Title: **Foxe Basin Polar Bears: Population Inventory and Sea-Ice Habitat Selection**

Project Co-Leaders

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Summary

The Government of Nunavut (GN) is responsible for the management and conservation of polar bear (*Ursus maritimus*) populations within its jurisdiction. This task involves periodic population inventories which are comprised of geographic delineation and estimation of demographic parameters including birth and death rates, population size and status. With this information, the GN recommends the Total Allowable Harvest (TAH) for the population to the Nunavut Wildlife Management Board (NWMB). In addition, under the Nunavut Land Claims Agreement (NLCA), the GN is required to manage wildlife under the *principles of conservation*; climate change and its consequences for polar bears has been highlighted as a conservation concern. We propose a study to: 1) delineate the Foxe Basin polar bear population using satellite telemetry; 2) conduct a 3-year mark-recapture survey to estimate demographic parameters; and 3) relate Foxe Basin polar bear movements, gathered from the telemetry data, to ice conditions in the context of climate change research. Additional objectives of this study are to build collaborations among the GN, academia and Parks Canada and to integrate Inuit Qaujimajatuqangit (IQ) with science in terms of study design and interpretation of data. We present this study as a 5-year field project, with final results expected in 2012.

Background

Canada and the other arctic nations have signed the *International Agreement for the Conservation of Polar Bears*. The mandate for polar bear conservation and management was passed from the federal government to the Northwest Territories with the passage of the Northwest Territories Act, followed by the Wildlife Act and associated regulations for polar bear management. With the onset of Nunavut, the Minister of Environment retained responsibility for conservation, wildlife research, and management. The Government of Nunavut recommends management actions to our co-management partner, the NWMB, which implements wildlife management within Nunavut.

Management of polar bear populations requires population inventories, which ultimately estimate population status. The proposed research includes a population inventory of the Foxe Basin polar bear population (Figure 1). The inventory will result in a recommendation for harvest management. Concomitantly we will address the relation of polar bear movement to ice conditions. Ice conditions experienced by polar bears will change with climate warming, potentially negatively affecting population status and Inuit harvest (Stirling *et al.* 1999). This latter application of the research falls within the GN mandate under the NLCA to manage wildlife under the *principles of conservation*.

Population Inventory

The Foxe Basin polar bear population has received relatively little recent research attention (Lunn *et al.* 1987, Taylor *et al.* 1990). No population boundary delineation using satellite telemetry (*e.g.,* Taylor *et al.* 2001) has occurred and demographic rates have not been estimated.

The mean population size for polar bears in Foxe Basin from 1989 to 1994 was estimated to be 2197 ± 260 SE (Taylor *et al.* 2006). In recent years, IQ has indicated increases in polar bear numbers, resulting in an increase in the 2005 TAH from 97 to 106 polar bears, which was considered sustainable with a population estimated at 2,300 bears. In reaction, national and international concern may affect the polar bear sport hunt across Nunavut. Sport hunters from the USA are discouraged from hunting in Foxe Basin because the *US Marine Mammal Protection Act* prevents import of polar bear hides from populations with an uncertain status or which do not have inter-jurisdictional agreements. This factor adds additional urgency to begin research that will bring credibility to the management of Foxe Basin polar bears.

There is community support for research on the Foxe Basin polar bear population. In 2004, this population was identified as one of the top three priorities by the Kivalliq Wildlife Board at the wildlife research priorities workshop in Rankin Inlet.

Polar Bear Habitat Selection

The GN must manage polar bears in the context and uncertainty of climate change. The effects of climate change have been manifested in decreased survival and birth rates, increased mortality and lower body weights of polar bears in Western Hudson Bay (WH; Stirling *et al.* 1999) and the Beaufort Sea (Monnett and Gleason 2006; Regehr *et al.* 2006) These changes in demographic rates in WH have resulted in a decrease from 2100 to 950 bears over the last 20 years. The decrease in population size is most often attributed to changing ice conditions (Stirling and Parkinson 2006). Polar bears and their prey are dependent on the sea ice and thus are vulnerable to climate change. The potential effects of reductions in sea ice on polar bears are many: survival; reproductive success and movement and distribution. Using the field effort associated with population delineation we propose to address seasonal movement and ice habitat selection of polar bears.

Inuit Qaujimajatuqangit

The Inuit of Nunavut are instrumental, in Nunavut's wildlife management, including research. This project will use community consultations, under permits issued by the Nunavut Research Institute (NRI), to help plan study design and interpret results with respect to polar bear habitat ecology. Specific questions will be addressed to elders concerning the extent, type and change of ice conditions. In addition, hunters and elders will be asked about their knowledge of polar bear health and movements.

Objectives

I. To geographically delineate the Foxe Basin polar bear population (2008, 2009).
II. To conduct a mark-recapture survey (2009 – 2011) of the polar bears in Foxe Basin to:
    a. estimate population size;
    b. estimate survival and recruitment;
    c. estimate population status (trend);
    d. determine Total Allowable Harvest (TAH)
III. To investigate movement and habitat selection of Foxe Basin polar bears as related to ice conditions (2007 – 2011).
IV. To collect and include IQ in the development of the study and interpretation of the results (2006 – 07)

Application of Results

The primary results include delineation of the Foxe Basin polar bear population boundaries, population enumeration, assessment of natural birth and date rates and determination of status (increasing, decreasing or stable). The final results of

the population inventory in 2011 will allow NWMB and the GN to establish revised TAH for the Foxe Basin polar bear population.

Satellite telemetry data will be used to assess the impact of sea ice on the movement and habitat selection of polar bears. These data will be used to predict changes in habitat use, and possibly population status, when sea ice habitat changes.

Study Area

The Foxe Basin polar bear population is comprised of Foxe Basin, northern Hudson Bay and the western most extent of Hudson Strait (Figure 1).

Chesterfield Inlet (8), Coral Harbour (40), Repulse Bay (12), Hall Beach (8), Igloolik (10), Cape Dorset (10), Kimmirut (10), Qikiqtaaluk Wildlife Board (4) and Kivalliq Wildlife Board (4) harvest from Foxe Basin (TAH in parentheses)..The Foxe Basin population is also harvested by Quebec communities (0-7 polar bears from 1997-2005), however the harvest is not regulated.

Project Design

Population Delineation

We will use satellite telemetry to collect data on female polar bear movement for population delineation (Taylor *et al.* 2001). We will pre-select capture locations to provide uniform deployment over the study area. Approximately 30 adult female polar bears with dependent young will be captured and collared in 2007 and 2008. These data will be provided electronically to the investigators by Argos once/month. The collars will be programmed for a two-year life span, after which time the collars will drop off automatically. The collars will be retrieved primarily by snowmobile and boat. Helicopters retrieval will only occur when helicopters are in the area for other purposes.

In addition to the satellite data, which we will collect, selected satellite and standard telemetry polar bear movement data from WH, Southern Hudson Bay (SH) and Davis Strait (DS) polar bear populations will also be included in the population delineation analyses. These data will be obtained via data-sharing agreements from the GN, the Ontario Department of Natural Resources and the Canadian Wildlife Service (CWS).

The analyses will follow the cluster analysis approach developed by Bethke *et al.* (1996) and Taylor *et al.* (2001). Data will be transformed before analysis and divided into four seasons: spring (16 March – 31 May), summer (01 June – 15 August), autumn (16 August – 15 November) and winter (16 November – 15 March). We will observe if geographical clusters are related to season or ice

condition. Space use by individual bears in the Foxe Basin population will be mapped using the Fixed-Kernel Method. All location points for each bear will be used in this analysis. The 95, 80 and 60% contours of the home range will be used to draw the population boundaries.

Estimation of Demographic Parameters

We will use standard mark-recapture methods to estimate the demographic parameters of the Foxe Basin polar bear population. One of the assumptions in classic mark-recapture analysis is that each individual has an equal opportunity to be captured. We will attempt to meet this assumption by capturing every bear seen during uniform geographic coverage of the population area over three field seasons (2009-2011), conducted during the open-water period. We will employ population and survival estimation mark-recapture models that can account for capture heterogeneity, *i.e.,* individual variation in capture probabilities. Survival estimates of all age and sex classes are based on the capture histories of marked bears and are estimated using open population models (*e.g.,* Cormack-Jolly-Seber model) within program MARK (White and Burnham 1999). The TAH for the Foxe Basin population can be calculated as a function of recruitment and survival.

Polar Bear Habitat Selection

We will investigate seasonal habitat selection using a combination of GIS data (sea ice maps) and polar bear location information to develop spatial, predictive Resource Selection Models (RSM). The analyses will build on the understanding and approaches to modeling polar bear habitat selection developed by Ferguson *et al*. (2000) and Durner *et al*. (2004). At this time the parameters of the RSM are unknown but are likely to include: ice cover; ice thickness; floe size; water depth, and distance to ice edge. Habitat selection during the ice-free seasons (summer, fall) will also be investigated. Model parameterization will be more challenging for this time period as there is little information available. Understanding of summer polar bear habitat use will be developed in the smaller study area of Wager Bay where it is possible to collect 3rd order (Johnson 1980) habitat use information that will contribute to model development.

Sea ice condition maps will be obtained from the US National Aeronautics and Space Administration (NASA) and the Canadian Ice Service (CIS). Both agencies create maps and charts derived from remotely sensed data from the following sources: NOAA passive microwave Special Sensor Microwave Imager (SSM/I with 25 km resolution), Advanced High Resolution Radiometer (AVHRR with 1 km resolution) and Defence Meteorological Satellite Program (SMSP) Operational Linescan System (OLS with 550 m resolution).

Field Methods

Polar bear immobilization will be necessary for the ***Population Delineation***, ***Estimation of Demographic Parameters***, and the ***Polar Bear Habitat Selection*** aspects of the study. Helicopter fuel caching and logistic preparations will occur in 2007 and 2008. Field operations for 2007 – 2011 must be based out of geographically distributed base camps to effectively and efficiently sample the Foxe Basin polar bear population uniformly. Field operations will be based out of the Kivalliq and Baffin communities and a Parks Canada base camp in Wager Bay. No logistics base is available at the eastern extent of Foxe Basin, north of Cape Dorset. We propose to construct a small cabin on the western coast of Baffin Island to serve also as a logistic base. We propose that this cabin will then become property of the Igloolik Hunter and Trapper's Organization (HTO), to be used by future hunters and researchers alike.

Polar bear capture will take place in late August - October 2007 – 2011. Polar bears will be immobilized with a dart gun from a Bell 206 using Zoletil (tiletamine hydrochloride and zolazepam hydrochloride), at a concentration of 200mg/ml and administered at approximately 5mg/kg. The following data and samples will be collected: auxiliary girth; zygomatic width; total straight length; a vestigal premolar tooth (aging); ear puncture (DNA); fat biopsy (fatty acid signatures); hair samples (heavy metals) and a claw tip (stable isotopes). Other information collected will include sex, an approximate field age, and body condition. We will mark the bears with ear tags and lip tattoos.

Whenever a polar bear is encountered in the survey area, it will be captured for the mark-recapture survey and/or the collaring effort. The survey area will be the entire coast line of the Foxe Basin population during the open water season. It is essential to cover the entire geographic extent of the population in every year of the mark-recapture effort to minimize a geographically-induced bias in the demographic estimates.

Inuit Qaujimajatuqangit

IQ on polar bears will be collected using focus group workshops with polar bear hunters and individual interviews with elders. Traditional knowledge of the area, gathered during community consultations will also be used to demarcate the area used by polar bears during the open water season to advise the capture teams. Other topics to be covered at the workshops will include polar bear seasonal distribution and abundance, health of bears, and sea ice conditions.

Community Consultation and Reporting

Community consultation will be shared between the University of Alberta (Kivalliq communities) and the GN (Baffin communities). A schedule will be set each year.

Inter-jurisdictional consultations and information sharing required with the Province of Quebec will be the responsibility of the GN.

The Kivalliq Inuit Association and Ukkusiksalik Park Management Committee will be informed about research occurring in Ukkusiksalik National Park (a segment of the Foxe Basin study area) as per an Inuit Impact Benefit Assessment (IIBA).

Annual meetings (2007/08) with the HTO's have occurred. Community meetings to discuss the final results of this research will occur in 2009/10 and 2010/11.

All results will be presented in person by the either co-leader. Visual aids (*e.g.*, maps, photographs, video, text) will be used to facilitate communication. Presentation materials will be in Inuktitut and English. A translator will be used for all verbal communications.

Translated short annual summary reports will be provided at the consultation meetings. The final report will be lengthy and will not be translated in its entirety. A translated summary document with the key findings will be produced.

Schedule for Consultation

Community	Organization	Date
Repulse Bay	HTO	May 2006
Rankin Inlet	Kivalliq Inuit Association – Lands Department	May & Aug 2006
Ukkusiksalik National Park	Ukkusiksalik Park Management Committee	Aug & Dec 2006
Repulse Bay	HTO	February 2007
Coral Harbour	HTO	February 2007
Chesterfield Inlet	HTO	February 2007
Baker Lake	HTO	February 2007
Rankin Inlet	HTO	February 2007
Hall Beach	HTO	Spring 2007
Igloolik	HTO	Spring 2007
Cape Dorset	HTO	Spring 2007
Kimmirut	HTO	Spring 2007

Schedule

Step	Start	End	Person Days
Deploy satellite collars (13)	19 Aug 2007	22 Aug 2007	8
Deploy satellite collars (20)	15 Aug 2008	1 Sept 2008	30
Mark – recapture field work	1 Aug 2009	30 Oct 2011	540
Data analysis & writing	1 Oct 2007	30 Sept 2012	2100

Anticipated Outputs

- Annual written research and financial reports as required by the NWMB
- Annual written summaries and presentations as required for community consultation
- Annual research permit reporting to the GN and Parks Canada
- Annual research reporting to the Federal/Provincial Polar Bear Technical Committee Meeting
- Presentations at professional conferences and workshops
- Bi-lingual poster illustrating research for display in communities
- Annual interim and final reports to the GN
- Peer-reviewed journal articles

Literature Cited

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Partners

Nunavut DOE
- Co-leader
- financial and in-kind

University of Alberta
- Co-leader
- confirmed, in-kind

Parks Canada
- confirmed, financial and in-kind

ArcticNet
- requested, financial and in-kind

Polar Continental Shelf Project
- requested, in-kind

Nunavut Wildlife Management Board
- requested, financial

Polar Bears International
- requested, financial

Evergreen Foundation
- confirmed, financial

Hunter Trapper Organizations
- requested, participant

Canadian Wildlife Service
- confirmed, collaborator and in-kind

National Aeronautics & Space Administration
- confirmed, collaborator and in-kind

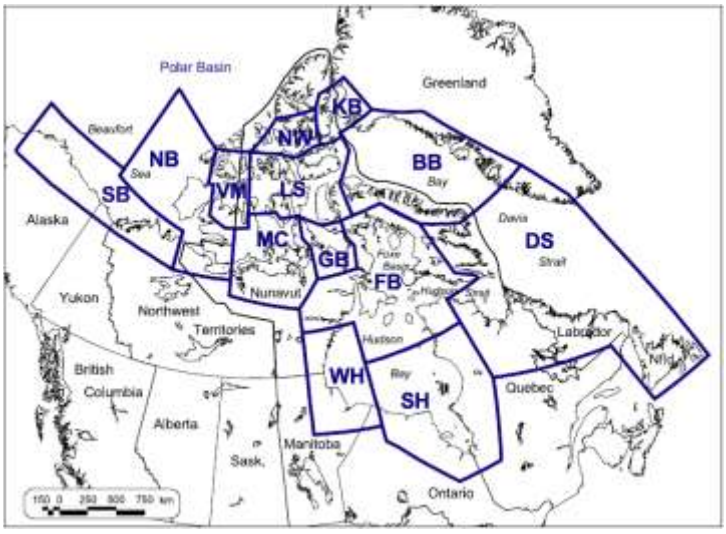

Figure 1. The polar bear (*Ursus maritimus*) populations of Canada. FB delineates the study area for the Foxe Basin polar bear population.

Budget and Contributors for 2007 - 08

Expenditure Type	***Total 2008/09***	***GN****	***NWMB****	***PCSP****	***Parks Canada***	***Peregrine***
GPS Satellite Collars (25 @ 4.5k/collar)	112500	**90000**				22500
Argos Fees (@ 1.0k/collar per year, includes 1.0 k for 13 collars in 2007)	38000	**38000**				
RFID tags (20 plus reader, antennas, software)	10000	**10000**				
Fuel – purchase (45 drums @ $350 /45 gal. drum)	15750	**15750**				
Fuel – deposits & labeling (approx. $110/drum)	4950	**4950**				
Fuel – caching (39 caches at approx. $4,000/cache)	156000	**81000**	25000	50000		
Helicopter - for 100 hours @ $1,500/hr	150000	**50000**	50000	50000		
Retrieve Collars – Snowmobile & Boat	5000					5000
Community Contracts - $150/day for HTO participation in field work for 15 days	2250					2250
Travel and accommodation in field (EP, VS)	12000	**6000**				6000
PCSP satellite phone charges	1000					1000
Food	5000				5000	
Additional capture equipment & supplies (tags, consumables)	5000					5000
Zolatil ($100/bear for 30 bears)	3000					3000
Total	$520,450	**$295,700**	$75,000	$100,000	$5,000	$44,750

*Requested