles with behaviours from the 66^{th} to the 100^{th} percentile.

If a bear showed signs of habituation in the response to tundra vehicles, I would predict that the vigilance bout length decreases and the between bout intervals increase over the course of multiple vigilant bouts within one observation period. I therefore calculated the mean times for each vigilance bout length and between bout interval for all bears and plotted these against individual numbers of head-up and intervals of an observation bout, respectively, to examine whether a functional response existed. I used simple linear regression to test these predictions for vigilance bout lengths and between bout intervals for males of the unpaired design. Sample sizes of the paired design were not adequate to allow appropriate statistical analyses. In addition, I observed one bear that had only one tundra vehicle for about two hours within 50 m to examine whether habituation would occur with less tundra vehicle commotion (see Chapter 3).

Paired t-tests were applied for the paired design to examine whether differences between sex, and with and without tundra vehicles existed. Two-factor analysis of variance (Zar 1999) was used to determine whether interactions in the paired design between sex and the presence versus absence of tundra vehicles were apparent. One-factor ANOVA was applied for the unpaired data sets to examine whether differences existed with versus without tundra vehicles. Differences attributed to sex were not examined because only males were observed without tundra vehicles. I used simple linear regression to examine whether a relationship existed between the observed variables and the number of tundra vehicles around a bear. Statistical analyses were considered significant at $\alpha = 0.05$.

Additionally, I calculated the mean time in vigilance for bears in the unpaired design as a proportion of the total observed time. For statistical analyses, I multiplied head-up as proportion of total time observed by the vigilant bout lengths as proportion of total time observed for each bear to arrive at a score for total time spent vigilant. The resulting values were subjected to the Mann-Whitney U test to test for differences between bears with versus without tundra vehicles. The overall mean values for males only and all bears with tundra vehicles were compared to bears with no tundra vehicles to examine overall changes in percentage of time spent in vigilance.

Results

Vigilance behaviour was recorded on a total of 53 individually identified bears, with 13 and 40 bears for the paired and unpaired design, respectively. Observations on 10 bears (six males and four females) were used for statistical analyses for the paired design.

Three bears of unknown sex were not included in the paired analyses. Data were recorded on 30 bears with tundra vehicles (6 females, 24 males), and 10 bears without tundra vehicles (all males) for the unpaired design. Mean observation time for vigilance behaviour per bear was 20.7 ± 1.1 min (n = 66).

When all paired data (n = 10 paired observations) were used for initial analysis, no significant difference between presence and absence of tundra vehicles was detected for the variables in question (head-up: t = 1.79, P = 0.107, df = 9; vigilance bout length: t = 0.26, P = 0.803, df = 9; between bout interval: t = - 0.08, P = 0.936, df = 9). When separated by sex, males (n = 6) showed a significant increase in head-up response when tundra vehicles were present (n = 6; t = 5.9, P = 0.002, df = 5), though females did not (n = 4; t = - 0.96, P = 0.409, df = 3). That interaction between sex and tundra vehicle absence and presence was also detected by the 2-way ANOVA (F = 16.09, P = 0.001, df = 1). No significant difference for males versus females was detected for vigilance bout length and between bout intervals in the presence and absence of tundra vehicles (vigilance bout length: males, t = 1.51, P = 0.191; females, t = - 0.57, P = 0.609; between bout interval: males, t = - 1.3, P = 0.250; females, t = 1.46, P = 0.240) [Fig. 10]. However, a significant interaction was detected between sex and tundra vehicles for between bout intervals (F = 4.67, P = 0.0462, df = 1), since males exhibited shorter intervals in the presence of tundra vehicles, while females showed a significant increase.

Vigilance behaviour of bears of the unpaired design was similar to vigilance behaviour of males of the paired design. Head-up of bears in the unpaired design with tundra vehicles present was significantly increased for all bears and males only versus absence of tundra vehicles (all bears: F = 8.99, P = 0.005, df = 39; males only: F = 11.06, P = 0.002, df = 33) [Fig. 11, a)]. Comparisons between males and females

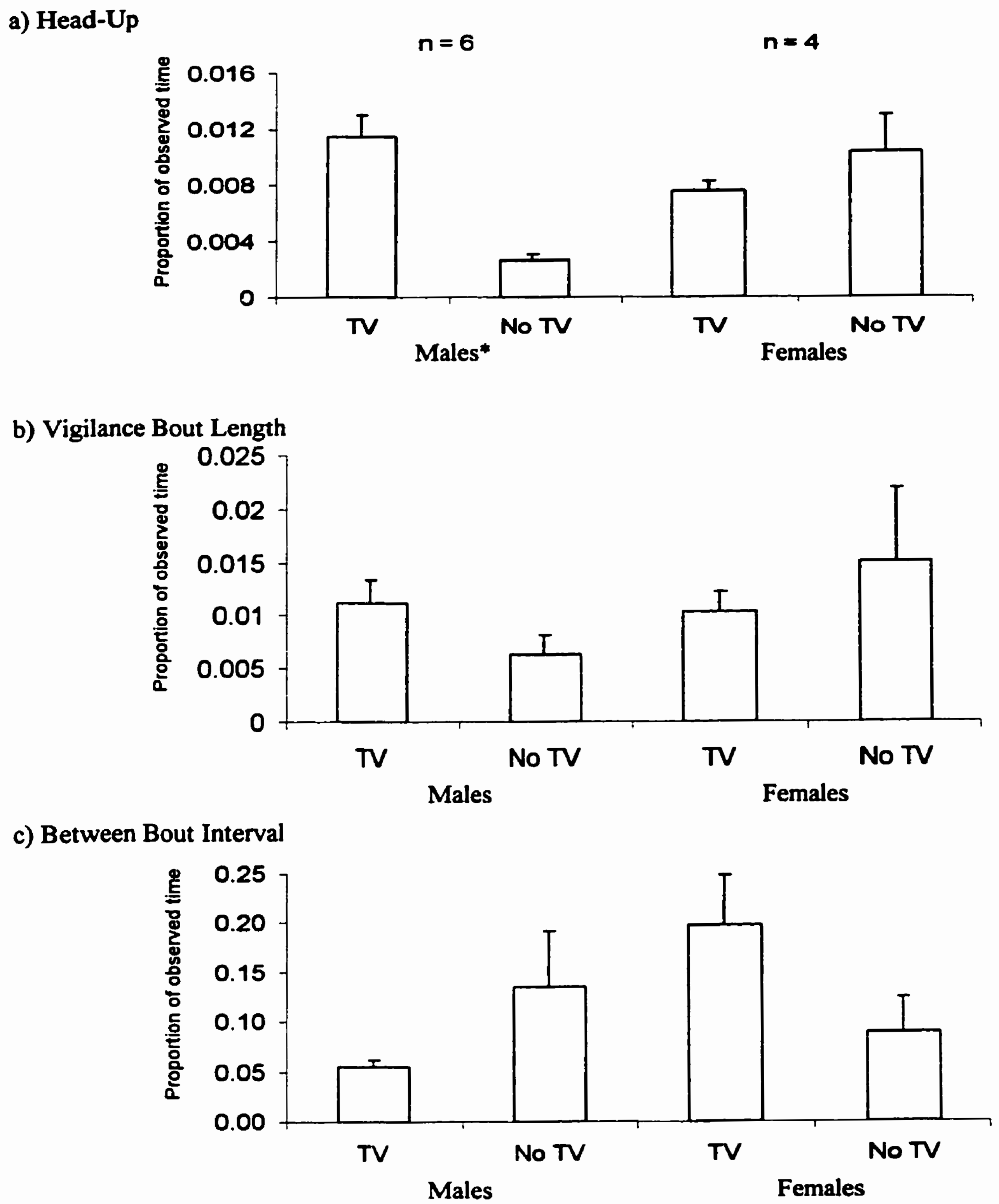


FIG. 10. Head-up (a), vigilance bout lengths (b), and between bout intervals (c) for male and female polar bears, as proportion of total observation time, in the presence and absence of tundra vehicles (TV) [Note: Error bars represent SE; * = significant at $\alpha = 0.05$].

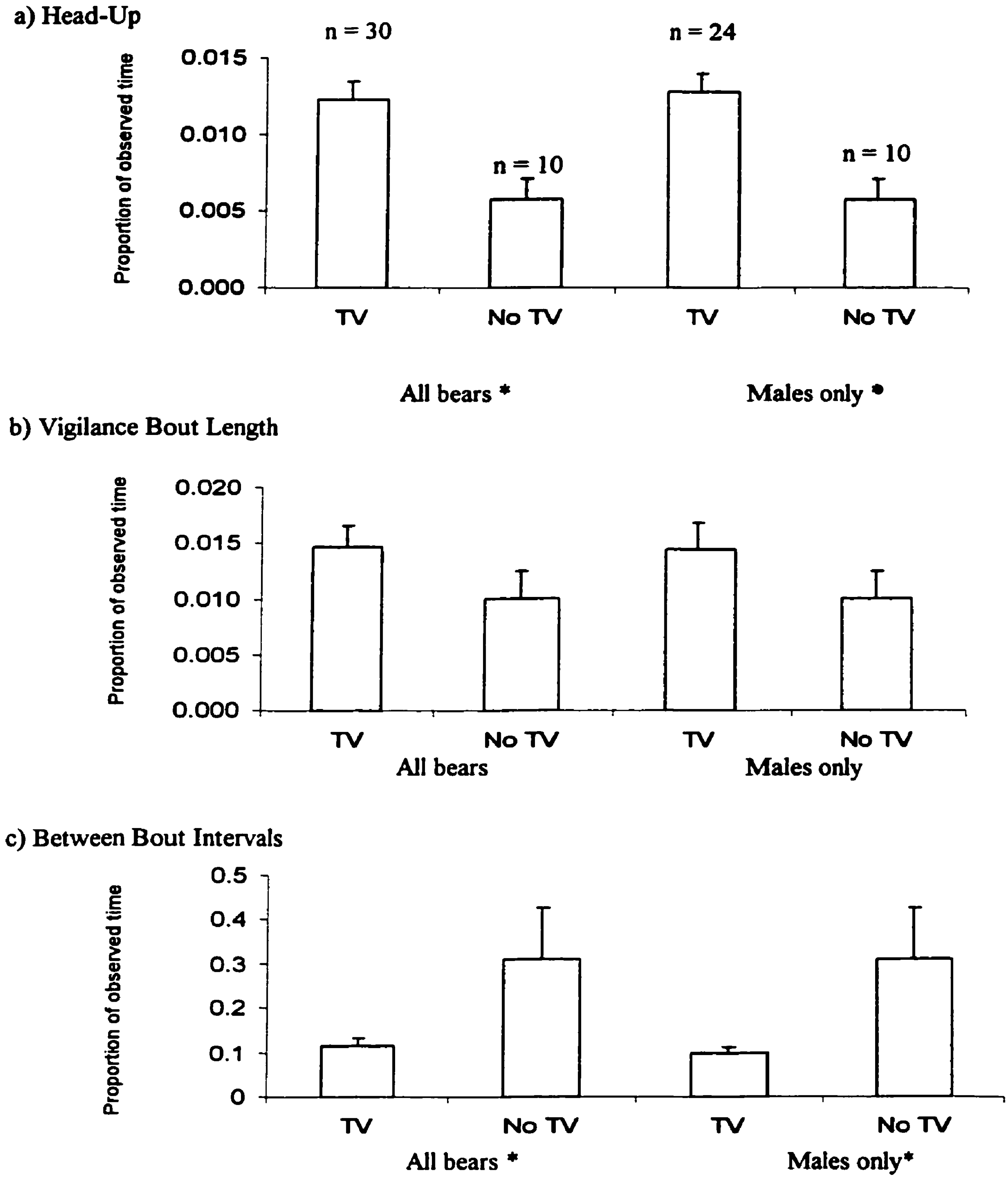


FIG. 11. Head-up (a), vigilance bout lengths (b), and between bout intervals (c) for all bears and males only, as proportion of total observation time, in the presence and absence of tundra vehicles (TV) [Note: Error bars represent SE; * = significant at $\alpha = 0.05$].

were not possible because the group without tundra vehicles consisted of males only. Vigilance bout length for all bears and males only did not differ significantly when tundra vehicles were absent or present (all bears: $F = 1.61$, $P = 0.211$, df = 39; males only: $F = 1.23$, $P = 0.275$, df = 33) [Fig.11, b)]. All bears and males only had significantly greater between bout intervals when no tundra vehicles were present (all bears: $F = 7.29$, $P = 0.010$, df = 39; males only: $F = 7.76$, $P = 0.009$, df = 33) [Fig. 11, c)].

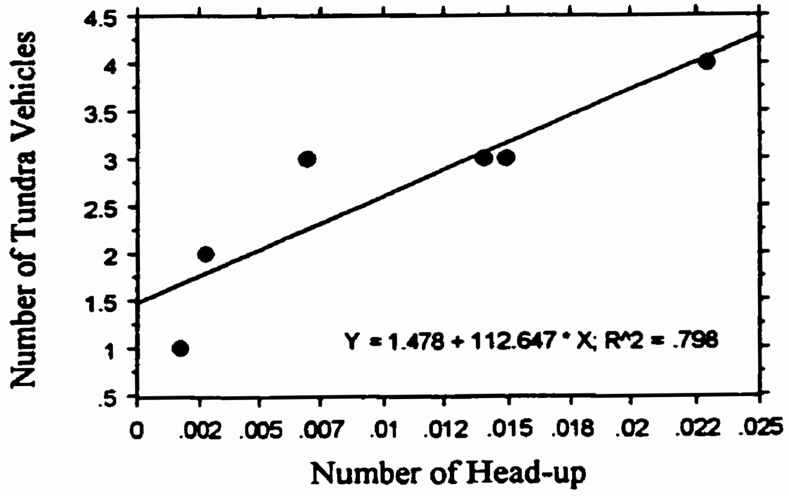
No relationship between the number of tundra vehicles and the measured variables was detected for all males (n = 23), adult males (n = 16), and subadult males (n = 7) [Table 2]. The G-power test (G-Power 2.1.1) set at medium size effect indicated a power of the test (1-β) of 0.426 (all males), 0.303 (adult males), and 0.134 (subadult males) with a size effect of 0.150. However, a significant relationship between the number of tundra vehicles and two variables was detected for female bears. Head-up as proportion of observation time increased as the number of tundra vehicles increased ($F = 15.80$, $P = 0.017$, df = 1) [Fig. 12, a)]. As the number of tundra vehicles decreased, between bout intervals increased ($F = 54.51$, $P = 0.002$, df = 1) [Fig. 12, c)]. There was no relationship detected between the number of tundra vehicles and vigilance bout length ($F = 0.79$, $P = 0.423$, df = 1) [Fig. 12, b)]. The G-power test for females indicated a power of the test of (1-β) = 0.115 with an effect size of 0.150.

Simple linear regressions indicated that no relationship existed between individual numbers of head-ups and the vigilance bout length ($F = 1.92$, $P = 0.181$, df = 1) [Fig. 13, a)], and the individual number of intervals and the between bout length ($F = 0.10$, $P = 0.754$, df = 1) for males of the unpaired design [Fig. 13, b)]. Head-up and vigilance bout length decreased, whereas between bout intervals of the male that was observed for two hours increased over the course of the observation time (Fig. 14). However, a greater

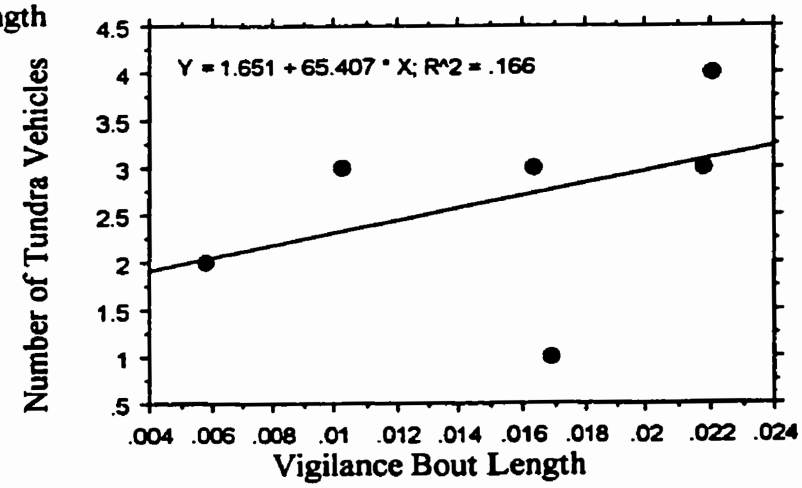
Table 2. Simple linear regressions of head-up (HU), vigilance bout lengths (VBL), and between bout intervals (BBI) for all males, adult males, and subadult males of the unpaired data set with tundra vehicles (TV) versus the number of TV.

	Variable	R^2	F	P
All males (n = 23)	HU	0.069	1.547	0.227
	VBL	0.028	0.609	0.444
	BBI	0.093	2.154	0.157
Adult males (n = 16)	HU	0.080	1.210	0.290
	VBL	0.085	1.308	0.272
	BBI	0.004	0.054	0.820
Subadult males (n = 7)	HU	0.075	0.407	0.551
	VBL	1.768E-4	0.001	0.977
	BBI	0.515	5.299	0.070

a) Head-up



b) Vigilance Bout Length



c) Between Bout Interval

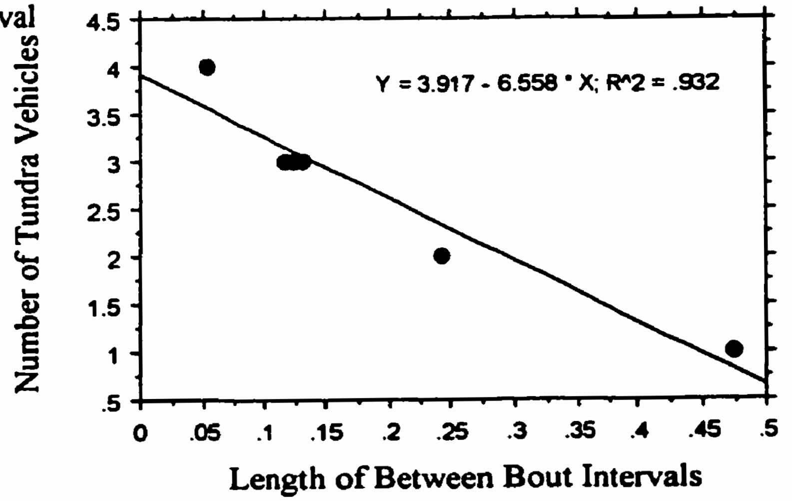
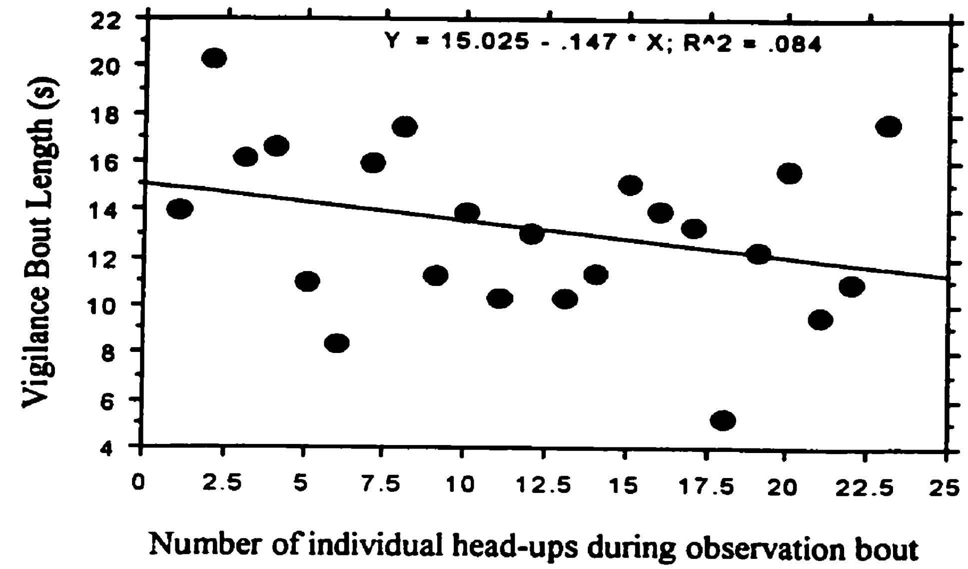


FIG. 12. Simple linear regressions of the number of tundra vehicles versus head-up (a), vigilance bout length (b), and between bout intervals (c) as proportion of observation time for female polar bears at Churchill, Manitoba.

a)



b)

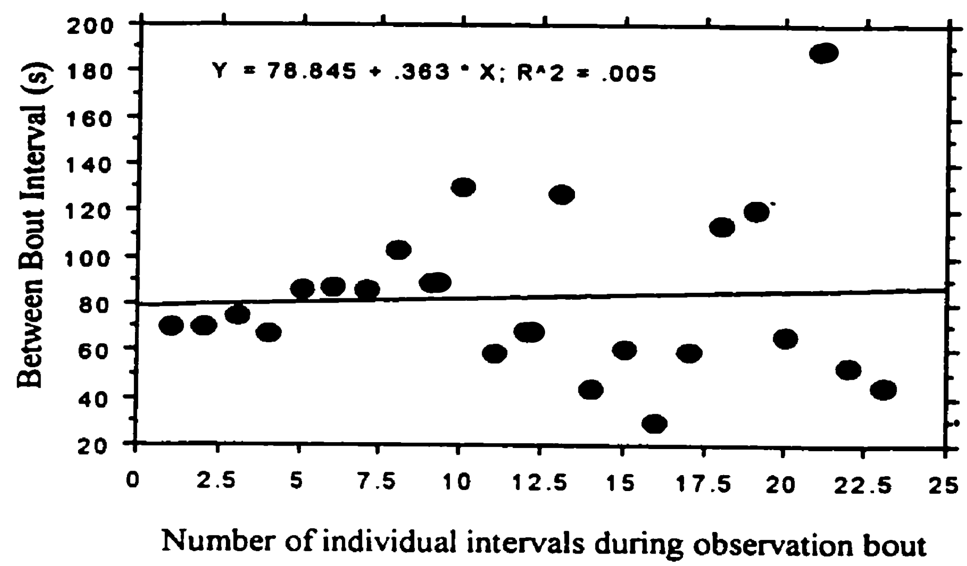


FIG. 13. Simple linear regressions of vigilance bout length versus the number of individual head-up (a), and between bout intervals versus the individual number of intervals (b) of male bears at Churchill, Manitoba.

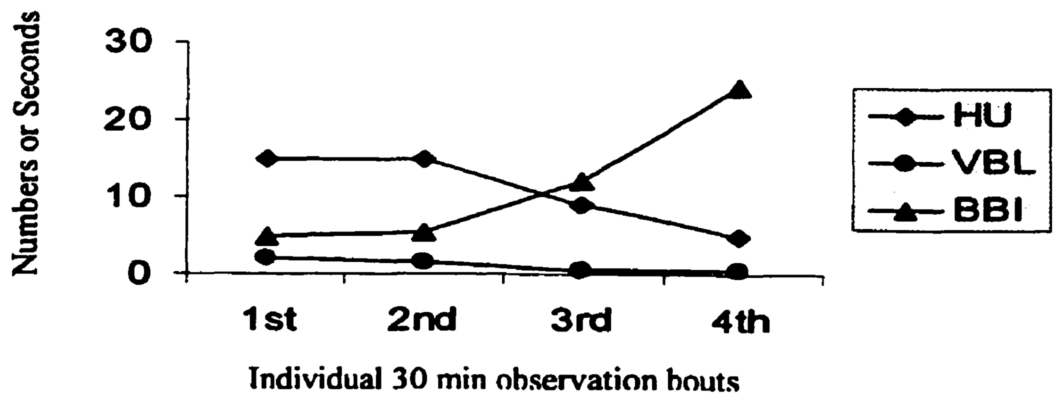


FIG. 14. Observations on head-up, vigilance bout length, and between bout interval of one male polar bear at Churchill, collected over a two-hour period with one tundra vehicle being mostly stationary.

sample size is required to allow definite inferences to be made about the variables in question while no tundra vehicle commotion occurs.

Total time spent vigilant for bears of the unpaired design was significantly greater for all bears ($U = 82$, $N_1 = 10$, $N_2 = 30$, $P = 0.034$) and for males only ($U = 64$, $N_1 = 10$, $N_2 = 24$, $P = 0.034$) in the presence of tundra vehicles versus absence. Bears in the presence of tundra vehicles spent 151.4% (all bears) and 154.8% (males only) more time being vigilant than bears without tundra vehicles (Fig. 15).

Comparisons of the variables collected up to and including the 33rd percentile with the 66th to 100th percentiles revealed that no significant differences existed between the times of data collection (head-up: $U = 10$, $N_1 = 5$, $N_2 = 10$, $P = 0.066$; vigilance bout length: $U = 15$, $N_1 = 5$, $N_2 = 10$, $P = 0.221$; between bout intervals: $U = 11$, $N_1 = 5$, $N_2 = 10$, $P = 0.086$).

Discussion

Vigilance behaviour of polar bears was significantly affected by the presence of tundra vehicles. In particular, the frequency for head-ups increased and the durations for between bout intervals decreased in the presence of tundra vehicles. Male bears examined via the paired design behaved similarly in the presence and absence of tundra vehicles as did all bears and males examined within the unpaired design. The increased vigilance response of polar bears to tundra vehicles corresponds to anti-predator vigilance recorded on other mammals and birds (Lendrem 1983; van Schaik and van Noordwijk 1989; Cheney and Seyfarth 1990; Forslund 1993; Cresswell 1994; Arenz and Leger 1997; Bshary and Noë 1997; Hunter and Skinner 1998; Treves 1999). Therefore, it could be concluded that those tundra vehicles are "perceived" as a possible threat by polar bears.

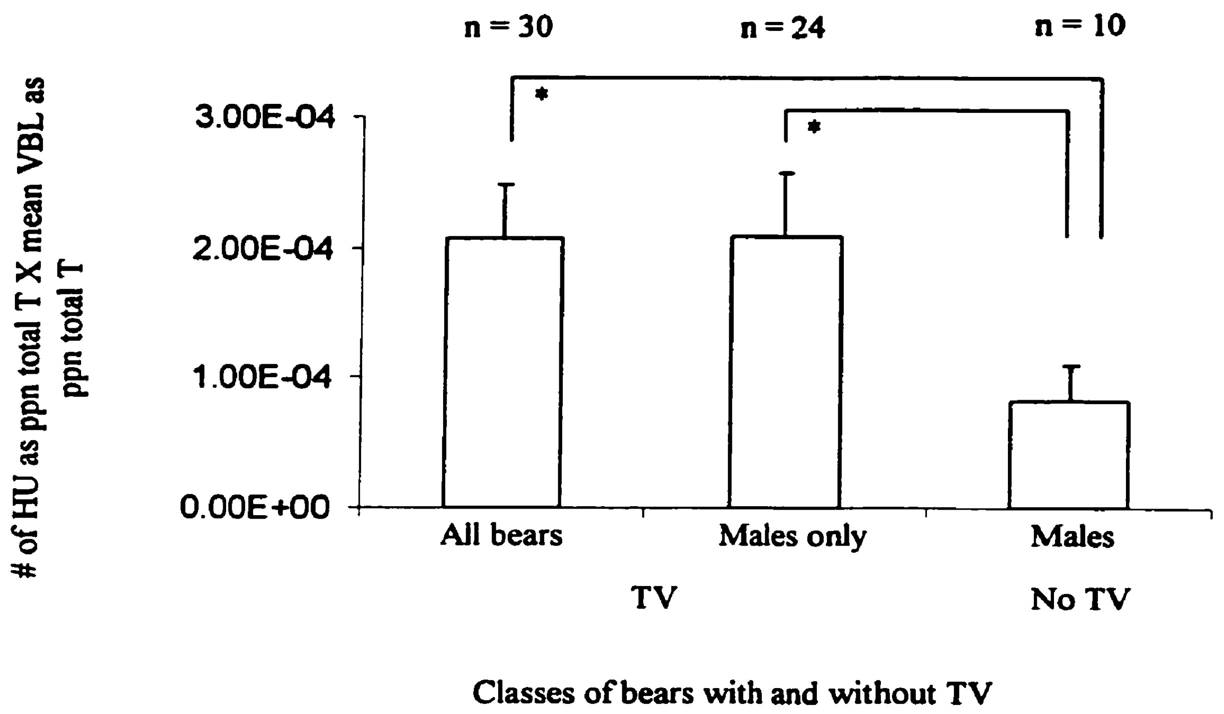


FIG. 15. Mean vigilance (number of HU x VBL) as proportion (ppn) of total observation time (total T) for bears with and without tundra vehicles (TV) of the unpaired design (Error bars represent SE; * significant at $\alpha = 0.05$). Vigilance increased by 151.4% for all bears, and by 154.8% for males only.

This, in part, can be supported by the fact that humans are hunting bears of this population from communities in Nunavut along the western Hudson Bay shore. Bears may have learned to form an association between the combination of humans, odours, and tundra vehicles and possible past experience while being hunted (McLean 1997). However, this assumption is questionable for two reasons: 1) most polar bear hunts are highly efficient due to the use of snowmobiles and firearms, and it is unlikely that a bear survives a hunting attempt by humans; and 2) even if a bear survived a hunt, it is unlikely that all bears present in the Gordon Point area would have been subjected to such an experience to form an association between tundra vehicles, humans, and an unsuccessful polar bear hunt.

Studies of animal cognition in recent years have lead to an acceptance of the notion that animals perceive objects, process information, make decisions, learn new skills, solve problems, and form rules and concepts (Terrace 1984; Yoerg and Kamil 1991; Griffin 1992). With these facts in mind, polar bears should be aware of their environment (e.g., being on the ice versus being on land), and components within their environment (e.g., conspecifics, other animals, plants, humans, human artifacts). Moreover, polar bears should be capable of discerning different objects from one another, for example ice-bergs from tundra vehicles. However, polar bears but may perceive tundra vehicles as an "out-of-place" anthropogenic stimulus. Bears may realize that tundra vehicles are part of the terrestrial ecosystem for some time during their fasting period, but cannot form an association due to the size, smell, and noise of the vehicle, human and food odours, and human noises. Bears may "know" (e.g., positive experience through rewards) that these vehicles don't represent life-threatening stimuli, but respond as if the vehicles were potential predators. As Quenette (1990) suggested, it is important to take the context of the occurrence of vigilance behaviour into account when attempting to interpret its significance. In this study, polar bears reacted to a stimulus in the form of tundra vehicles, which are present during polar bear viewing activities. However, to explicitly elucidate whether the response was elicited by the tundra vehicles, the vehicle noises, the visitors on board the vehicle, the noises of visitors, the odour of humans and food, the viewing distance, or a combination of some or all of these factors needs further examination because all these variables could not be controlled during data recording.

Vigilance bout lengths did not differ significantly in the presence and absence of tundra vehicles for bears in the paired and unpaired designs. Bears may have been selected to scan their surroundings for a specific time to be effective in assessing their surroundings, independent of the presence of a stimulus (Dimond and Lazarus 1974), following what Barlow (1968) termed a "modal action pattern". However, the visual scanning without tundra vehicles, and given that the length of time devoted toward that behaviour was similar, could indicate that bears were scanning the area for opponents. During the field season, bears were observed traveling or resting, and every few minutes they would scan their surroundings and sniff the air for about 10 – 15 s. These "programmed" scans may prove selectively advantageous to minimize risk of injury or death when faced with opponents or mates (Maynard Smith and Parker 1976; Clutton-Brock et al. 1979).

Between bout intervals in the presence of tundra vehicles were shorter in duration for males of the paired design and bears of the unpaired design as compared to absence of tundra vehicles. Tundra vehicles presented a continued stimulus for bears to react with increased vigilance, resulting in decreased between bout intervals. The fact that the same tundra vehicle did not stay with a bear during viewing for prolonged periods of time could also explain this behaviour (see Chapter 3). Vehicle commotion may represent stimuli to which polar bears respond with an increased frequency of head-ups and a decrease in between bout intervals, hence sensitization occurs (Domjam and Burghard 1986; Immelmann and Beer 1989). Habituation involves a waning in the response to a repeated, neutral stimulus (Eibl-Eibesfeldt 1970). This response was observed for all variables when one bear was observed with one, mostly stationary tundra vehicle. If commotion of vehicles would be eliminated, or reduced, vigilance response of polar bears could decrease during the viewing session.

It has been suggested that habituation and sensitization occur simultaneously and that, if a slight change in the stimulus to a habituated individual is presented, habituation is replaced by a highly sensitized state (Groves and Thompson 1970; Whittaker and Knight 1998). Therefore, the commotion and noise around a bear could have involved too many, quickly changing stimuli for a bear to become habituated to (see Chapter 3), and consequently would not result in a response similar to when tundra vehicles were absent.

The frequencies of head-ups and the durations of vigilant bout length and between bout intervals of adult and subadult males were not significantly affected when more than one tundra vehicle was present during viewing activities. One tundra vehicle was enough to elicit a significant increase in the observed responses as compared to absence of tundra vehicles. A magnification of the responses with increasing number of tundra vehicles was not observed. If male bears "recognize" that vehicles represent an anthropogenic stimulus, and that this stimulus is non-lethal, the observed response would be expected. Vigilance incurs a cost (Treves 2000), and only in case of a direct threat or risk would increased vigilance (and increased costs) be advantageous to the scanning animal (e.g., Hunter and Skinner 1998).

It should be made clear that, based on the results of this baseline study, the distinction of the number of vehicles engaged in viewing activities around a male bear is between zero and one with respect to an increased vigilance response. Any number of tundra vehicles > 1 may affect wildlife-viewing aesthetics and visitor satisfaction. Visitors commented on the number of tundra vehicles engaged in viewing activities, and that a greater number decreases visitor experience (World Wildlife Fund Canada 1999). Tour operators and management agencies should seek a compromise where the stress on bears is minimized, and visitor satisfaction is maintained.

Females within the paired design behaved opposite to male bears, and also showed an increased response to the number of tundra vehicles. Either cubs of the year or yearlings accompanied three of the four females. The increase in head-ups and vigilant bout length, and decrease in between bout interval with no tundra vehicles may represent a "protective" behaviour, which could reduce predation or infanticide risks (Caro 1987; Steenbeek et al. 1999; Toïgo 1999). Adult male polar bears have been known to kill cubs, either for food, to initiate mating, or for other speculative reasons (Dyck and Daley *In press*; Lunn and Stenhouse 1985; Taylor et al. 1985; Derocher and Wiig 1999). One could speculate that females with cubs "felt safer" when tundra vehicles were present. Tundra vehicles could represent a "safety buffer" that kept male bears at a distance, similar to the selfish herd-effect (Hamilton 1971; review: Elgar 1989; Roberts 1996), or other environmental factors (e.g., exposed versus covered areas, being on the ground versus in the canopy) that reduce the risk of exposure and predation (Lipetz and Bekoff 1982; de Ruiter 1986; Roberts 1988; van Schaik and van Noordwijk 1989; Cords 1990; Bednekoff and Ritter 1994; Burger and Gochfeld 1994; Rose and Fedigan 1995). However, a case of cannibalism and infanticide from the Gordon Point area was reported during October 2000 (Dyck and Daley, *In press*), and to determine whether tundra vehicles create a "safety buffer" for family groups, more observations of interactions between family groups and tundra vehicles are required.

The number of tundra vehicles affected how vigilant female polar bears with cubs were. Bears were more "relaxed" with less vehicles around. However, the observed responses in the presence of tundra vehicles were less pronounced than without vehicles. A manipulative study should be conducted to examine what the vehicle threshold for family groups is in order to minimize stress on particularly this sex and age class (Watts et al. 1991; Calvert et al. 1998). Moreover, the difference could also be an artifact of the small sample size because there are not many family groups at one time in the study area. In addition, too little is known about polar bear vigilance behaviour in general.

Total time spent vigilant as proportion of total time observed increased significantly (by 151 – 154%) for all bears and males only, respectively, when tundra vehicles were present. There is evidence that vigilance is costly where there is a trade-off between energy gain and scanning for predators while foraging (Barnard 1980; Underwood 1982; Lendrem 1983; Illius and Fitzgibbon 1994). However, little is known about the cost of vigilance while an animal is resting. The resting metabolism of an animal is lower than when the animal is active (Schmidt-Nielsen 1990). To what degree head lifts and the maintenance of head postures affect the energy balance of an animal are poorly known. In general terms, it would be intuitive that more energy during head-ups and vigilant bout lengths is expended given the increased frequency in head-lifts while vehicles are present. In addition, stress hormone levels during these activities could also increase (Wingfield et al. 1997). The questions that arise are how much energy is expended during a day, or a season of bear viewing, how may it affect a polar bear's energy balance in terms of future fitness, and what are the hormonal and/or physiological responses to increased and maintained vigilance?

Conclusions

My observations lasted for 20 minutes/bear. Bears were surrounded by tundra vehicles for at least 3 h (see Chapter 3), having many stimuli presented to them in the form of commotion and noise. Increased vigilance while vehicles are present could lead to smaller rates of vigilance decrement because the central nervous system cannot sustain vigilance for an extended period of time (Dukas and Clark 1995). Vigilance recovery usually occurs during rest and sleep (Dimond and Lazarus 1974; Jerison 1977; Parasuraman 1979; Horne and Minard 1985; Steriade et al. 1993). If an animal cannot obtain the necessary rest or sleep, the cost of vigilance could very likely be a reduction in the rate of vigilance recuperation (Dukas and Clark 1995). Consequently, an animal that cannot recover from increased vigilance activities may have difficulties performing other activities or challenging tasks (Horne and Minard 1985; Horne 1988; Dukas and Clark 1995).

Given this information from this baseline study, vigilance behaviour might prove to be a useful indicator in assessing anthropogenic effects on wildlife. The context should be clearly defined in which the behaviour occurs. Moreover, to examine the sole factors of vigilance, the targets of the scans and proximity to conspecifics should be taken into consideration (Treves 2000).

Chapter 5

Daily activity patterns of polar bears at Churchill, Manitoba re-visited: seasonal variation and differences by sex and age-class

Abstract

Data on polar bear behaviour using focal animal sampling were collected at Churchill, Manitoba during the ice-free period from 7 July through 18 November, 2000. The classified behaviours were resting, feeding, traveling, swimming, and other. When resting, feeding, and traveling behaviours of lone bears, females, and all bears were compared to Knudsen's data (1978), all behaviours differed significantly. Knudsen's data were used for comparison because he provided a rare account of polar bear daylight activities from an area without tundra vehicles. Observed polar bears spent 64.3 % resting, 15.7% feeding, and 20.1% traveling. No differential behaviour for sex (males: 58.4% resting, 14.5% feeding, 20.7% traveling; females: resting: 41.2%, 19.7% feeding, 26.5% traveling) and age-classes (adults: 64.0% resting, 10.0% feeding, 19.4% traveling; subadults: 39.9% resting, 38.3% feeding, 18.3% traveling; cubs: 26.7% feeding, 20.8% resting, 35.5% traveling) was detected. Seasonal effects were detected for feeding (summer: 3.3%; fall: 24.0%) and swimming (summer: 16.4%; fall: 0%). Bears exhibited a preference for tide flats when traveling and resting, and for willows when feeding.

Key words: polar bear, *Ursus maritimus*, activity pattern, behaviour, sex and age-class, ice-free season, Churchill, Manitoba,

Introduction

Polar bears depend on the sea ice to hunt their primary food source, ringed seals (Stirling and Archibald 1977; Smith 1980). Hudson Bay is generally ice-free from July until mid-November, which forces the bears to come ashore (Stirling et al. 1977). Bears feed little and undergo a lengthy fast, and are sustained by their stored fat reserves during that period (Russell 1975; Knudsen 1978; Nelson et al. 1983; Lunn and Stirling 1985; Watts and Hansen 1987; Ramsay and Stirling 1988; Ramsay and Hobson 1991; Ramsay et al. 1991, 1992). Once on land, polar bears segregate by sex and age class along the western shore of Hudson Bay, where adult males remain on the coast, family groups move 30 – 50 km inland, pregnant females travel toward the denning areas, and subadults are found throughout coastal and inland areas (Derocher 1987; Derocher and Stirling 1990a, b).

The western Hudson Bay polar bear population is the most studied polar bear population in the world. However, information on daylight activity patterns of polar bears during the ice-free period is restricted to observations by Knudsen (1978). His data were collected on bears spending their summers on North Twin Island, James Bay, and therefore individuals of the southern Hudson Bay polar bear population (Knudsen 1978; Lunn et al. 1998). His data are valuable insofar as they also allow insight into activity patterns of polar bears once on land. For years, Knudsen's data were used as a "rule of thumb" regarding feeding behaviour of polar bears (i.e., polar bears feed little during the ice-free period [Lunn and Stirling 1985; 2291; Stirling 1986: 172; Ramsay and Stirling 1988: 625; Derocher and Stirling 1990a: 1392; Derocher and Stirling 1990b: 1395; Ramsay and Hobson 1991: 598]). Investigators rarely speculated about whether seasonal variation or sexual differences in activity patterns of polar bears exist that are on land during the ice-free period. Knudsen (1978) only reported whether differences existed between lone bears and females with cubs.

In this paper, daylight activity patterns during the ice-free period of individuals of the western Hudson Bay population are reported. Given spatial segregation and differences in energy demands between sex and age classes, I examined whether differences also exist in daylight activity patterns between sex and age-classes (i.e., males versus females, adults versus subadults), whether seasonal variation (i.e., summer versus fall) in activity could be detected, and how my data compared to Knudsen (1978).

Materials and Methods

Polar bears were observed in the Gordon Point area (58^{O}45' N to 58^{O}48' N, and 93^{O} 38' W to 93^{O} 50' W; Fig. 1), approximately 35 km east of Churchill, Manitoba (Fig. 1) from 7 July until 18 November, 2000. Observations were conducted either from the ground, an 8m high wooden observation tower, or from an All-Terrain Vehicle (ATV) using Bushnell 45X spotting scopes, usually at ranges of 200 to 1500 m. Observations were conducted along the coastline in the Gordon Point area from about 08:00 h to 21:00 h in the summer, and from 09:00 h to 16:00 h in the fall.

To determine whether there were any polar bears within the Gordon Point area, a 360-degree scan from an observation tower was conducted as part of a daily routine. If no bear was spotted, an ATV was used to travel along the coastline and to continue scanning the area for bears. If one bear was present, observations on daylight activities began, using that bear as a focal animal (Altmann J. 1974). Where multiple bears were present, a focal bear was randomly selected using a random number table. All members of a family group (i.e., female bear with offspring) were observed and their behaviours recorded. An attempt was made to observe bears as long as possible, or for two hours minimum, unless the animal(s) were out of sight for more than five minutes. Knudsen's (1978) classifications and criteria for three major activity categories, including resting, feeding, and traveling were used. I added one additional criterion for traveling: pauses during travel $\leq$ 10 s were recorded as travel because bears tended to stop, sniff, and visually scan their surrounding beyond their immediate vicinity (McAdam and Kramer 1998) for that period of time; if bears paused for > 10 s, the pause was recorded as resting. In addition, I recorded data on swimming, nursing, lactating, drinking, digging, solitary play, and play-fighting. The latter six categories were grouped together as "other behaviour" for the purpose of analyses because they were observed less frequently than expected. Data for these separate categories were collected throughout the field season. Descriptions of the behaviours are given below:

Behaviour:	**Description:**
1. Swimming	animal is submerged in water, diving, or moving in a lake or Hudson Bay,
2. Play fight	animal is engaged in what appears to be a nonaggressive interaction with one or more conspecifics as either actor or receiver (Ramsay and Waterman, unpublished)
3. Lactation	female bear is nursing cub(s),
4. Solitary play	animal is engaged in actions with an inanimate object or own body part (see Henry and Herrero 1974)
5. Drinking	animal is slurping/licking up water,
6. Nursing	cub(s) are suckling on nipples,
7. Digging	animal is digging up vegetation, soil, gravel, or is digging a resting pit.

All behaviours were recorded in seconds using digital stopwatches. Sex (i.e., male, female, and unknown), age class (i.e., adult ≥ 5 years of age; subadult < 5 years; yearling = about 18 months of age; cub of the year = 7-11 months of age; and unknown), date, start and end time of observations, and specific individual characteristics for identification (i.e., scars) were recorded (see Knudsen 1978 for details). Habitat types for resting, feeding, and traveling in the Gordon Point area were recorded using scan samples (Altmann, J. 1974), which allowed an examination of whether habitat preferences existed for displayed behaviours. Habitat types were recorded either as willow, lakeshore, tide flats, or coastal tundra (see Clark and Stirling 1998 for descriptions). I extended the definition of Clark and Stirling (1998) for tide flats where I included beach ridges along the coast within about 250 m of the high-tide water line. A few observation samples were repeated measures on the same individual, as in Knudsen's study, and some caution should be taken in the interpretation of the results (Machlis et al. 1985). Statistical tests were considered significant at $\alpha = 0.05$.

To allow comparison between this study and Knudsen (1978), I grouped bears into the same two categories: lone bears (adult males, subadult females and males) and females with cubs where only the behaviour of the female was used for analyses. To compare the results of both studies, I converted Knudsen's observation times for resting, feeding, and traveling behaviours into seconds. Datasets were compared using contingency table analysis.

The dataset then was reassembled to examine possible effects of age and sex classes, and of season on behaviour. I first examined whether age-class (adult, subadult, cub) was a factor that influenced daylight activity patterns. When no difference in behaviours for age-classes was detected, I examined whether sex affected activity patterns. Lastly, I reassembled the dataset to examine whether season had an effect on the displayed activity patterns. Observations were divided into summer (July – September) and fall (October – mid November; Lunn and Stirling 1985). First, all repeated measures on the same individuals were added so that each individual bear contributed only one sample to the overall set of data. I then transformed the actual times for each behaviour into proportions with respect to each bear's total time observed. Arc sine square-root transformations were performed on all proportions so that the resultant data had an underlying distribution that was nearly normal (Zar 1999). Parametric assumptions were met, therefore single-factor ANOVA analyses were performed with sex, age class, and season as independent variables, and the different behaviours as dependent variables. All bears of unknown sex and age were excluded from these analyses.

Results

From 7 July until 18 November 2000, 83 observations on 73 bears (38 adult males [AM], 2 adult females [AF], 2 family groups with sets of twin cubs of the year [COY], 2 family groups with sets of twin yearlings [YRLG], 1 AF with a 2-year old cub, 2 subadult females [SF], 10 subadult males [SM], and 7 unknown [U]), identified by individual characteristics, were conducted. Two AM were excluded from all analyses because of very short observation times (< 15 min). These two bears got up from their resting locations and moved out of sight.

Total observation time was 202.8 h, with an observation time per bear of 150.2 ± 13.0 min (2.5 h). The majority of observations (71%) were begun between 1000 h and 1400 h, but were otherwise evenly distributed throughout the day.

The proportionate representation of resting, feeding, and travel behaviours differed significantly for all classifications of bears when compared to Knudsen's data (Fig. 16) [lone bears: $G = 47,047.48$, $P = 0.0001$, df = 2; females with cubs: $G = 46,188.58$, $P = 0.0001$, df = 2; all bears: $G = 72,759.62$, $P = 0.0001$, df = 2].

Age class had no effect on the different behaviours examined (all behaviours df = 64; resting: $F_{[2,62]} = 0.77$, $P = 0.466$; feeding: $F_{[2,62]} = 2.23$, $P = 0.116$; traveling: $F_{[2,62]} = 0.83$, $P = 0.440$; swimming: $F_{[2,62]} = 0.48$, $P = 0.624$; other: $F_{[2,62]} = 1.37$, $P = 0.261$) [Fig. 17]. No significant difference in the behaviours between sexes was detected (all behaviours df = 64; resting: $F_{[1,63]} = 0.79$, $P = 0.376$; feeding: $F_{[1,63]} = 0.75$, $P = 0.389$; traveling: $F_{[1,63]} = 0.44$, $P = 0.509$; swimming: $F_{[1,63]} = 0.07$, $P = 0.792$; other: $F_{[1,63]} = 1.29$, $P = 0.261$) [Fig. 18]. Seasonal differences were detected for swimming ($F_{[1,63]} = 21.21$, $P = 0.0001$, df = 64) and feeding ($F_{[1,63]} = 6.48$, $P = 0.013$, df = 64) where swimming occurred more frequently in the summer than in fall, and feeding occurred more frequently during fall than during summer. Resting ($F_{[1,63]} = 0.20$, $P = 0.654$, df = 64), traveling ($F_{[1,63]} = 1.63$, $P = 0.206$, df = 64), and other behaviour ($F_{[1,63]} = 0.36$, $P = 0.551$, df = 64) showed no significant effect of the seasons (Fig. 19). Length of individual feeding bout (n = 70) was 18.6 ● 3.9 min (mode = 37.6 min).

Bears traveled significantly more in tide flats and less in willow than expected, and fed significantly less in tide flats and more in willows than expected (chi-square analysis, $G = 58.33$, $P = 0.0001$, df = 4). In addition, resting along the tide flats was significantly greater than expected, whereas resting in willows and lakeshores was less than expected. ($\chi^2 = 6.48$, $P = 0.039$, df = 2) (Fig. 20).

Mean monthly temperatures recorded at the Churchill airport by the National Oceanic and Atmospheric Administration Service from 1 July to 18 November, 2000 were: July = 11.9 °C, August = 12.8 °C, September = 6.3 °C (= summer);

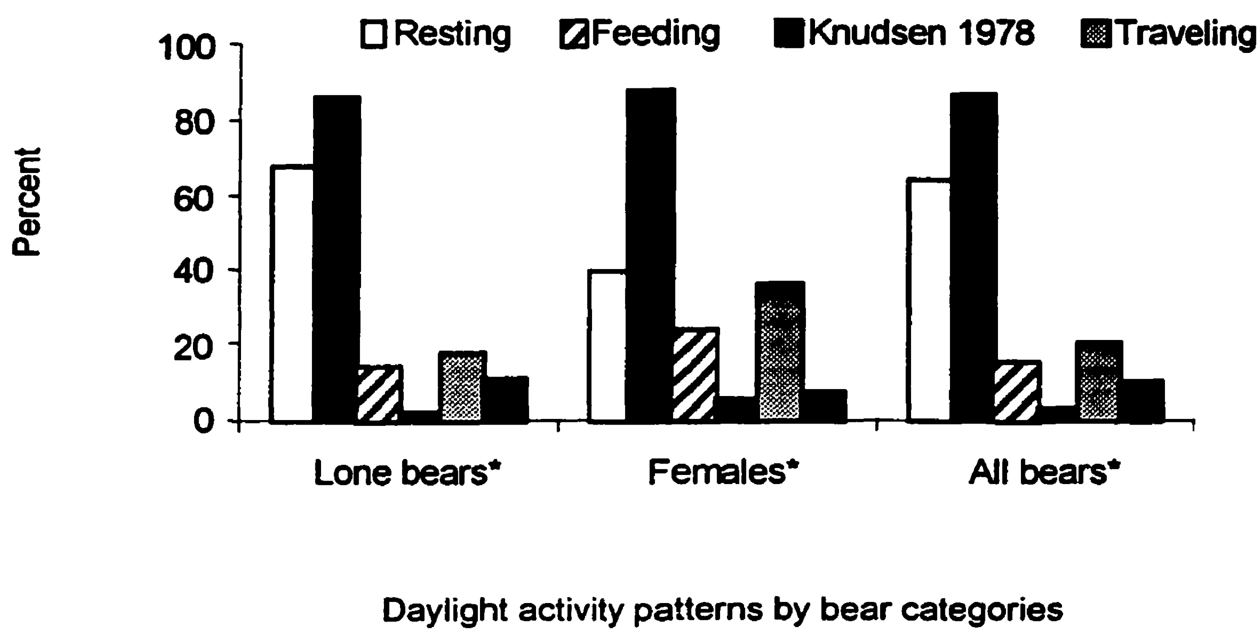


FIG. 16. Comparison of percent daylight activity patterns of polar bears (lone bears, females, and all bears) collected at Churchill during 2000 between Knudsen (1978) and this study (Note: "*" indicates where comparisons were statistically significant at $\alpha = 0.05$). The black columns to the right of each colour-coded column indicate the representative Knudsen data for resting, feeding, and traveling.

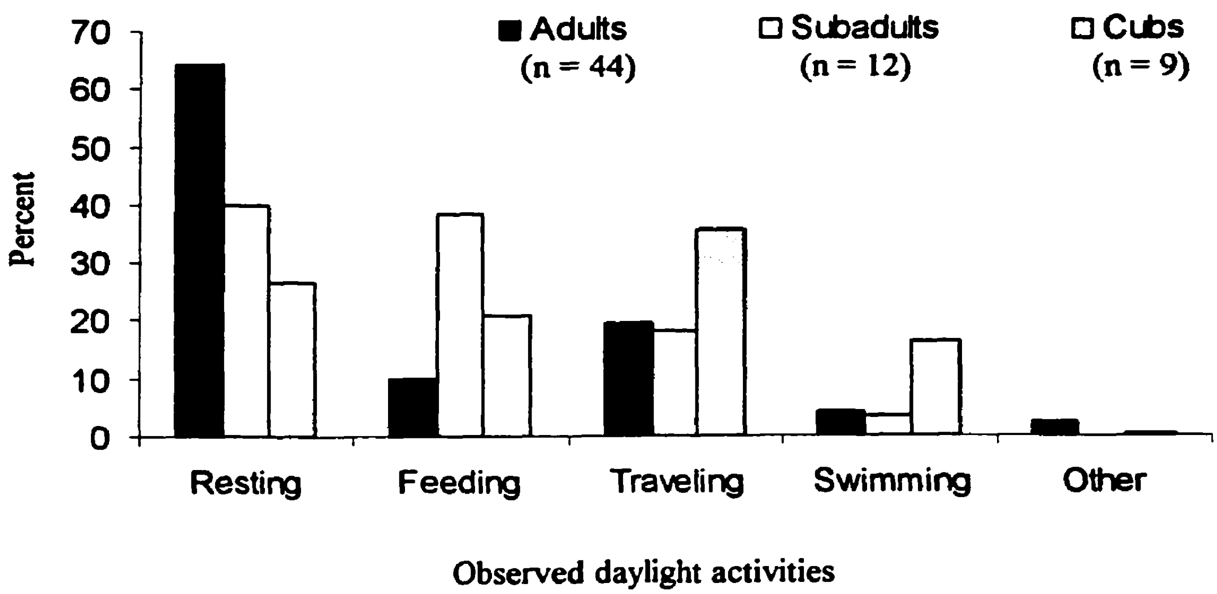


FIG. 17. Comparisons of daylight activities in percent for different age-classes of polar bears (adults, subadults, and cubs) collected at Churchill from 7 July through 18 November 2000.

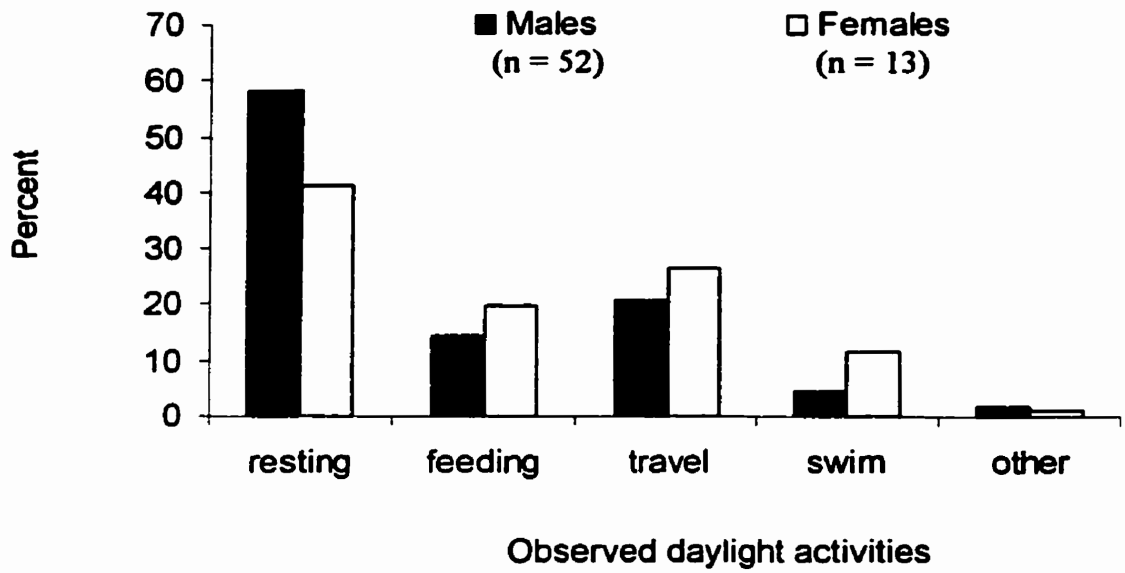


FIG. 18. Comparisons of daylight activity patterns in percent for male and female polar bears collected at Churchill from 7 July through 18 November 2000.

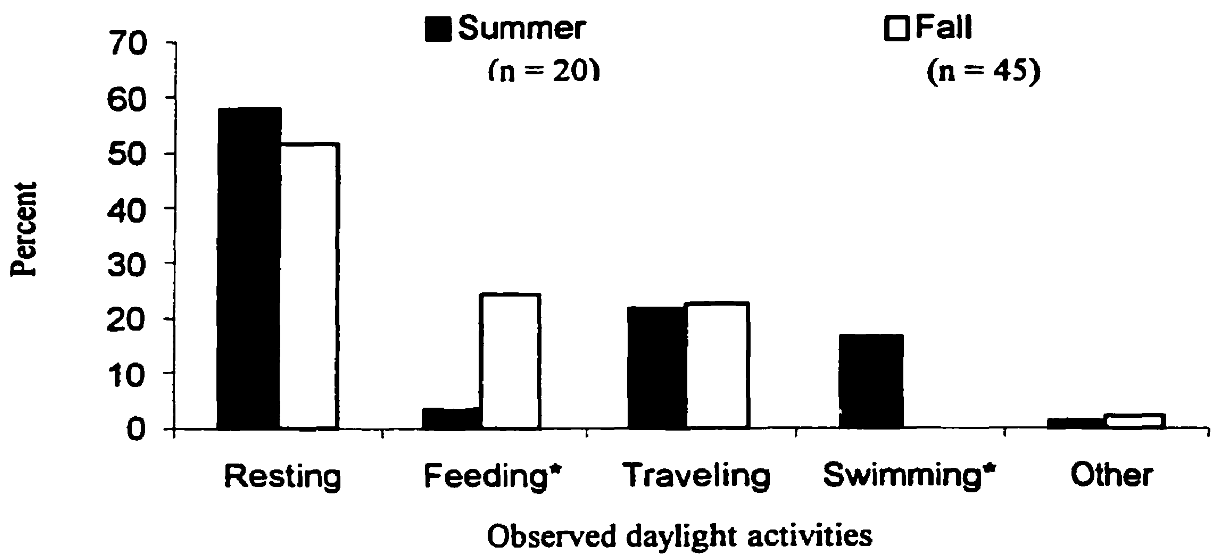


FIG. 19. Comparisons of summer versus fall daylight activities of polar bears in percent collected from 7 July through 18 November 2000 at Churchill ("*" indicates where statistically significant at $\alpha = 0.05$).

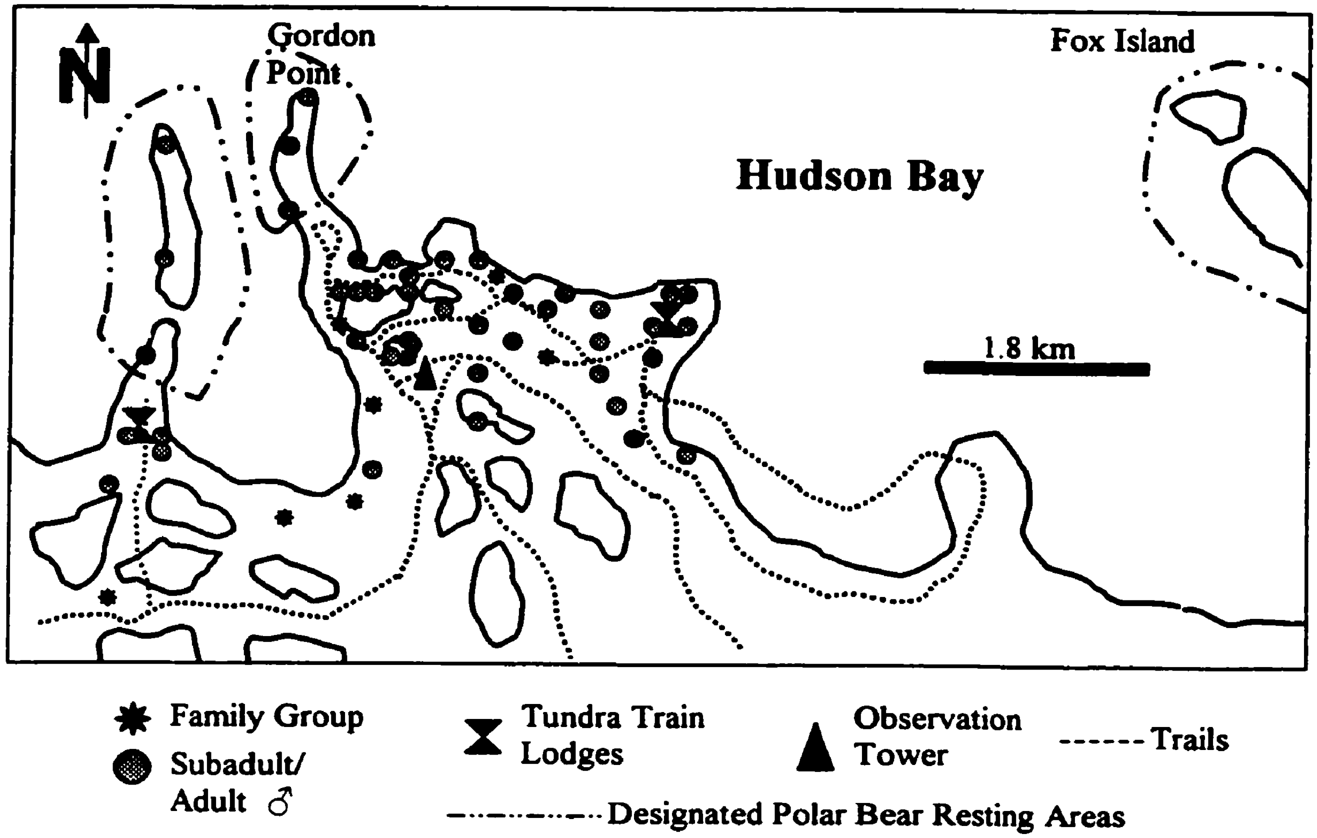


FIG. 20. Preferred polar bear resting locations in the Gordon Point Area. The locations do not represent the quantity of bears, rather the various locations that bears selected to rest.

October = 0.5 °C, November = - 8.7 °C (= fall).

Discussion

It is fallacious to assume that data collected on the same species in different sub-populations can be applied generally across space and time. For example, indirect methods to predict body mass of polar bears are frequently used where one "general" morphometric equation is applied. However, Cattet et al. (1997) showed that great variations in morphometry exist among polar bear populations, and equations must be developed for each population to reflect differences among sex, age, and reproductive classes. Variation in resting, feeding, and traveling behaviours of polar bears exist in comparison to Knudsen (1978), and generalizations should therefore not be made. Bears in this study spent more time traveling and feeding, and less time resting as compared to Knudsen (1978). Further, the present results suggest that polar bears can make substantial use of terrestrial food sources (Ramsay and Hobson 1991; Chapter 6), and that they do not rely entirely on their stored fat deposits while on shore. Moreover, they feed when an opportunity arises (Lunn and Stirling 1985), and they travel moderately. How much and how long bears will feed during the ice-free period may depend on timing of ice break-up, physical condition of bears at the time of reaching the mainland, and the availability and distribution of terrestrial food items (e.g., berries or kelp). The fact that more traveling in the Gordon Point area was observed overall might result from the presence of tundra vehicles in the study area. The study area is a major congregation site of polar bears along the southwestern shore of Hudson Bay during the fall. Two tour companies provide polar bear viewing from tundra vehicles throughout this area. Bears may be disturbed and displaced by approaching tundra vehicles, noise, or helicopter over-flights (see Chapter 3), which could have resulted in greater travel behaviour (Bowles 1995; Gutzwiller 1995) as compared to North Twin Island, where no tourism existed when Knudsen conducted his study. Polar bears showed an increased vigilance response to tundra vehicle activity (see Chapter 4) where bears were more vigilant in the presence of tundra vehicles than without. Therefore, it can be concluded that tundra vehicles are responsible for an increase in travel bouts of bears in the Gordon Point area. However, the empirical data that were collected could not address this question. A detailed study to fully examine the interactions between bear behaviour and tundra vehicles is warranted including "control" observations in a non-tundra vehicle location (e.g., Wapusk National Park or Cape Tatnam).

More bouts of feeding were observed in the study area as compared to Knudsen (1978). This could be explained by higher seasonal availability or distribution of berries in the study area as compared to North Twin Island. However, Russell (1975) reported higher frequencies of occurrence and abundance by volume for berries in polar bear scat for the Twin Islands in James Bay when compared to the mainland. That could result from differences in berry abundance between years when these studies were conducted. Subjectively, during 2000, the berries seemed to occur in higher densities as compared to previous years, which could explain higher feeding rates despite the bears' relative fatness. Alternatively, if tundra vehicle activity causes bears to travel at higher rates, then an increase in feeding bouts may point towards greater energy demands than when bears are not subjected to these activities. In contrast, feeding could be a displacement activity because it occurs under circumstances in which it is apparently irrelevant to ongoing activities (e.g., resting), and could therefore reflect "frustrations" arising from conflict or stress situations (Tinbergen 1952; Zeigler 1964; McFarland 1966; Baker and Aureli

1997; Lewis and Campagna 1998; Schino 1998).

During the late 1960's, bears were so fat that "...they looked like they would burst if you stick a needle in their belly. Nowadays, every bear appears skinny compared to back then" (C. Jonkel, 2001; pers. comm.). These anecdotal observations could point toward other underlying reasons for increased feeding bouts during the ice-free period in the Gordon Point area, such as lower food availability (e.g., seals) while bears are on the ice, or greater competition among bears for prey items.

Feeding on terrestrial food items during fall was much more common than during summer. Polar bears have been on land and fasting for about three months by October (Stirling et al. 1977; Derocher and Stirling 1990a), and they are known to lose weight on a daily basis (Derocher and Stirling 1995b; Atkinson et al. 1996). Polar bears are closely related to brown bears (Kurtén 1964), and it is thus likely that polar bears retain physiological adaptations necessary to digest vegetation. This is in part supported by very little interspecific variation of digestive efficiencies between black and brown bears (Pritchard and Robbins 1990). Therefore, increased feeding behaviour of polar bears during fall may be explained by a negative energy balance where bears minimize daily weight loss in times of uncertainty regarding freeze-up of Hudson Bay. In addition, feeding on terrestrial food sources may be an adaptation or response to possible climate change (Stirling and Derocher 1993). Feeding during summer is probably less frequent as bears returned to the mainland from an almost eight month long hunting season.

The data indicate that there was no differential behaviour between sex and age class during the study period where bears used the same habitat. Similar results have been reported for feeding behaviour (Derocher et al. 1993), where male and female polar bears of four age-classes (cubs, yearlings, subadults, and adults) differed only for adults.

However, once bears are segregated spatially on the mainland, their general behavioural patterns may be comparable due to similar needs. To confirm these observations, behavioural observations of polar bears during the ice-free period in their "segregation areas" (e.g., different habitats for different sex and age class) are needed.

Bears spent proportionately more time resting when compared to the other behaviours, suggesting that they follow a strategy of energy conservation and hyperthermia prevention (Øritsland 1970; Knudsen 1978; Best 1982; Hurst et al. 1982a, b; Watts and Hansen 1987; Ramsay et al. 1991). Travel and resting did not differ between summer and fall. One would expect bears to spend more time resting when ambient temperatures are higher to prevent overheating (e.g., during summer) and to be more active when temperatures are cooler (e.g., during fall). However, this was not the case. This may suggest that polar bears either do not overheat easily (Best 1982), or walking is not as costly as assumed under "normal pace" walking conditions (Hurst et al. 1982a, b; Watts et al. 1991).

Swimming was only observed up until September. Travel behaviour and warmer temperatures during the summer months combined may impose a risk of hyperthermia (Øritsland 1970; Best 1982). Consequently, bears may choose to spend time in water to cool off, or to keep out of reach of biting insects, similar to lying in shallow pits along the coast or dug into permafrost along lake shores, which serve the same function (Jonkel et al. 1972; Clark et al. 1997).

Polar bears preferred tide flats when traveling and resting over willows and lake shore. Tide flats are wide-open areas that would allow bears better detection and assessment of opponents when traveling or resting, as compared to resting or traveling in willows. Assessment of the size of opponents was also suggested by Stirling (1974) when he observed bears encountering each other on Devon Island. Resting along the coastline in tide flats may also facilitate thermoregulation as winds coming off Hudson Bay may aid in convective heat loss (Best 1982; Clark and Stirling 1998). This is supported by the findings of Derocher and Stirling (1990b) where adult male bears were found in resting pits along the coast. Alternatively, tundra vehicles tended to use coastal and inland trails where bears may have been more disturbed by their presence when resting. In addition, willows and lake shore may not provide the necessary field of view when resting to assess an opponent, or conspecifics.

Feeding in willows was preferred over any other habitat type. Vegetation along tide flats included grasses (e.g., *Elymus arenarius*), sedges (Cyperaceae), and marine algae (e.g., *Laminaria* spp., *Rhodymenia palmate*). Distribution of berries, however, was in many areas associated with willows. An examination of some of the feeding areas of polar bears confirmed that blueberries (*Vaccinum uliginosum*) grew mostly within willowed patches. This preference for willow areas for feeding may in fact also indicate a food preference related to the energy content of the food source. *Vaccinum uliginosum* is an important food source for high-latitude brown bear populations (e.g., Pearson 1975; Murie 1981), and if large quantities are consumed considerable contributions toward the bears' energy budget could be achieved (Welch et al. 1997). Detailed studies are needed to examine terrestrial feeding behaviour of polar bears and energy content of selected food items. Only with those data can an inference be drawn about contributions to the overall net energy balance of polar bears.

Chapter 6

Possible energy contributions from terrestrial food sources to the overall energy budget of polar bears

Abstract

Polar bears of western Hudson Bay are forced to come ashore during the ice-free period for about four months each year. While on land, bears lose body mass on a daily basis as they generally feed little at that time. Opportunistic feeding on terrestrial vegetation has been reported. The contributions of these food items to the overall energy budget of polar bears is unknown. Therefore, a mathematical approach was used to calculate energy content of consumed food items, and to estimate overall contributions to the energy budget based upon masses of food items consumed. I estimated that bears could either decrease their daily body mass loss, or depending on the quantity of food consumed and age of the bear, body mass could be maintained or gained throughout the ice-free period.

Key words: polar bear, *Ursus maritimus*, terrestrial feeding, ice-free period, energy budget, Churchill, Manitoba

Introduction

Polar bears depend on sea ice to hunt their primary food source, ringed seals (Stirling and Archibald 1977; Smith 1980). Hudson Bay is generally ice-free from July until mid-November, which forces bears to come ashore (Stirling et al. 1977). While on land, bears use terrestrial food sources, such as sedges (*Carex* spp.) and berries (Russell 1975; Knudsen 1978; Lunn and Stirling 1985; Derocher et al. 1993). Other investigators suggested that polar bears make little use of terrestrial food (Ramsay and Hobson 1991). Nevertheless, the energetic importance of herbivorous forage items for polar bears could not be explained because caloric contributions to the total energy budget of polar bears were unknown (Derocher et al. 1993).

In this paper, I summarize some food items consumed by polar bears while on land, and describe potential energetic contributions to the total energy budget of polar bears using a mathematical approach. The stimuli for these estimates were observation bouts conducted on feeding polar bears during the summer and fall of 2000 in the Gordon Point area (see Chapter 5).

Materials and Methods

A behavioural study on polar bears was conducted in the Gordon Point area at Churchill, Manitoba (study area coordinates: 58^{o} 45' N to 58^{o} 48' N, and 93^{o} 38' W to 93^{o} 50' W; Fig. 1), approximately 35 km east of town, from 7 July to 18 November 2000. To determine which terrestrial food items were used, polar bears were observed directly feeding on specific food items and fresh scats were collected and their contents examined. Fresh berries and kelp were collected along the coast to obtain the mean mass of these items. The berries included blueberries (*Vaccinium uliginosum*), cranberries (*V. macrocarpon*), crowberries (*Empetrum nigrum*), soapberries (*Sheperdia canadensis*), and common bearberry (*Arctostaphylos uva-ursi*) whereas the kelp included *Rhodymenia* spp. I grouped feces into three categories: berries, grasses (e.g., sedges, seaweed, kelp, and other vegetation), and other components (e.g., human food, garbage, bones, etc.). Body mass loss (BML) of polar bears per day and caloric values for some of these food sources were located in primary literature. The mean BML per day was converted into energy equivalents of grams of fat. I used energy equivalents for grams of fat as it was assumed that body fat is lost first and at a higher rate than protein (Atkinson et al. 1996). The energy equivalent of 1000 g of fat is 39.3 MJ (Blaxter 1989).

I expressed the energy content of 100 g of selected food items in fat equivalents (e.g., 1000 g fat x energy content of 100 g selected food item)/39.3 MJ = g of fat). The next step involved the calculation of necessary food mass intake (kg) for bears of a specific age class to maintain a stable mass (i.e., BML per day = 0 kg) [e.g., for adults: {850 g BML x 100 g berries}/g fat equivalents = g of food necessary to consume; or {100 g berries x 33.4 MJ energy content of BML}/ energy content of 100 g berries]. One assumption made in this study was that polar bears do not spend much energy and time in order to search for patchily distributed food items, as is predicted by optimum foraging theory (Charnov 1976a, b). During field observations it was noticed that female polar bears with cubs, once in a patch of berries or kelp, spent several hours and even days within that patch, or the vicinity of the patch. Male bears were more active in the search for berry patches and other food items.

The mass of food necessary to maintain a stable body mass is also expressed in the quantity of individual food items (e.g., for adults: [kg of food necessary to maintain

BML = 0 kg x 20 berries]/ kg mass for 20 berries = quantity of individual berries). Lastly, how much of the specific food items in kg would need to be consumed by a polar bear to maintain BML = 0 kg was calculated. In addition, I compared calculated values with published literature to examine whether these calculated values could be obtained by feeding polar bears. These calculations also allowed for a hypothetical examination of how the mass of food items consumed could affect daily loss of body mass (e.g., g of fat) of polar bears during the ice-free period.

Results

Mean body mass loss (BML) per day and associated loss of energy differs among age classes for polar bears of western Hudson Bay, with subadults losing the most energy and body mass (Derocher and Stirling, 1995) [Table 3]. When bears were observed feeding or their feces were examined, common bearberry, soapberries, blueberries, cranberries, crowberries, and kelp were the most common in frequency of consumption or occurrence in the feces. Forty-three fecal samples were collected. The ratio of feces containing berries : grasses : "other components" was 30 : 10 : 3. Other components of feces included corn, peas, plastic, fur, and bones. Energy content of berries and kelp per 100 g ranged from 385 kJ for common bearberry to 145 kJ for crowberry (Table 4). Crowberries had the greatest individual mass of the three berry species examined (Table 5). Values for the mass per berry fall within the range reported by Welch et al. (1997). The overall kelp mass was probably underestimated with 548.8 g per stipe and blade due to small sample size (n = 3) [Table 5]. For simplicity of calculations, I used 600 g per piece of kelp.

When energy content (MJ) of food items was converted into fat (g) equivalents,

Table 3. Age classes of polar bears, their mean body mass loss per day (BML) in kg, and calculated energy equivalents.

Age Class	BML [a] (kg)	Calculated Energy Equivalents (MJ)
Cubs	0.25	9.82
Yearlings	0.63	24.75
Adults	0.85	33.40
Subadults	1.05	41.26

[a]Adapted from Derocher and Stirling, 1995b.

Table 4. Some terrestrial food items of polar bears, their energy content based on 100 g serving, and g of fat equivalents based on energy content.

Common Name	Scientific Name	Energy content/100 g (kJ)	Mass of fat (g) based on energy content
Common bearberry	*Arctostaphylos uva-ursi*	385.00 [a)]	9.80
Soapberry	*Sheperdia canadensis*	300.00 [a)]	7.63
Kelp	*Rhodymenia* spp.	290.00 [b)]	7.38
Blueberry	*Vaccinium uliginosum*	234.00 [c)]	5.95
Cranberries	*Vaccinium macrocarpon*	205.00 [c)]	5.22
Crowberry	*Empetrum nigrum*	145.00 [a)]	3.69

(Note: [a)] Kuhnlein 1989; [b)] Kuhnlein and Soueida 1992; [c)] USDA 1999).

Table 5. Mean weights (mean ± SE) for selected berries and kelp collected along the coast at Churchill, Manitoba.

Food Item	(g/20 berries)	(g/berry)
Common bearberry	6.84 ± 0.29	0.342
Blueberry	4.55 ± 0.19	0.227 ± 0.009
Crowberry	5.57 ± 0.14	0.278 ± 0.006
Cranberry	4.22 ± 0.13	0.210 ± 0.006
Soapberry	-	0.210 [b)]
Kelp		
Leaf[a)]	85.24 ± 27.00	
Stem[a)]	463.68 ± 107.04	
Total	548.83 ± 127.22	

(Note: [a)] n = 3; [b)] Welch et al. 1997; "-" = no data available) common bearberry had 2.7 times more fat (g) equivalents then crowberry. Soapberry produced similar results to kelp (Table 5). Cubs, with a BML of 0.25 kg per day, hypothetically would need to feed on the least mass or quantity of food items to achieve BML = 0 kg, which ranges from 2.50 kg for kelp to 6.70 kg of crowberries (Table 6). Subadult bears would need to consume larger quantities of food items to achieve a BML = 0 kg (i.e., over 10 kg of common bearberry) [Fig. 21]. If, for example, a yearling bear with BML = 0.63 kg searches for food along the coast, it would take consumption of either 6.43 kg of common bearberry, 8.25 kg of soapberries, 8.53 kg of kelp, 10.58 kg of blueberries, 12.07 kg of cranberries, or 17.07 kg of crowberries in order to maintain its body mass (Table 6). If, for example, the same bear consumed 3.20 kg of common bearberry (Figure 21), approximately 0.32 kg of body fat equivalents would be contributed by that food, or in other words, assuming that no additional energetic output occurs, that bear would lose only 0.31 kg of body fat per day, rather than 0.63 kg.

Discussion

Various methods and models have been developed by investigators to examine optimal foraging theory of predators and herbivores (Emlen 1966; Charnov 1976a, b; Belovsky 1978). Some underlying assumptions of these models are that (1) food items encountered within a patch are clumped; (2) traveling occurs between patches; and (3) energy gained within one patch decreases over time, and a decision has to be made by the "predator" when to travel to another patch (Charnov 1976b). Subjectively, observations of feeding polar bears confirm these assumptions, but empirical data are required that would allow for inferences to be made whether polar bears feeding on terrestrial food items follow the assumptions of optimal foraging.

Table 6. Mass of food intake (kg) and quantity of selected food items required to maintain BML = 0 kg.

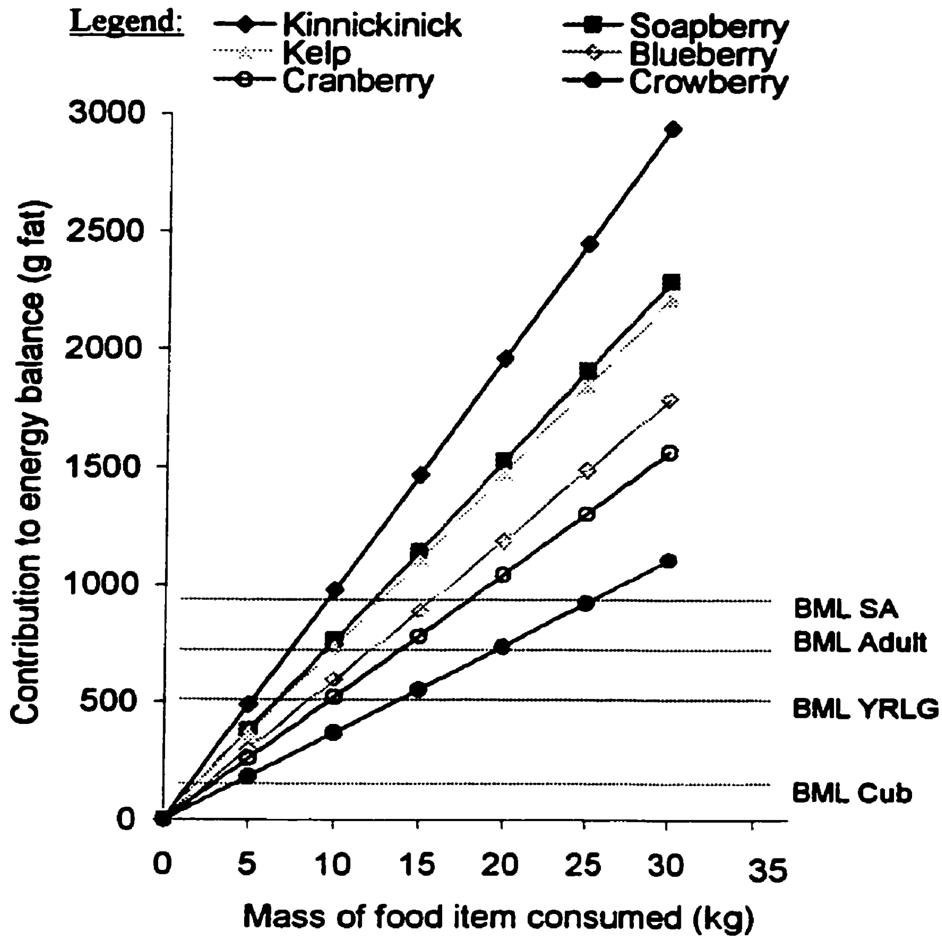
	Adult		Subadult	
Food item	Mass of Food (kg)	Quantity	Mass of Food (kg)	Quantity
Common bearberry	8.68	-	10.72	-
Soapberry	11.13	-	13.75	-
Kelp	11.52	19	14.23	24
Blueberry	14.27	62863	17.63	77665
Cranberry	16.29	77571	20.13	95857
Crowberry	23.03	82841	28.46	102374

(Note: " – " indicates no data available).

Table 6. Continued

	Yearling		Cub	
Food Item	Mass of Food (kg)	Quantity [a)]	Mass of Food (kg)	Quantity [a)]
Common bearberry	6.43	-	2.55	-
Soapberry	8.25	-	3.27	-
Kelp	8.53	14	3.39	6
Blueberry	10.58	46607	4.20	18502
Cranberry	12.07	57476	4.79	22809
Crowberry	17.07	61402	6.77	24352

(Note: a) = Pieces of kelp or individual berries)



(Note: SA = Subadult; YRLG = Yearling)

Fig. 21. Relationship between mass of food item consumed (kg) and contributions to the energy budget in g of fat for selected terrestrial food sources of polar bears.

Due to the fact that polar bears segregate by sex and age classes while on land (Derocher and Stirling 1990a, b), only specific terrestrial food items are available to them, depending on the distribution and occurrence of these food items. That would mean, for example, that adult males, which spend most of the ice-free period along the coast (Derocher and Stirling 1990b) could feed predominantly on kelp (*Rhodymenia* spp) because of its abundance along the coast. On the other hand, bears that are farther inland (e.g. family groups, subadults of both sexes) would have easier access to blueberry, crowberry, soapberry, cranberry, and common bearberry as these plants grow on drier areas, gravel ridges, heath, moss, and around White spruce (*Picea glauca*) islands (Johnson 1987). Spatial segregation may indirectly govern food preferences of polar bears while on land. However, Derocher et al. (1993) reported that most adult and subadult males fed on berries rather than vegetation that occurred along the coastline (e.g., kelp). Consequently, these bears must have traveled farther inland to encounter and feed upon berries even though kelp has higher energetic content. This feeding behaviour may be explained by the fact that energetic content of food is not the only factor dictating food preference of polar bears. Rather, other factors such as mineral composition (e.g., Na^{2+}) may explain such preferences. For example, the energy content (kJ) of kelp is greater than blueberries, cranberries, or crowberries (Kuhnlein 1989; Kuhnlein and Soueida 1992; Table 4). However, Na^{2+}-content of kelp is about 300 times greater than that of the berries (Kuhnlein 1989; Kuhnlein and Soueida 1992). Greater intake of Na^{2+} requires greater water intake to maintain homeostasis and osmoregulation (Schmidt-Nielsen 1990). Sodium-hunger has been attributed to moose feeding on aquatic vegetation (Belovsky and Jordan 1981; Fraser et al. 1982; Jordan 1987), but conflicting evidence exists as well (Faber et al. 1988; Christian 1989; MacCracken et al. 1993). If bears are sodium-depleted, one would predict that males as well as females would feed predominantly on kelp. However, Derocher et al. (1993) reported that subadult and female bears fed mostly on blueberries and crowberries between 1986 and 1992. Spatial segregation could explain the selection for these food items of females and subadults. Whether or not osmoregulation is a factor that influences food preference is poorly understood.

Welch et al. (1997) reported that feeding efficiency of brown and black bears was determined by berry density, size, presentation, bear bite size and rate, capacity of the bear's gastrointestinal tract to process food, and digestibility. During experimental trials, these bears had a maximum daily fresh fruit intake of 34 % of their own body mass. However, maximum intake of berries as determined by feeding efficiency of bears was approximately 70 000 berries/day (Welch et al. 1997). Subjectively, the most common berries in the Churchill area during 2000 were blueberries and crowberries. If, for example, a polar bear feeds for 12 h/day and has an intake rate of 30g/min of blueberries (Welch et al. 1997), then roughly 21.6 kg of blueberries are consumed. Derocher et al. (1993) reported that significant amounts of berries were found in two necropsied bears (Derocher et al. 1993: 252). However, a quantity associated with "significant" was not provided. The fat equivalents of 21.6 kg berries could contribute substantially to the energy budget of a bear leading to a net body mass gain. If polar bears conform to the lengths of brown and black bear feeding bouts as reported by Welch et al. (1997), and feeding efficiency is similar, then all sex and age classes of polar bears could maintain their body mass, and in fact could gain weight over an extended period of time.

Ice break-up and freezing of Hudson Bay can vary, sometimes extending the ice-free period by 2-3 weeks (Stirling and Derocher 1993). This extended period could be critical for the survival and subsequent reproduction of some individuals if they arrive on land in poor body condition at the beginning of the summer. If climatic changes become more pronounced, then hunting periods for bears could become shorter and the ice-free period could get extended (Stirling et al. 1999). In this case, bears would need to feed opportunistically on other food items in order to make up for lost body mass.

While bears are on land, polar bear viewing excursions are offered via tundra vehicle and helicopter tours (see Chapter 2). Bears showed increased vigilance (a visual scanning of their surroundings) response in the presence of tundra vehicles (see Chapter 4). Moreover, as tundra vehicle and helicopter activities were at their peak from 1 October through 15 November, feeding of polar bears of terrestrial food items also increased. In addition to that, traveling behaviour of bears occurred more frequently during 2000 as compared to other published data (Knudsen 1978; see Chapter 5). While these human activities occur in the Gordon Point area, metabolic activity of bears may be increased (i.e., increased vigilance and travel) that requires consumption of opportunistic food sources in the form of a herbivorous diet.

Polar bears are closely related to brown bears (Kurtén 1964), and no interspecific differences in digestive or metabolic activities exist between black and brown bears (Pritchard and Robbins 1990). Therefore, by feeding on the outlined food items for several bouts/day, I hypothesize that terrestrial food sources could contribute substantially to the overall energy budget of polar bears during the ice-free period. However, a detailed study should be undertaken to quantify these hypothesized values and parameters in order to determine what the absolute contributions to the energy budget are, and to examine food preference for selected food items.

Chapter 7

Summary, Conclusions and Recommendations

This thesis reports findings of a baseline study conducted on the polar bear (*Ursus maritimus*) viewing industry at Churchill, Manitoba. The objectives of this research, as outlined in Chapter 1, were (1) to provide quantitative and qualitative information on helicopter and tundra vehicle activity; (2) to quantify vigilance behaviour of polar bears in the presence and absence of tundra vehicles; (3) to quantify daylight activity patterns of polar bears during the ice-free period including resting, traveling, and feeding; (4) to provide an estimate of the contribution of terrestrial food sources to the energy budget of polar bears; and (5) to provide management strategies based on the results of the analyses.

Chapter 3 examined the dimensions of the nature tourism activities at Gordon Point from October through November 2000. An estimated 9,720 visitors (or 270 visitors/day) came to view polar bears. There were 15 ± 1 (mean ± SE) tundra vehicles (TV) per day in the study area. Those vehicles did not always adhere to established trail systems, and visitors on them were noisy during viewing of bears. Individual viewing sessions per bear lasted for a minimum of approximately three hours, and were conducted at a closest estimated distance of 24 ● 3 m. In 88% of all approaches, resting bears were viewed at distances of ≤ 30 m. Some tundra vehicles approached a bear, or vacated the direct vicinity of a bear on average every 10.2 ± 1.7 min. The mean number of tundra vehicles around a bear was 2.1 ± 0.1 vehicles, (range: 1 – 9 vehicles), with 1 – 3 TV being most common. Family groups had the greatest maximum number of tundra vehicles within the estimated viewing distance (5.5 ± 1.2 TV). There were 15.8 ± 2.5 helicopter over-flights per day in the study area (range: 7 – 36). Helicopters landed 4.7 ● 1.1 times per day in the area, and remained on the ground for about three minutes. Both Designated Polar Bear Resting Areas (Fig. 1) were completely submerged by water, and therefore considered to be inaccessible to polar bears, on average every other day between 15 August through 7 November 2000 (see Chapter 3).

Vigilance behaviour (e.g., scanning of the surroundings) of polar bears in the presence versus absence of tundra vehicles was examined at distances of about 20 m (see Chapter 4). In general, the frequency of head-ups in the presence of tundra vehicles was greater than without. Also, between-bout intervals decreased in length of time when vehicles were present. The vigilance bout-length did not differ in the presence versus absence of tundra vehicles. No relationship was detected between behaviour of males (i.e., adult and subadult) and the number of tundra vehicles, whereas for females a relationship was detected for the frequency of head-ups and between-bout intervals. When multiple tundra vehicles were present, habituation could not be detected. However, data on one bear indicated that, when one vehicle remained mostly stationary, habituation to the tundra vehicle occurred (e.g., the response to the stimulus wanes after prolonged presence of the stimulus). The vehicle threshold (e.g., number of tundra vehicles where bears begin to show significantly increased responses) could not be determined from the data collected.

When daylight activity patterns of polar bears were compared to published information, significant differences were detected for resting (64.3%), traveling (20.1%), and feeding (14.5%) [see Chapter 5]. From 7 July through 18 November 2000, bears rested less, and fed and traveled more than previously reported. No significant differences between age and sex-classes were detected. Feeding occurred more frequently in the fall (24.0%; summer: 3.3%), and swimming in the summer (16.4% versus fall: 0%). Bears preferred tide flats when traveling and resting, and willows when feeding. Potential energetic contributions from terrestrial food sources to the overall energy budget of bears during the ice-free period were examined using a mathematical approach (Chapter 6). Terrestrial food sources could contribute substantially to the overall energy budget either to maintain a stable body mass, or could increase body mass if feeding occurred over an extended period of time.

Polar bear viewing activities in the Gordon Point area are complex, and many variables need to be taken into account when considering recommendations. Factors identified through this baseline study, which affect bear behaviour either as a single factor or through an interaction of multiple factors, are (a) viewing distance; (b) number of tundra vehicles around a bear/family group; (c) tundra vehicles approaching and vacating the vicinity of a bear approximately every 10 min; (d) length of individual viewing sessions around a bear; (e) behaviour of visitors on tundra vehicles; and (f) locations of resting bears within the study area. Based on the findings of this study, the following recommendations are provided:

Recommendation 1:
Manitoba Conservation should dialogue with private stakeholders (tundra vehicle operators, guides, helicopter operators) to establish a bear-viewing protocol that describes consistent and predictable tundra vehicle and helicopter approaches of bears.

Nature tourism activities in the Gordon Point area (e.g., approach of bears by tundra vehicles, behaviour of passengers on vehicles) are unpredictable and inconsistent. Education of tourists and tour operators could help establish a predictable and consistent behaviour during bear-viewing activities. Predictability and consistency in human behaviour and activities during wildlife viewing can reduce stress on wildlife, and safely habituate wildlife to human presence (Aumiller and Matt 1994). Habituation should not be confused with food conditioning. Conditioning to human food occurs when bears have fed on human food or garbage, and learn to associate humans and/or human artifacts as potential sources of food (Herrero 1985; Gilbert 1989). This protocol could be an operational policy/strategy for nature tourism operators in Churchill, and part of the strategic ecotourism policy framework developed by Manitoba Department of Culture, Heritage and Tourism (formerly known as Manitoba Department of Industry, Trade, and Tourism) [Keszi 1998].

Recommendation 2:
Manitoba Conservation should seek to encourage further research into the polar bear viewing industry to gain better understanding for designing management regimes, to monitor current practices by tour operators, and changes in polar bear behaviour/physiology.

Research, monitoring, and examination of human dimensions should be viewed as essential feedback loops to ensure that the most appropriate management practices are applied, and that the overall process stays adaptive (Gutzwiller 1993; Bath 1998). A possible action plan for adaptive management is shown in Figure 22. Research and assessing effects of tundra vehicle activity on bear behaviour and physiology could lead to education of tourists and operators, as well as possible guidelines. Enforcement by Manitoba Conservation and/or Parks Canada personnel, tour operators, or non-government agencies should be encouraged to ensure adherence to agreed regulations or codes of conduct (Fig. 22). To ensure that management practices are effective,

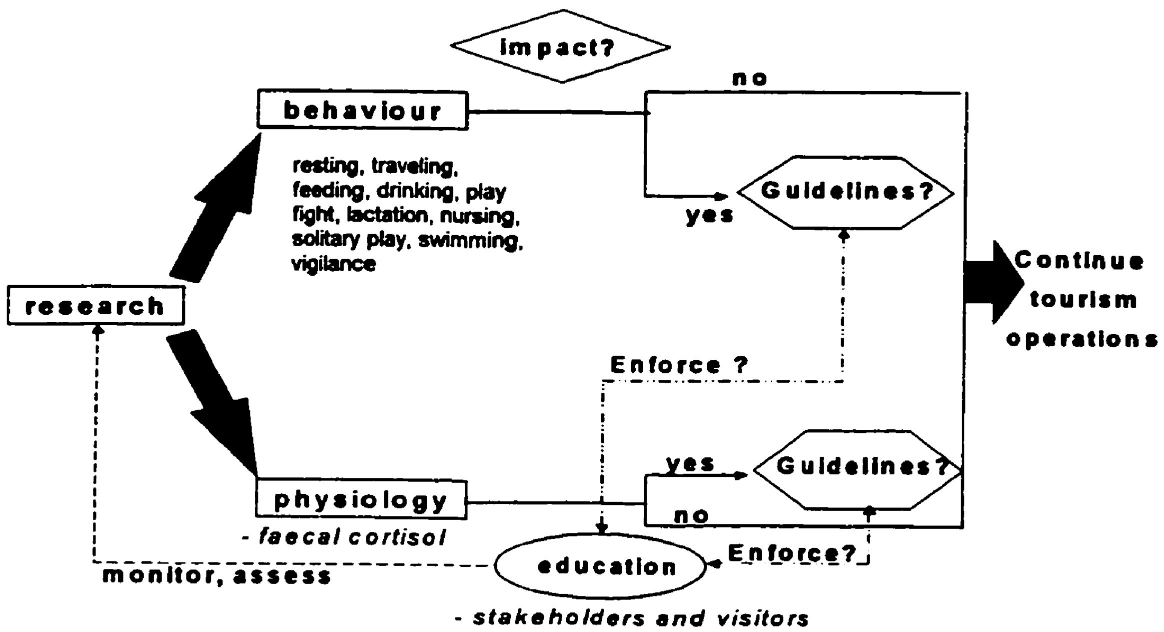


FIG. 22. Outline of a possible strategy for adaptive management for the polar bear viewing industry at Churchill.

monitoring should be conducted on a regular basis.

> *Recommendation 3:*
> **Require that viewing distances between tundra vehicles and resting bears be set at a minimum distance of 20 m.**

Resting polar bears showed increased frequencies of head-ups and decreased time intervals between vigilance bouts in the presence of tundra vehicles at an estimated closest distance of 20 ● 3 m (see Chapters 3 and 4). Data from this study did not allow for an examination of polar bear responses at viewing distances of > 20 m. A manipulation study is warranted to determine experimentally a viewing distance at which vigilance in polar bears is reduced in the presence of tundra vehicles. The benefit of such a study would be to provide scientific and educational information on viewing distance, how it affects bears, and what can be done to minimize effects of viewing activities.

In addition, neither the energetic costs of increased vigilance nor the effects of tundra vehicle noise on bears are well understood. These variables should be investigated in conjunction with a manipulation study on viewing distance.

> *Recommendation 4:*
> **Establish a bear-viewing regime where tundra vehicle movements around resting bears are minimized.**

During bear-viewing activities, vehicles approached and vacated the vicinity of bears every 10.2 ± 1.7 min (see Chapter 3). Commotion caused by tundra vehicles contributed toward an increased response by polar bears. It is my impression that, once a vehicle moves in or leaves, new stimuli are presented to the bear that elicit increased responses. Therefore, drivers/guides should coordinate among themselves which bear(s) is(are) approached, and remain stationary without other vehicles contributing to commotion.

Recommendation 5:
Passengers on tundra vehicles should avoid loud noises (e.g., talking, yelling) during viewing of bears.

On numerous occasions it was observed that passengers on tundra vehicles were noisy (e.g., talking loudly, whistling, making aggressive noises toward bears, yelling) to get the viewed bear's attention (see Chapter 3). Bears reacted to noise and human gestures with increased stress responses at McNeill River State Game Sanctuary, but when loud noises, fast and exaggerated movements were avoided, bears were less stressed (Aumiller and Matt 1994). Drivers and guides on tundra vehicles should explain explicitly to passengers why loud noises during the viewing sessions should be avoided. This form of education could help to carry this recommendation through. The guides and drivers not only have an obligation toward their employers, but also toward the conservation of polar bears. Therefore, the drivers and guides should seek to educate passengers as much as possible about many different aspects of polar bear behaviour as to increase awareness of possible threats and concerns.

Recommendation 6:
Tundra vehicles should not pursue polar bears during viewing activities.

Watts et al. (1991) demonstrated that a polar bear's metabolism could increase between 4 and 12 times compared to the basal metabolic rate for walking at various speeds. During 2000, it was observed that bears, especially family groups, were pursued by tundra vehicles (see Chapter 3). The International Union for the Conservation of Nature emphasized the special status that female polar bears and their offspring should receive (Calvert et al. 1998). Females with cubs have higher energetic costs due to lactation, and any unnecessary expenditure of energy (e.g., pursuing of family groups for photographic opportunities causes bears to move) should be avoided (see Chapters 2 and 3). Bears make a choice about their proximity to humans, and whether they avoid humans and their artifacts. If humans decide to approach a bear, high stress levels can be induced. On the other hand, if a bear chooses to approach humans, stress could be low (Aumiller and Matt 1994). Therefore, during polar bear viewing, pursuits of bears by tundra vehicles should be avoided.

Recommendation 7:
The Designated Polar Bear Resting Areas in the Gordon Point area should be re-examined.

During this study, the two Designated Polar Bear Resting Areas [DPBRA] (Fig. 1) at Gordon Point were only accessible to polar bears every other day because they were submerged by water (see Chapter 3). In addition, there were only a few locations preferred by bears in those DPBRA. The majority of resting locations were present along the shore, outside the DPBRA (Fig. 20). A new proposed DPBRA is outlined in Figure 23. The new proposed DPBRA includes preferred resting locations of polar bears as observed during the 2000 field season at Churchill. However, the current information is based on one year of research, and a second year of field observations would be necessary to confirm what has been recorded to date. Using this option, both tundra train lodges would remain and tour operators may consider possible changes for their day-to-day operations including driving routes.

Churchill's polar bear industry, together with other spin-off sectors (i.e., arts and craft sales, restaurants, bed and breakfast enterprises) presumably contribute greatly to local and provincial revenue (Pelesh 1988, Newton 2000). As such, more emphasis may be placed on environmental monitoring programmes, and how this huge industry affects the local community, wildlife, and environment. Agencies associated with brown bear viewing locations, such as the National Park Service at the McNeil, Brooks River, and Pack Creek, Alaska, attempt to feed information into their management regimes (Aumiller and Matt 1994; Fagen and Fagen 1994; Olson and Gilbert 1994). Social and economic research about Churchill's visitors could help in providing necessary information to design management strategies or policies.

The outlined recommendations are only suggestions, which could be expanded by operators, local people, and agencies during brain-storming sessions. Most visitors are highly educated (MacKay 1998), and show great interest in environmental awareness and sensitivity (World Wildlife Fund Canada 1999). If visitor satisfaction is decreased, fewer people may choose Churchill as a destination (Butler 1980; see Figure 3). Moreover, if the western Hudson Bay polar bear population shows more stress-related signs (see

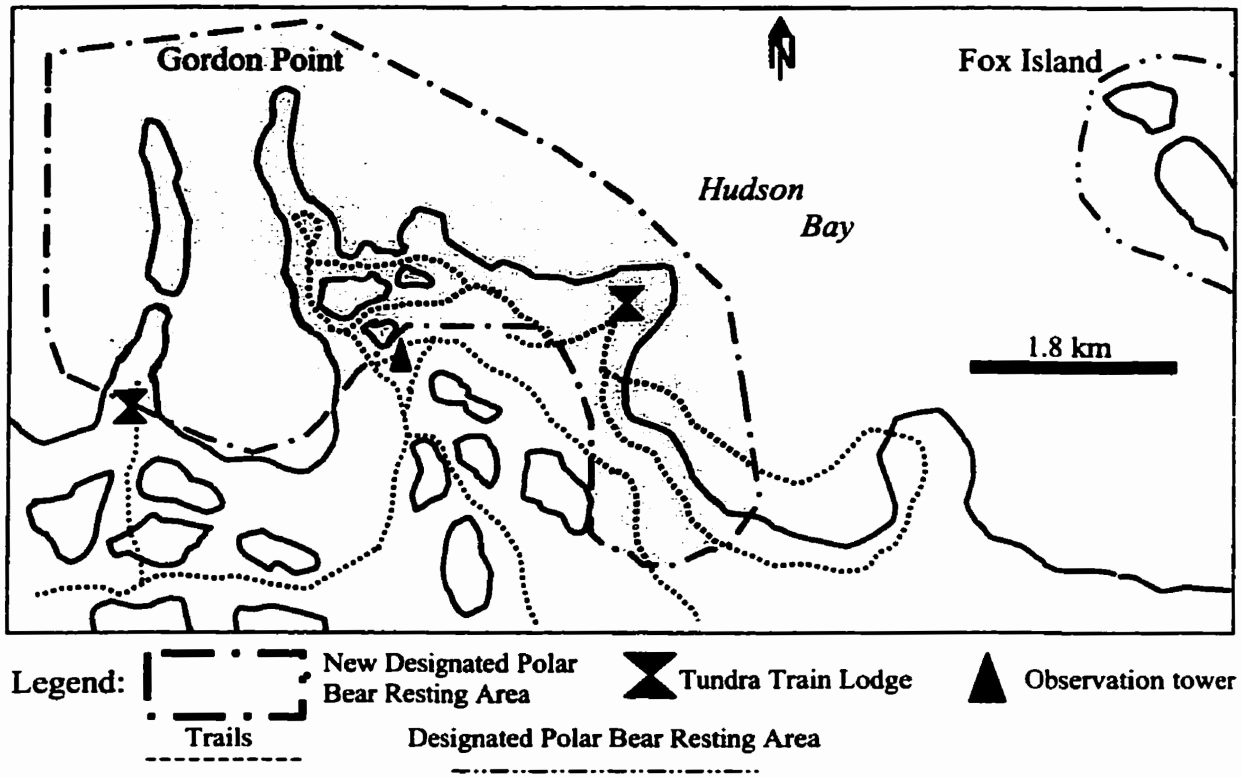


FIG. 23. Outline of a new proposed Designated Polar Bear Resting Area at Gordon Point, Churchill, Manitoba.

Chapter 2), the management agencies are prepared to react by implementing preventative management actions. Participatory planning and partnerships between local operators, government agencies, and travel organizers could potentially benefit all parties involved as all share interests in the same resource (Bramwell and Sharman 1999, Timothy 1999).

In summary, this study examined the dimensions of the polar bear viewing industry and how resting bears were affected by the presence of tundra vehicles in the Gordon Point area at Churchill. The question is not how to manage bears, but rather to design management actions that allow polar bear viewing that minimizes the effect on bears. Hence, management actions (e.g., education for tourists and tour operators, policies) should be designed that manage human activity in this area. Cooperation among all parties (e.g., Manitoba Conservation, Manitoba Department of Culture, Heritage and Tourism, tour operators, Parks Canada) is necessary to accomplish this goal. Data from this study could be used as baseline information that could help tour companies in designing internal company guidelines. Manitoba Conservation could utilize data (i.e., distances between tundra vehicles and bears, vigilance data) to specifically design and implement monitoring protocols (see Fig. 22). Moreover, established codes of ethics and guidelines by other organizations could be coupled with pertinent information from this study. For example, Stonehouse (1990), D'Amore (1993), The Ecotourism Society of America (1993) [Appendix 1], Fennell and Malloy (1995), and World Wildlife Fund (1997) provide many practical codes or guidelines for wildlife viewing and nature tourism in remote areas that could be adopted at Churchill. One tour company has been working on a driver's manual that could be in effect as early as fall of 2001. Appropriate actions taken by either Manitoba Conservation or the tour operators will enhance visitor experience and contribute toward the conservation of polar bears.

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Appendix 1

ECOTOURISM GUIDELINES FOR NATURE TOUR OPERATORS:

by The Ecotourism Society 1993

PREDEPARTURE PROGRAMS -- VISITOR INFORMATION AND EDUCATION

Guideline:
Prepare travelers to minimize their negative impacts while visiting sensitive environments and cultures before departure.

Offer visitors the educational materials they need to learn about the places and people to be visited and introduce the importance of contributing to the conservation of places being visited.

Educate visitors about the full range of natural and cultural phenomenon to be observed.

Educate visitors to consider the effects of their visit in advance and to modify their behavior while traveling, with the objective of minimizing impacts.

Provide introductory information on the people and ecosystems to be visited in pre-departure packages. Stress the importance of reading pre-departure information, such as selected bibliographies, and review additional resources for each destination.

Keep information objective and well-grounded using examples of phenomenon visitors might encounter.

Provide general travel ethics addressing standards for behavior in natural areas and with local cultures.

Provide information on the equipment, clothing and personal supplies suitable to the regions being visited.

Warn against bringing disposable goods that contribute to the solid waste burden in the region.

Provide information on products that are illegally traded.

Provide information, as required, on avoiding the accidental transport of foreign, exotic species into isolated ecosystems being visited.

Visitor Benefits:
Visitor is attuned to the full range of opportunities for viewing wildlife and learning about different cultures.

Awareness of personal responsibility to minimize impacts on the environment and local cultures before departure.

Visitor has proper gear and clothing for environments and cultures to be visited.

GUIDING PROGRAMS -- GENERAL PRINCIPLES OF GUIDING TOURS

Guideline:
Prepare travelers for each encounter with local cultures and with native animals and plants.

Objectives:
Pave the way for reciprocal sensitivity between cultures by teaching tourists to be unobtrusive while they are encountering environments and cultures.

Provide visitors with the opportunity to learn more about the social and political circumstances of the region being visited.

Provide visitors with the opportunity to learn more about local environmental problems and conservation efforts.

Techniques:
Provide quality orientation and enough leaders to manage the group according to the sensitivity of the environment visited.

Give quality interpretation at all times; explain local cultures and describe natural history. Encourage interaction with local people while overseeing contact to avoid cultural errors.

Conduct briefings before each stop, including behaviors to avoid, restricted practices and zones, special alerts for fragile and endangered species, specific distances to maintain with local wildlife, and local regulations.

Use of time on road and in cities for educational discussions of all kinds including balanced discussions of local issues.

Visitor Benefits:
Awareness of how to encounter cultures and environment with minimum negative impact.

Insight into the visitor's own role and potential contribution to local conservation and sustainable economic development efforts.

GUIDING POGRAMS -- PREVENTION OF ENVIRONMENTAL IMPACTS

Guideline:
Minimize visitor impacts on the environment by offering literature, briefings, leading by example, and taking corrective actions.

Objectives:
Help visitors to minimize their negative impacts by enhancing their understanding of the fragility of the environment.

Company guides should pursue the following procedures:

Provide a set of environmental guidelines, created by the company, specific to the area being visited.

Obtain and distribute available guidelines for each natural area visited.

Allow protected area staff to introduce guidelines if possible.

Brief visitors on proper behavior - on trails, in campsites, around wild animals, around fragile plants - and with trash, with human waste, with fires, and with soaps.

Advise all travelers on the level of difficulty of each excursion to prevent damage to the environment caused by lack of experience or ability to maneuver in unfamiliar terrain.

Discourage unrealistic expectations of observing rare wildlife and plants by interpreting all aspects of the ecosystem.

Advise against collecting souvenirs from natural areas, such as feathers, bones & shells, unless it is specifically condoned by local authorities.

Advise against purchasing specific crafts that are produced from threatened natural resources.

Visitor Benefits:
Learns how to travel without leaving footprints.

Gains a greater understanding of travel's impact on the environment.

Is informed of the rules and regulations of natural areas and the need to follow them.

GUIDING PROGRAMS -- PREVENTION OF CULTURAL IMPACTS

Guideline:
Minimize traveler impact on local cultures by offering literature, briefings, leading by example, and taking corrective actions.

Objectives:
Protect the integrity of the cultures being visited by minimizing visitor contribution to acculturation and the decline of local values. Enhance visitor understanding of local cultures but avoid improper intrusions into the private lives of others.

Techniques:
Company guides should be aware of the following procedures:

Interpret local cultural values and history of local cultures.

Provide a set of cultural guidelines created by the company, specific to the area being visited. Where available, obtain and distribute guidelines written by local communities.

Advise visitors to accept differences, adopt local customs, and be unobtrusive. Discuss appropriate behavior when photographing.

Discuss appropriate behavior when purchasing goods, tipping, and responding to begging.

Visitor Benefits:
A better understanding of local values and cultures and how to behave with local peoples to minimize cultural impacts.

The ability to look, listen and learn from others without intruding.

MONITORING PROGRAMS -- PREVENTION OF ACCUMULATED IMPACTS OF TOURISM

Guideline:
Use adequate leadership, and maintain small enough groups to ensure minimum group impact on destinations. Avoid areas that are under-managed and over-visited.

Objectives:
Diminish accumulated effects of tourism on sensitive sites.

Avoid overloading local visitor management capabilities if there are inadequate funds and staff to manage visitors in sensitive sites.

Contribute to an effort to disperse tourism, and lighten the load on popular destinations during peak seasons.

Recognize sites, in advance, that are inappropriate for tourism, or need assistance with existing damage.

Techniques:
Be sensitive to total number of groups visiting sites simultaneously. Informally census the number of groups encountered on trails or roads within protected areas and keep track of sites with rapid increases. Notify authorities or landowners if the number of groups is growing rapidly.

Monitor negative environmental impacts, including trail erosion, improper waste dumping, littering, water pollution, species harassment, illegal collecting of plants or animals, feeding of wildlife, or wild animals that have become abnormally tame or aggressive. Notify authorities or land owners both verbally and, if need be, in writing.

Assist land managers in monitoring key, indicator species, or offer logistical assistance to researchers working on tourism impacts.

Design itineraries and promotions to avoid overselling popular sites, particularly those that are inadequately managed for visitation during peak seasons.

Watch for accumulated cultural impact and work to prevent or buffer them. Indicators include; inflated prices for goods in communities; hostility towards tourists from local communities; black markets, drug dealing and prostitution catering to the tourist industry.

Visitor Benefits:
Avoids contributing to the destruction of sites visited.

Learns to recognize the negative impacts of tourism and the importance of notifying the authorities when this occurs.

Learns to avoid overloading popular sites, by making trips in off-season or avoiding peak visitation hours.

Learns to recognize cultural impact and avoids contributing to the decline of local values.

MANAGEMENT PROGRAMS -- PREVENTION OF NATURE TOUR COMPANY IMPACTS

Guideline:
Ensure managers, staff and contract employees know and

participate in all aspects of company policy to prevent impacts on the environment and local cultures.

Objectives:
Make the nature tour company as environmentally and culturally sensitive as possible, both in the office and in the field.

Techniques:
Establish an environmental code and objectives manual for the company.

Confidence in the personnel who are leading the organization and the tours.

MANAGEMENT PROGRAMS -- TRAINING

Guideline:
Give managers, staff and contract employees access to programs that will upgrade their ability to communicate with and manage clients in sensitive natural and cultural settings.

Objectives:
Offer meaningful opportunities for staff and contract employees to work within a sustainable economy.

Techniques:
Establish clear guidelines for staff regarding opportunities and company support available for training, via internal training programs (natural and cultural history) and via training programs available locally (language skills and first aid, accounting, mechanics).

- Establish an operator's consortium for training.
- Establish a relationship with a local educational facility and work to integrate needed training components into the curriculum.
- Work with nongovernmental organizations to establish an ecotourism training program.

Visitor Benefits:
Opportunity to contribute to a local sustainable economy that offers local people opportunities to be employed in increasingly responsible positions.

MANAGEMENT PROGRAMS -- CONSERVATION CONTRIBUTION PROGRAMS

Guideline:
Be a contributor to the conservation of the regions being visited.

Objectives:
Put tourism-generated revenues into the hands of local environmental organizations and protected area management agencies for conservation initiatives.

Ensure that tourism revenues cover the costs for the management of tourism on wild lands and protected areas.

Help parks and protected areas generate revenue, thereby providing economic impetus to a conservation agenda on the national level in destination countries.

Techniques:
Provide corporate contributions to local non-profit conservation initiatives and protected areas through direct corporate donations, partnerships, technical assistance, education programs, publicity, facilitation, direct staff involvement, and becoming involved in joint initiatives.*

Facilitate visitor contributions to local conservation initiatives during the trip by: providing literature on projects in the regions being visited and guidelines for in-kind contributions; arranging briefings and visits to local projects with project staff; or offering opportunities for visitors to volunteer.

Facilitate visitor contributions to local conservation initiatives after the trip by: sending follow-up mailings to clients with local nonprofit membership literature, brief descriptions of projects that need assistance, upcoming opportunities to do volunteer services, or opportunities to work at home by being an ambassador or fund raiser or organizer for local projects.*

Encourage writing to government and corporate organizations whose policies are damaging to the environment or local cultures in the areas visited by providing addresses and contact names.

*This may not apply to non-profit organizations running tours

Visitor Benefits:
A better understanding of how tourism can be a net contributor to the conservation of cultures and environment visited.

A chance to be a part of the effort to conserve a beloved place on a long-term basis and preserve biological diversity and cultural heritage worldwide.

MANAGEMENT PROGRAMS -- LOCAL EMPLOYMENT & JOBS PROGRAMS

Provide competitive, local employment in all aspects of business operations.

Make ecotourism beneficial to local communities.

Provide local people access to jobs that are not destructive to the environment.

Provide local people with a full range of opportunities beyond the service employment sector.

Techniques:
Hire locally-owned businesses including transport (vehicle and boat rental services), accommodations (hotels, lodges, camps), and restaurants.

Buy local supplies from food and craft vendors and avoid all products made from endangered or threatened species.

Hire local office and field staff. Pay competitive wages, above minimum wage for the region, and offer acceptable benefits.

Contribute to community enterprises and development efforts that support a wide variety of local residents, with special sensitivity to indigenous groups.

Visitor Benefits:
Opportunity to contribute to a sustainable market economy,

e.g. to provide job opportunities that are not destructive to the environment.

Awareness that the choices visitors make affects the lives and livelihoods of others.

LOCAL ACCOMMODATIONS CHECKLIST

Offer site-sensitive accommodations that do not waste local resources or destroy the environment and that provide ample opportunity for learning about the environment and sensitive interchange with local communities.

Ensure all aspects of the visitor's experience are in harmony with the natural and cultural environment.

Review the following check list of considerations when booking new accommodations.

Select accommodations that are in compliance with environmental regulations.

Review facility's level of destruction to natural surroundings.

Consider facilities efforts to maintain a scale in keeping with the local environment and to reflect national or local cultural design motifs in architecture and interior design.

Review facility's use of energy saving devices and renewable energy resources.

Review facility's treatment of solid and organic waste. Ensure that solid waste is safely disposed of and that recycling programs are in place where possible. Ensure that all waste products are treated to prevent effects on natural resources.

Determine if restaurant is composting and using other techniques to reduce waste such as avoiding paper products and styrofoam.

Determine if facility is offering meaningful opportunities for locals.

Check into training programs offered by lodge.

Review opportunities for locals to have sensitive cultural interchange, on their own terms, with visitors.

Look for locally produced craft and food items available for sale on the premises or used in facility restaurants, and ensure that all products from threatened natural resources are avoided.

Check for the interpretive/educational materials inside the facility that are available to guests. Look for field guides, videos, books, pamphlets, and check lists of species found locally.

Check for availability of interpretive services outside, such as self-guided trails and guide services.

Check for the facility's sensitivity to interpretive opportunities; i.e. how well the facility has interpreted its own land's natural features and natural resources, or the local cultural backgrounds and perspectives of its own staff, for visitors.

Ask if owners contribute to conservation or community development efforts with financial, technical or logistical support.

Avoid sites that bait animals, or that keep exotic species on the property that were trapped in the wild, especially threatened or endangered species.

Visitor Benefits:
An appreciation of the possibilities for sustainable living.

Greater sensitivity to the role of the resort in a community, its impact and contribution to locals, and how to select resorts that are environmentally and socially sensitive.

Better opportunities for sensitive cultural interchange and enlightening field trips accompanied by staff or representatives of local communities.