Re-estimating the abundance of the Lancaster Sound polar bear subpopulation via genetic mark-recapture sampling

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Name	Affiliation	Role	Employment (person days)	Training (y/n); If yes, indicate type of training provided)
Up to 3 Conservation Officers	GN-DOE	Logistics & field assistance	n/a	Y-Survey and sampling methods
Polar Bear Bio I	GN-DOE	Logistics and field assistance	n/a	Y- Survey and sampling methods
Up to 2 individuals to be nominated	Arctic Bay HTO	Field assistant	Up to 20 days	Y – Survey and sampling methods
Up to 2 individuals to be nominated	Resolute Bay HTO	Field assistant	Up to 20 days	Y- Survey and sampling methods
Up to 2 individuals to be nominated	Grise Fiord HTO	Logistics and field assistance	Up to 20 days	Y- Survey and sampling methods
TBD	TBD	Analyses assistance	contracted	N
TBD	TBD	Contracted Biologist	Contracted	N

SUMMARY

The Lancaster Sound (LS) polar bear subpopulation is one of Nunavut's largest polar bear populations – it spans a geographical area of about 470 000 km^2 (with about approximately 250 000 km^2 of sea-ice) and is home to an estimated 2541± 391(mean ± 1 SE) polar bears. There are no current data for LS and the population estimate derived from data in the late 1990's has a high degree of uncertainty, in part due to environmental changes and a prolonged male-biased harvest that has been part of the polar bear management system. In order to fulfill mandated wildlife monitoring objectives and provide appropriate management advice to the Nunavut Wildlife Management Board, we propose to undertake a 3-year study (2021-2023) involving genetic biopsy mark-recapture techniques to reassess the size and status of the LS polar bear subpopulation. In order to conduct the research, logistical preparations such as fuel purchase and caching, are required beforehand. This proposal is for the preparatory work (fuel caching) ahead of the population study that is planned for 2021-2023.

BACKGROUND

The Lancaster Sound (LS) polar bear subpopulation is one of Nunavut's largest polar bear populations – it spans a geographical area of about 470 000 km^2 (with about approximately 250 000 km^2 of sea-ice), and is home to an estimated 2541± 391(mean ± 1 SE) polar bears (Taylor et al. 2008a). The LS subpopulation is relatively distinct from neighboring polar bear subpopulations, which was revealed by movements of adult female polar bears fitted with collars, mark-recapture data from past years (Bethke et al. 1996, Taylor et al. 2001), as well as genetic studies (Paetkau et al. 1999, Malenfant et al. 2016). The most recent population study was conducted from 1989 to 1997, which renders the status of LS as data deficient as assessed by the IUCN Polar Bear Specialist Group (Durner et al. 2018).

Additional factors that increase the uncertainty about the LS subpopulation status are changes in sea-ice distribution and freeze-up and break-up patterns (Maslanik et al. 2011, Markus et al. 2009, Sou and Flato 2009, Stirling and Parkinson 2006, Regehr et al. 2016, Stern and Laidre 2016). In several polar bear subpopulations, earlier sea ice break-up and later freeze-up have affected polar bear body condition, reproduction, and survival rates (Stirling et al. 1999,

Rode et al. 2010, Regehr et al. 2007). How and if these changes have affected LS polar bears during the past two decades is currently unknown.

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OBJECTIVES

The objectives of the field research project (2021-2023) are to:

1) Work with community HTOs to design and implement a comprehensive survey using genetic biopsy sampling or genetic biopsy sampling in combination with selective collaring, to reliably estimate the abundance of polar bears in LS during the spring on-ice season (e.g., May – June) or semi-ice free season (during August to October) of 2021, 2022, and 2023.

2) Estimate the current population size and composition of the LS polar bear subpopulation.

3) Compare a new estimate of abundance with the one derived during a past study in-order to gain insight into population trend and status in LS, to the extent possible.

4) Estimate survival and reproductive parameters (to the extent possible) in-order to facilitate population viability analyses.

5) Evaluate on-ice or on-shore polar bear distribution (to the extent possible).

6) Enhance public participation and provide HTO-designated personnel with training in survey methods.

7) Utilize a small number of collars to understand how, or if, the population boundaries and distribution of bears have changed with changing sea ice conditions, evaluate where possible denning areas exist and if these have changed over time, and lastly, gain improved survival and emigration estimates for a more accurate population abundance estimate.

APPLICATION OF THE RESULTS

1) Collected data on polar bear abundance will be used to further inform polar bear harvest management (a priority of the NWMB, the Qikiqtaaluk region, and the GN) by providing a new abundance estimate using an alternative research technique.

2) In addition, the data form the basis for: (a) TAH recommendations; (b) development and revisions of management plans; and (c) updating status reports for LS at the territorial, national and international levels (e.g., Canadian Species at Risk Act, COSEWIC status, PBTC and PBSG assessments).

3) New information on the abundance and status of LS will also assist Parks Canada in making joint management decisions especially in light of the planned Marine Conservation Area within the LS boundary.

4) Information on polar bear distribution during the spring (or fall) will provide insight into possible distributional shifts that occurred over the past decades which, in turn, may be used to inform environmental impact assessment processes within the geographic range of this subpopulation.

5) Possible data from collars on denning areas will assist other interested parties (e.g., NIRB, Parks Canada, GN) in ensuring that these areas are regarded as sensitive and that appropriate protective measures are put into place.

6) Continued development and demonstrated application of a less invasive wildlife research technique, which is a top priority of Inuit, and both the GN and the Nunavut Wildlife Management Board (NWMB).

STUDY AREA

This demographic unit has been previously delineated based on the movements of collared adult female bears (Taylor et al. 2001), the locations of where bears were marked and subsequently recaptured/harvested (Taylor and Lee 1995), and DNA analysis (Paetkau et al. 1999, Malenfant et al. 2016). Lancaster Sound (Figure 1) is characterized by high biological productivity and high densities of ringed seals and bears (Schweinsburg et al. 1982, Stirling et al. 1984, Kingsley et al. 1985, Welch et al. 1992). As sea-ice break-up begins in eastern Lancaster Sound and Jones Sound and progresses to the west, polar bears move with the disappearing ice westward and north-westward to summer on remaining areas of both annual and multi-year ice within the Queen Elizabeth Islands.

PROJECT DESIGN

a) Fuel purchase and caching

The first year (2020-2021) is the preparation of the study including purchase of fuel and caching. We will purchase fuel during spring of 2020 which will be delivered by sealift

season 2020. During early spring (e.g., March) of 2021 we will begin caching so that research activities can begin for the 2021-2022 field season.

b) Timing of the study

The last LS population study (Taylor et al. 2008a) was conducted during the spring time. This enabled the research team to have relatively safe access to available bears on the sea-ice platform, however, bears are dispersed over a large area at lower densities. We will anticipate our field season to last between May to June to facilitate a direct comparison to the last LS population study. Depending on traditional knowledge collected from communities during consultations and satellite imagery, we may decide to sample the shores of the coastline during the mostly summer ice-free period between August and October. During July, Jones sound becomes ice-free and bears are forced on shore. As the ice-break up continues in a westerly direction, Lancaster Sound, Admiralty and Prince Regent Inlets become ice-free as well. Later during the summer/fall, only broken ice remains to the far west in the Viscount Melville Sound areas and west of Bathurst Island. The concentration of bears onshore during summer/fall would likely result in more bears being sampled during the ice-free period rather than the on-ice sampling.

Genetic Mark-Recapture

The proposed study design is fundamentally similar to that of the previous physical mark-recapture study conducted in LS (Taylor et al. 2008a) and Baffin Bay (SWG 2016) but does not involve the immobilization and handling of bears. Instead, DNA extracted from a small sample of skin and hair collected via a biopsy dart is being used to identify each bear (Pagano et al. 2014); effectively genetically ”marking" each individual (and permitting future identification) without the need for physical handling via ear-tagging or lip-tattooing. The ”recapture" event occurs when either the bear is biopsy darted on a later occasion or when a genetic sample is recovered from a polar bear harvested in Nunavut.

During the 2021 – 2023 field season, biopsy darting activities will be carried-out on the LS sea-ice and across smaller islands. During our search for bears we will also conduct inland-transects approximately every 35km for about 10-15km. It is very likely that females with offspring are still emerging from dens, or migrate from denning sites towards the sea-ice – using inland transects will assist in detecting these bears. In addition, because it is breeding season, some males may sequester some females and push them into valleys or up-lands where they would

not be available for mating with other male individuals. Consultation meetings with Hunters and Trappers Organizations will provide more information on where to focus these inland transects, and whether they will be beneficial at all.

In order to cover such a large study area, and given the vagaries of spring weather, we are planning to make use of 2 – 3 helicopters/teams (A-Star B2, or Bell 407), with each team beginning operations in different areas within the study area. Some field bases will be PCSP at Resolute, Grise Fiord, Arctic Bay, the Idlout outpost camp at Creswell Bay, Fort Ross, Polar Bear Pass cabin, True Love bird sanctuary camp of the Arctic Institute of North America on Devon Island, Dundas Harbour, and other possible camps (to be determined).

Once a bear is located, a small sample of tissue (<5 mm diameter), mostly skin, is taken using a biopsy dart fired from a dart rifle from the helicopter (Pagano et al. 2014). The darts are designed to fall to the ground after impact and can be retrieved without handling a bear. For each bear observed, GPS coordinates and information on location, behavior, body condition, estimated age/sex (when possible) and group/litter size are recorded. During the course of the study, a proportion of biopsied bears will be recaptured (re-biopsied) during subsequent field seasons. Potentially, some bears may also be biopsied more than once during the same field season since they will carry no visible mark from the previous sampling. However, within season re-sampling will be minimized by avoiding repeated searches of the same area. Tissue samples for genetic analyses will also be collected from bears harvested in Nunavut throughout the study in-order to detect the harvest (recovery) of previously biopsied bears and determine the ratio of genetically marked to unmarked animals in the population. Moreover, tissue of harvested bears from neighbouring subpopulations such as M'Clintock Channel, Baffin Bay, Norwegian Bay, Viscount Melville Sound, and Gulf of Boothia will also be collected for genetic analyses to allow recovery of previously marked bears

DNA extracted from biopsy and harvest tissue samples are analyzed in-order to determine each sampled bear's (and re-sampled) unique genetic identity and determine its sex. Accepted genetic identification techniques, similar to those described by Kendall et al. (2009) and which have undergone rigorous validation to verify their accuracy, will be used (Paetkau et al. 1999, Paetkau 2003). Tissue samples collected during the previous capture study (1990-1997) also will be analyzed and to facilitate estimation of survival rates. However, >20 years passed since the last inventory was conducted and it is expected that few bears are still alive to be included in the new study.

Similar to other mark-recapture techniques, genetic mark-recapture does not require the location and sampling of every bear in the population. The number of bears that must be sampled in-order to achieve a coefficient of variation of approximately 10 percent cannot be accurately determined at the present time since it depends on the current size of the population. Based on simulations using a range of theoretical population sizes from 1500-3000 bears (which falls within the range predicted by scientific data and Inuit Knowledge), it is estimated that collecting the location and biopsy sampling between 250 and 450 bears per year will meet the target precision, given that most of the study area will be searched.

We anticipate to utilize capture and recapture data from the past and this new study to obtain more rigorous estimates of survival and population trend over time. Data will be analyzed in program MARK (White and Burnham 1999) using open population models facilitating the inclusion of both live and dead (i.e., harvest) recoveries, as well as the recovery-recapture models to estimate survival, recapture and recovery probabilities (Peacock et al. 2012; Burnham 1993; Taylor et al. 2005). Models will include survival (the probability of surviving interval t to t+1), recapture probability (the probability of re-observing a live marked animal), dead reporting probability (the probability that an animal dies from harvest and is reported), and fidelity (the probability that an animal does not permanently emigrate from the sampling area and remains observable in the future). Since we will not be able to biopsy cubs of the year because they are too small and injury is a possibility, our abundance estimator (Horvitz-Thompson; McDonald and Amstrup 2001) will be based on bears on ages ≥ 1. Population growth will be estimated using a matrix-projection model that is based on polar bear life-history (Regehr et al. 2017). For all analyses, we will include where possible co-variates that can assist in explaining observations and initial model-results (e.g., sea-ice metric components that affect survival and reproduction; Regehr et al. 2007, 2017). As we continue to collect data throughout the study period, we will also explore the option of applying integrated population models (e.g., Regehr et al. 2018).

COMMUNITY CONSULTATION AND REPORTING

Community / HTO	Before research	During research	Completion of research
Resolute Bay HTO	Fall 2020	Spring 2021, 2022, 2023	Spring 2026
Arctic Bay HTO	Fall 2020	Spring 2021, 2022, 2023	Spring 2026
Grise Fiord HTO	Fall 2020	Spring 2021, 2022, 2023	Spring 2026

SCHEDULE

Output or step	Start date (dd/mm/yyyy)	End date (dd/mm/yyyy)	Person days per year
Logistical preparations (e.g. fuel caching, cabin prep, field equipment)	Mar 2020, 2021	June 2021, 2022	30
Order fuel	Spring 2020, 2021	Spring 2020, 2021	10
caching	Spring 2021	Spring 2021, 2022, 2023	30
Biopsy darting	Spring 2021	Spring 2021, 2022, 2023	90
Harvest sampling	Spring 2021	Spring 2023	200
Analysis of tissue samples	Summer 2021, 2022, 2023	Winter 2021, 2022, 2023	N/A
Final data analyses, preparation of reports and peer-reviewed publications	Spring 2024	Spring 2026	200

COMMUNITY SUPPORT

Community/corresponding HTO (e.g. Iqaluit, Amarok HTO)	Support requested (Y/N)	Support obtained (Y/N)
Resolute Bay HTO	Will be requested	Pending
Arctic Bay HTO	Will be requested	Pending
Grise Fiord HTA	Will be requested	Pending

ANTICIPATED OUTPUTS

Output	Submission/deadline (dd/mm/yyyy)	Recipients
Interim reports (written)	15/12/2021/2022/2023	NWMB, and other funding organizations
Final report (written/verbal)	30/09/2021/2022/2023/ 2025	NWMB, and other funding organizations
Interim financial report (written)	15/12/2021/2023/2024/ 2025	NWMB, and other funding organizations
Final financial report (written)	1/04/2022/2023/2024	NWMB, and other funding organizations
Progress reports	Winter 2021/2022/2023	HTO's, QWB, and other funding organizations
Community summary report and oral presentation (written/verbal)	Winter 2021/2022/2023	Affected HTOs, QWB
GN file report (written/verbal)	Summer 2021/2022/2023/2025	GN, NWMB
Research and financial reports as required by other funding agencies	Summer-Fall 2021/22/23	TBD
Revised status assessment (written/verbal)	February 2026	Polar Bear Technical Committee
Revised status assessment (written/verbal)	TBD	Polar Bear Specialist Group
Publications addressing Lancaster Sound subpopulation estimate and demography	TBD	Peer reviewed journals
Presentations of results at conferences (written/verbal)	TBD	Public

PROPOSED PARTNERS

- ✓ GN Department of Environment
- ✓ Environment and Climate Change Canada
- ✓ Hunters and Trappers Organizations
- ✓ Nunavut Wildlife Management Board
- ✓ World Wildlife Fund Canada
- ✓ Nunavut General Monitoring Program
- ✓ Parks Canada Agency
- ✓ Nunavut Tunngavik Inc.

BUDGET Item	Field planning ($K) Year 2020/2021	Funds ($K) (2021/2022)	Funds ($K) (year 2)	Funds ($K) (TBD) (year 3)
Fuel purchase@100/dr x 350	105.6	35		
Camp moving 20hrs@2300.00		46		
Fuel Caching 80 hrs @ 2300/hr, 5K Twin Crew	189			
Fuel Caching 70 hrs @ 2300/hr, local fuel caching for springs + 5K crew exp		166		
Fuel drum moving/loading	2	3		
Field Equipment	10	6		
Cabin/base camp set-up		2		
Survey Helicopters (up to 350hours)@2200.00		770		
Travel crew to field sites		15		
Food & Accommodation		34		
Genetic Analyses of Samples (@$45/sample) and harvest samples since 1990		40		
Shipping		5		
HTO field assistants 60d x 250/d		10		
Contracted services (field crew, data analyses)		50		
Miscellaneous costs		10		
TOTAL [1]	306.6	1,196		

[1] Does not include collaring work

CONTRIBUTIONS – fuel caching

Contributor	Funds ($K)/In-kind (PY) Year 2020/2021		
GN	168.6 (plus personnel time approx TBD)	GN-base funding	
NTI	138	requested	
NWMB		requested	
Total	306.6		

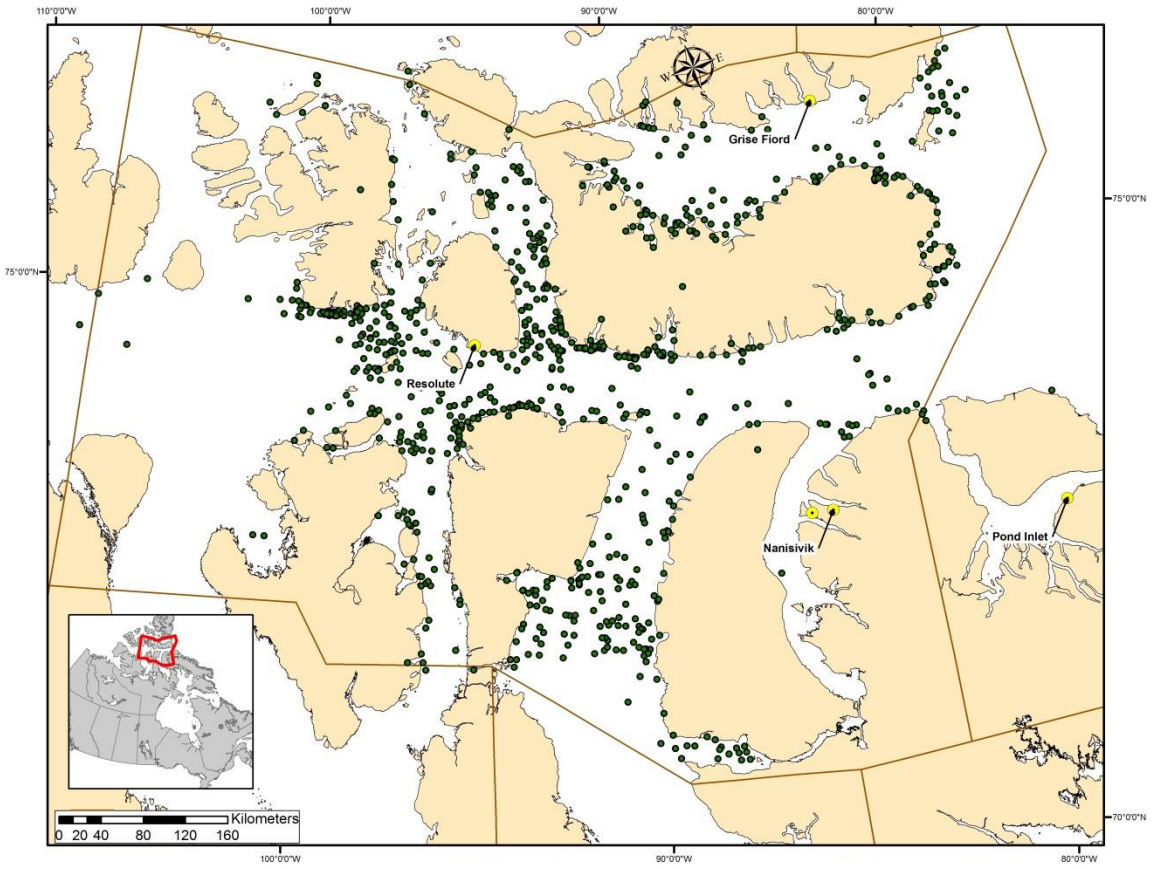

Figure 1. The Lancaster Sound polar bear subpopulation study area with capture locations from the past study (1992-1997).

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Appendix 2

Fuel cache distribution – to be finalized with PCSP