ESTIMATING THE ABUNDANCE OF THE GULF OF BOOTHIA POLAR BEAR SUB-POPULATION BY GENETIC MARK-RECAPTURE

FIELD REPORT TO

DEPARTMENT OF ENVIRONMENT

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AND

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SUMMARY

The Gulf of Boothia (GB) polar bear subpopulation is one of the largest in Canada and is managed entirely by Nunavut. The most recent demographic study on the GB subpopulation estimated the mean total number for the 1998-2000 study period to be 1,592 (± 361) bears. A new 3-year research project was initiated in 2015 to provide updated information on the abundance of bears in GB. This mark-recapture study differs from the previous studies that relied on chemical immobilization of all bears for capture and marking. This study does not involve capture of bears but instead utilizes DNA extracted from tissue samples obtained using biopsy darts to uniquely identify individuals. The sub-population abundance estimate and status will be assessed by means of genetic mark-recapture.

Between 29 April and 26 May 2015, we spent 96 hours of helicopter flight time searching for polar bears. Most of the GB subpopulation range was surveyed but poor weather and logistical constraints limited the intensity of the coverage of the whole area. We flew a total distance of approximately 11,737 km searching for polar bears. A total of 185 bears (in 115 groups) of various age classes and both sexes were encountered, of which 152 were successfully biopsied. The rate of sampling averaged 1.8 bears per hour of search time. The number of bears encountered during the spring of 2015 was equivalent to approximately 10% of the previous 1998-2000 mark-recapture population estimate currently used for harvest management. However, until genetic results are available it is impossible to discern how many different individual bears were encountered.

General impressions from the first year of sampling suggested that polar bears were abundant and in good condition in GB. Preliminary habitat use analysis showed that polar bear densities were higher than expected in active pack ice and lower than expected in shore fast ice. Seal observations suggested that shore fast ice was preferred by seals while they avoided inactive pack ice. Seal kill densities were higher than expected in active pack ice and brash ice (found mainly as a transition between shore fast ice and active pack ice) but lower than expected in shore fast ice. Preparations are under-way for the second field season which will begin in April of 2016.

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ᐃᑭᕌᓯᐅᑉ ᐃᒪᖓᓂᑦ (GB) ᓇᓄᐃᑦ ᓇᓅᖃᑎᒌᑦ ᐊᒥᓲᓂᖅᐸᐅᔪᑦ ᑲᓇᑕᒥᑦ ᐊᐅᓚᑕᐅᑦᓱᑎᓪᓗ ᓄᓇᕗᒻᒥᐅᓄᑦ ᑭᓯᐊᓂ. ᖃᐅᔨᓴᖅᑕᐅᕋᓛᓚᐅᖅᑐᖅ ᖃᓄᐃᑉᐸᓪᓚᐊᓂᖏᓐᓂᑦ ᐃᑭᕌᓯᐅᑉ ᐃᒪᖓᓂᑦ ᓇᓅᖃᑎᒌᓂᑦ ᓇᓚᐅᑦᓵᖅᑕᐅᔪᑦ ᑲᑎᑦᓱᑎᒃ ᖃᑦᓯᐅᓂᖏᓐᓂᑦ 1998-2000 ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐃᒪᓐᓇᐃᑎᓪᓗᒋᑦ 1,592 (±361) ᓇᓄᐃᑦ. ᓄᑖᖅ ᐊᕋᒍᓐᓄᑦ ᐱᖓᓱᓄᑦ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᖑᔪᖅ ᐱᒋᐊᖅᑎᑕᐅᓯᒪᔪᖅ 2015-ᒥ ᐊᑐᐃᓐᓇᐅᑎᑦᓯᓂᕐᒥᑦ ᓄᑖᙳᕆᐊᖅᓯᒪᔪᓂᑦ ᑐᓴᖅᑕᐅᔪᑦᓴᓂᑦ ᖃᓄᖅ ᐅᓄᖅᑎᒋᓂᖏᓐᓂᑦ ᓇᓄᐃᑦ ᐃᑭᕌᓯᐅᑉ ᐃᒪᖓᓂᑦ. ᑖᓐᓇ ᓇᓗᓇᐃᒃᑯᑎᖅᑕᐅᓲᑦ-ᐱᔭᐅᑲᓂᖅᑐᑦ ᖃᐅᓴᓂᕐᒥᑦ ᐊᔾᔨᒋᙱᑦᑕᖓᑦ ᖃᐅᔨᓴᕈᑕᐅᖃᑦᑕᖅᓯᒪᔪᓂᑦ ᑕᑎᖃᖅᓯᒪᒻᒪᑕ ᖁᑭᐅᑎᒥᑦ ᓄᑭᖄᙵᓂᖅᑐᓂᑦ ᓇᓄᓕᒫᓄᑦ ᐱᔭᐅᔪᓄᑦ ᑎᑎᕋᐃᓂᕐᒧᓪᓗ. ᑖᓐᓇ ᖃᐅᔨᓴᕐᓂᖅ ᐱᔭᐅᓂᖃᕐᓂᐊᖏᑦᑐᖅ ᓇᓄᕐᓂᑦ ᑭᓯᐊᓂ ᐊᑐᕐᓂᐊᖅᑐᑦ ᓯᕗᓕᖅᓲᑎᖓᓂᑦ ᐱᔭᖕᒋᓐᓂᑦ ᑕᖕᒋᖅᓂᑦ ᖃᐅᔨᓴᖑᑦᓴᓂᑦ

ᐊᑐᖅᓱᑎᒃ ᑳᐳᑎᐅᑉ ᐃᓱᖓᓂᑦ ᐊᔾᔨᐅᖏᓐᓂᖏᓐᓂᑦ ᓇᓄᓇᐃᖅᓯᓂᕐᒥᑦ. ᓇᓅᕐᑲᑎᒦᑦ ᖃᓄᖅ ᐅᓄᖅᑎᒋᓂᖏᓐᓂᑦ ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᑦ ᖃᓄᐃᓕᖓᓂᖏᓐᓂᓪᓗ ᖃᐅᔨᓴᖅᑕᐅᓂᐊᖅᑐᑦ ᓱᕉᓕᖅᓱᕈᑎᓂᑦ ᖃᐅᔨᓴᕐᓂᖅ ᓇᓄᓇᐃᒃᑯᑎᖅᑕᐅᓃᑦ-ᐱᔭᐅᑲᓂᖅᑐᑦ.

ᐊᑯᓐᖓᓂᑦ ᐃᐳᓗ 29 ᐊᒻᒪᓗ ᒪᐃ 26, 2015, ᐃᑲᕐᕋᕐᓂᑦ 96-ᓂ ᖁᑖᒎᓕᒃᑯᑦ ᖃᖓᑕᓚᐅᕋᑦᑕ ᕿᓂᖏᓐᓇᖅᓱᑕ ᓇᓄᕐᓂᑦ. ᐃᓚᖓ ᐃᑭᕋᔭᐅᑉ ᐃᒪᖓ ᓇᓅᕐᑲᑎᒦᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᖅ ᑭᓯᐊᓂ ᓯᓚᑦᓯᐊᖑᖏᓐᓂᖅ ᐊᑐᖅᑕᐅᔭᕆᐊᓕᓐᓂᓪᓗ ᐊᐅᓚᑦᓯᓂᖅ ᑭᒻᓕᕐᑲᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᕐᓂᕐᒥᑦ ᐃᓘᓐᓇᖓᓂᑦ. ᖃᖓᑕᓚᐅᖅᑐᒍᑦ ᐅᖓᓯᓐᓂᓕᒻᒥᑦ 11,737 ᑭᓛᒥᑐᓂᑦ ᕿᓂᖅᓱᑕ ᓇᓄᕐᓂᑦ. ᑲᑎᑦᓱᑎᒃ 185 ᓇᓄᐃᑦ (115 ᑲᑎᖓᔪ) ᐊᔾᔩᖏᑦᑐᓂᑦ ᐊᕿᒎᓖᑦ ᑕᒪᒃᑮᒃ ᐊᕐᓇᕐᓗᐃᑦ ᐊᖑᔅᓪᓗᐃᓪᓗ ᓇᓄᖅᓯᐊᕆᔭᐅᓚᐅᖅᑐᑦ, 152 ᑳᐳᑎᐅᑉ ᖃᐅᔨᓴᖅᑕᐅᑦᓯᐊᓚᐅᖅᑐᑦ. ᖃᑦᓯᐅᓂᖏᑦ ᖃᐅᔨᓴᒐᔅᓴᐃᑦ ᐃᒪᐃᓐᓇᐃᓚᐅᖅᑐᑦ 1.8 ᓇᓄᐃᑦ ᐃᑲᕐᕋᑖᒦᑦ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ. ᖃᑦᓯᐅᓂᖏᑦ ᓇᓄᐃᑦ ᓇᓄᖅᓯᐊᕆᔭᐅᔪᑦ ᐅᐱᕐᖓᑦᓵᖓᓂᑦ 2015 10-ᐳᓴᓐᑎᖓᓂᑦ ᖃᐅᔨᓴᕐᓂᐅᕐᑲᑦᑕᖅᓯᒪᔪᒧᑦ 1998-2000 ᓇᓄᓇᐃᒃᑯᑎᑦᑕᐅᓃᑦ-ᐱᔭᐅᑲᓂᖅᑐᑦ ᖃᑦᓯᐅᓂᖏᑦ ᓇᓚᐅᑦᓵᖅᑕᐅᔪᑦ ᐊᑐᖅᑕᐅᓯᒪᕋᑖᓂᑦ ᐊᖑᓇᓱᓐᓂᕐᒧᑦ ᐊᐅᓚᑦᓯᓂᕐᒧᑦ. ᑭᓯᐊᓂ, ᓱᕉᓕᖅᓱᕈᑎᓂᑦ ᖃᐅᔨᓴᕐᓂᖅᒧᑦ ᖃᓄᐃᓕᖓᓂᐅᔪᑦ ᐊᑐᐃᓐᓇᐅᓕᖅᐸᑕ ᐃᓕᑕᖅᓯᓂᖅᑲᕆᓐᓇᖏᑦᑐᒧᑦ ᖃᓄᑎᒋ ᐊᔾᔩᖏᒻᒪᖔᑕ ᓇᓄᐃᑦ ᓇᓄᖅᓯᐊᕆᓚᐅᖅᑕᕗᑦ.

ᖃᓅᓇᓱᒋᔭᕗᑦ ᓱᕉᓪᓕᕐᒥᑦ ᐊᕐᕌᒍᒻᒥᑦ ᖃᐅᔨᓴᖓᓯᓂᑦ ᓄᐊᑦᓯᓂᕐᒥᑦ ᐃᓱᒪᓕᐅᖅᐳᑦ ᓇᓄᐃᑦ ᐊᒥᓃᒋᐊᖏᓐᓂᑦ ᖃᓄᐃᖏᑦᓱᑎᓪᓗ ᐃᑭᕋᓴᐅᑉ ᐃᒪᖓᓂᑦ. ᐱᒻᒪᕆᐅᔪᖅ ᓇᔪᖅᑕᐅᔪᖅ ᐆᒪᔪᕐᓄᑦ ᐊᑐᖅᑕᐅᔪᖅ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᑕᑯᔅᓴᐅᑎᑦᓯᓚᐅᖅᑐᖅ ᓇᓄᖅᑕᖅᑲᐅᓗᐊᕐᓂᖓ ᐅᓄᖅᑐᒻᒪᕆᐅᓚᐅᖅᑐᖅ ᓯᑯᑕᓕᒻᒥᑦ ᐅᓄᓗᐊᕐᑎᓪᓗ ᓯᓈᓂᑦ ᓯᑯᑕᓕᒻᒥᑦ. ᓇᑦᓯᖅᓂᑦ ᑕᑯᓐᓇᕐᓂᖅ ᓇᓄᓇᐃᖅᓯᓚᐅᖅᑐᖅ ᓯᓈᓂᑦ ᓯᑯᓂᑦ ᐱᔭᐅᒍᒪᓂᖅᓴᐅᓚᖅᑐᖅ ᓇᑦᓯᕐᓄᑦ ᐅᐸᑦᑕᐃᓕᓚᐅᖅᓱᑎᒃ ᓯᑯᕐᑲᓗᐊᖅᑐᓂᑦ ᓯᑯᕐᑲᓗᐊᖏᑦᑐᓂᓪᓗ (ᓇᓂᔭᐅᓚᔪᑦᑐᑦ ᓅᐸᓪᓕᐊᓂᐅᔪᓂᑦ ᐊᑐᕐᖓᓂᑦ ᓯᓈᑉ ᓯᑯᖏᓐᓂᑦ ᓯᕐᑯᕐᑲᓗᐊᖅᑐᒥᓪᓗ) ᑭᓯᐊᓂ ᐅᓄᙱᓐᓂᖅᓴᐅᓚᐅᖅᑐᑦ ᓯᑯᕐᑲᓗᐊᖅᑐᒥᑦ. ᐊᑐᐃᓐᓇᕈᖅᑎᓐᕞᓪᓚᐊᔪᑦ ᐊᐃᑉᐸᖓᓂᑦ ᖃᐅᔨᓴᕐᓂᕐᒥᑦ ᐱᒋᐊᕐᓂᐊᖅᑐᒥᑦ ᐃᐳᓗ 2016.

NAITTUQ

Taamna Ikarasaup Tariungani (GB) nanuqarnia angitqiyauyuq Kanadami munariyauyuqlu tamaat Nunavunmin. Nutaangutqiyat qaffiuyaakhainnik ukunani GB nanuqarningani nalautinniarhimayuq tamatqiutihimayuni amigaitilaanginni uvunga 1998-2000mi qauyiharnikkut ukiunginni imaa ittuq 1,592 (± 361) nanuit. Nutaaq pingahunik-ukiulik qauyiharnikkut havaktauyukhaq aullaqtitauyuq 2015mi tuniyaamik uplumiutanik ilitturipkaitjutinik amigaitilaanginni nanuinni Ikarasaup Tariungani. Una naunaiyaqhimanikkut-piffaarniq aallangayuq taapkunanga hivuagut qauyiharnirnin aturutiqaqpaktut havautikkut nutqaqtihimatjutikkut tamainnik nanunik pinikkut naunaiyarnikkullu. Una qauyiharniq pingittuq pinirnik nanunik kihimi atuqupaktuq DNA-nik pihimayut timaanin naunaiyaqtakhanik pihimayut timiliqitjutikkut kapuutinin aallakkiit naunaiyarnikkut atauhillaaqtarlugit. Nanuqarningani amigaitilaangani nalautinniarhimaut qanurittullu qauyihaqtauniaqtut imaatut timitiqutigut naunaiyaqhimanikkut-piffaarnikkut.

Talvannga 29 Qitiqauyaqmin uvanilu 26 Qiqiayaqluarviamun 2015, tingmivaktugut 96-sini ikaarnirni halikaaptakkut tingmipluta qinirhiapluta nanunik. Tamatqivyakhugu Ikarasaup Tariunga qauyihaqtauut kihimi hilarlungnirmun aulapkaitjutikhatigullu kikliqarniit kikliqaaqtitpaktaa qinirhiaqpiarniarningani tamaani nayuqtauvimik. Tingmivaktugut tamaat ungahiktilaanganik imaakiaq 11,737 km qinirhiapluta nanunik. Tamatqiutihimayut 185nik nanunik (ukunani 115ni katimatjutini) aallakkiinguyunik ukiuqaaqtunik anguhallunik arnarlungniklu takuyauvaktut, taapkuat

152nguyut nakuuyumik kapiyauvaktut. Amigaitilaangit ihivriuqtauvaktun 1.8nik ikaakninirmi qiniqhiaqtauvaktugut nanungnik. Qaffiuyut nanuit takuvaktavut uvani upingakmi 2015mi aadjikutavyauyuq 10 pusanmik talvanga1998mi-2000mun naunaitkuhiqhimayut tiguyauvakhimayut nanuit amigaitilaangit aulahimayut anguyauyukharnik munagidjutingnik. Kihiani, talvuuna kitungmangit naunairutiit pigiaqaqtun taima ayungnavyaqtuq naunaiyaiyaangat qaffiuyut allatqiinguyut nanuit tiguyauvakhimayaptingni.

Naunaitun ilitagidjutikhangit hivulliqpaaqmi ukiungani ihivriuqtauviani naunaiqtitivaktuq taima nanuit amigaitpaktun inuuhirittiaqpakhutiklu talvani GB Ikarasaup Tariungani. Aulaviluagiyaingit ihivriudjutikhangit takunaqtun taima nanuit amigaitilaangit angitqiyauvakhimayuq aulaviiniitunik hikumi ikikliyumiqhimayutlu tapkuat hinigainiinginaqtuni hikumi. Nattirnik qunngiaktauvakhimayut taima hinigainiitun kayumiktumik hikum hanigaini atuluaqpaktaingit nattiit taima hanitqunahuaqhimaitungit aulahimaaqtun hikukyuangit angiyut. Nattiit anguyauvakhimayut amigaiqyumiqhimavakhimayut aulahimaanginaqtuni hikumi katitiqyuaqhimayunik hikumi (takunaqtun aulahimaanginaqtunik hinaanin aulahimaaqtuniklu hikut aulayut katitiqyuahimayunik hikunik) ikiktugaluaq talvanga hinigainiitunik aulayut hikut. Uplaungairutikhat aulayut kinguligiikhimayuni maniqami qunngiaktauyukharnik aulaniaqtun Qitiqauyaqviami 2016mi.

BACKGROUND

Most of Canada's, and more than half of the world's polar bears (*Ursus maritimus* Phipps) exist in Nunavut. In conjunction with that, approximately 80% of the world's total harvest of polar bears occurs in Canada, mainly by local Inuit, but also by sport hunters via Inuit-guided hunts. Of the 13 Canadian polar bear populations, 12 are within or shared with Nunavut. Therefore, most of the responsibility for management and conservation of polar bears fall to the Government of Nunavut.

As a signatory nation, Canada is committed to the *International Agreement for the Conservation of Polar Bears and their Habitat* (signed in 1973). The mandate for polar bear management was passed from the federal government to Nunavut with the passage of the Nunavut Act, followed by the Wildlife Act and associated regulations for polar bear management. With the onset of Nunavut, the Minister of Environment retains ultimate responsibility for conservation, wildlife research, management, enforcement, and conservation education as identified in the Nunavut Final Agreement/Nunavut Land Claim Agreement.
An initial mark-recapture study was done from 1973-78 (Furnell and Schweinsburg, 1984), where M'Clintock Channel (MC) and Gulf of Boothia (GB) were not identified as demographic units. However, a summed population estimate for both areas of 1081 was derived. The estimate was known to be biased by non-representative sampling, and was subsequently increased to 900 for GB and 900 for MC based on the belief that the current harvests were sustainable, and the estimated number was the one required to sustain the harvest. In the mid-1990s, the MC estimate was revised downwards to 700 based on hunter reports of reduced densities of polar bears. Both populations were later delineated based on movements of satellite radio-collared adult female bears in adjacent areas, tag returns of harvested bears (Taylor and Lee, 1995; Taylor et al., 2001), and local knowledge of Inuit about how local conditions may influence the movements of polar bears.

The last population inventory work for GB was completed in 2000, where abundance for GB (mean ± SE) was estimated to be 1592 ± 361 polar bears, respectively (Taylor et al., 2009). Based on the latest GB inventory and results, the population is considered to be stable or very likely increasing due to high recruitment and survival rates (COSEWIC, 2008; Taylor et al., 2009), however, caution is warranted regarding long-term trends especially when one considers observed environmental changes in other polar bear populations (e.g., Foxe Basin [Sanahatian and Derocher, 2012]; Baffin Bay and Davis Strait [Rode et al., 2012]; Western Hudson Bay [Regehr et al., 2007a]; Beaufort Sea [Regehr et al., 2007b]). The GB sub-population is currently harvested at an annual TAH of 74 bears (mean harvest of 61 bears between 2005/06 – 2010/11). Although no genetic similarities between these two populations were detected in a past genetic study (Campagna et al. 2013; Paetkau et al., 1999), in recent years, the distinction between the MC/GB subpopulations has been put into question by Inuit hunters (Keith et al., 2005), and new genetic analyses (Saunders, 2005) suggesting some considerable interchange between both subpopulations.

The current data for GB are dated, in accordance with commitments under the 2005 Polar Bear Memorandum of Understanding (MOU) for GB we propose to undertake a 3-year study (2015-2017) involving genetic mark-recapture to reassess the size and status of the GB polar bear subpopulation.

OBJECTIVES

Our project objectives are to:

1) Design and implement a comprehensive survey using genetic biopsy sampling to reliably estimate the abundance of polar bears in GB during the springs (e.g., April – May) of 2015, 2016, and 2017.

2) Estimate the current population size and composition of the GB 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 GB.

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

5) Evaluate polar bear distribution with respect to environmental variables, particularly ice conditions, topography and food availability distribution (to the extent possible).

6) Demonstrate the utility of genetic mark-recapture as a less invasive alternative to physical capture for the purpose of population monitoring.

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

STUDY AREA

The current population boundaries for both MC and GB are mainly based on telemetry data and movements of adult female bears in adjacent areas (Taylor et al., 2001; Bethke et al. 1996; Schweinsburg et al. 1982). These boundaries have also been supported by recent genetic work (Campagna et al. 2013; Malenfant pers. comm.). The GB boundary encompasses roughly the area between 72 01 – 67 10 N, and 94 40 – 69 30 W (i.e., the areas south of Prince Regent Inlet, including the Gulf of Boothia and Committee Bay), covering a size of approximately 160 000 km^2 (Fig. 1) There are 6 communities (Gjoa Haven, Hall Beach, Igloolik, Kugaaruk, Repulse Bay, Taloyoak) harvesting from this sub-population. Recent analyses of sea ice conditions for the GB population area indicates that there are large inter-annual variabilities with respect to

freeze-up and break-up dates, suggesting no clear patterns up to 2000 (Barber and Iacozza, 2004).

MATERIALS AND METHODS

Genetic Mark-Recapture in GB

For GB, DOE proposes to use biopsy darting and harvest sampling to genetically mark, recapture and recover bears of GB. Recent testing of biopsy darting in Foxe Basin and Southern Beaufort Sea (Peacock et al, 2009a), Baffin Bay and Kane Basin (DOE unpublished data) suggest this method is a viable alternative to traditional mark-recapture studies that have been used in GB (Taylor et. al, 2009). This proposed approach is also supported by biopsy studies that have been successfully applied previously to marine mammals (e.g., humback whales: Palsbøll et al., 1997), and other bear species (e.g., black bears *U. americanus*: Boersen et al., 2003; brown bears *U. arctos*: Boulanger et al., 2004).

During the spring of 2015-2017 (April - June; = 3 biopsy seasons), biopsy darting will be conducted throughout the GB study area. Indications of how bears are distributed throughout the study area will be collected from communities that harvest from GB, and past capture and harvest locations. Unlike some polar bear populations that are seasonally ice-free (e.g., WH, DS, FB, SH, BB), sea-ice in GB never disappears completely.

The capture crew will use a Bell 206 LR helicopter and systematically search the study area for bears. Search effort will be concentrated mainly across the sea ice with higher search efforts within 50-60km of the coastline, and in fiords and inlets. Approximate transect lines flown at a distance of approximately 7-12 km (depending on bear density) will facilitate the systematic search approach. Moreover, past capture data as well as sea-ice condition at the time of sampling will be considered to distribute the effort as to minimize potential sampling bias resulting from differences in space and habitat use among the age, sex, and reproductive classes of bears. The multi-year sampling design will also help in mitigating issues that are potentially associated with capture heterogeneity. Local knowledge indicates that polar bears of M'Clintock Channel and GB move between both populations. In order to address this notion and to gain insight into possible polar bear movements across land we will fly inland transects within the study area approximately every 30km of coastline for up to 10-15km inland.

From every encountered bear except cubs-of-the-year (COYs), a small sample of tissue (~5mm in diameter) will be taken using a biopsy dart (Pneu-Dart Inc.; DNA dart) which is fired from a dart rifle from the helicopter. These darts are designed to fall to the ground after impact, and they can be retrieved easily without handling a bear. The small size and design of the dart allow quick preparation, sampling with minimum risk to and pursuit of bears. Retrieval of darts proved to be somewhat difficult initially because of their color. However, the retrieval was improved by painting the dart shaft bright orange, and attaching fluorescent tape (~7-10 cm; see Plate 1). Initial pilot studies using biopsy

darting showed that the sample collected provides a highly suitable sample (>98%) for determining sex and identity of bears. DOE has tested this new non-invasive research method in Foxe Basin, and applied it to large-scale studies in Baffin Bay and Kane Basin (DOE unplublished data).

In addition to biological samples, we will also record GPS coordinates and information on location, behavior, body condition, estimated sex/age (whenever possible) and group/litter size of bears encountered. As mentioned above, small COYs will not be sampled in order to avoid injury. These individuals will be excluded from the mark-recapture analysis, however, they will be accounted for in the final population estimate using a correction factor derived from litter size and survival.

During the course of this study, a proportion of biopsied bears will be re-sampled (=recaptured or re-biopsied) during subsequent field seasons, and also likely during the same field season since bears do not carry any visible marks. However, within season resampling will be minimized by avoiding search effort in previously searched areas to the extent possible.

While the crew searches for bears, observations of sea-ice (e.g., sea-ice type either as smooth, intermediate, and rough) and seals (e.g., locations and species to the extent possible) will be recorded along each flight path.

Harvest Sampling

In order to obtain unbiased or less-biased estimates of population size and survival rates, tissue samples from bears harvested in GB and surrounding populations are incorporated. In addition, monitoring harvested bears for tags also allows to determine the proportions of marked to unmarked bears in the harvest. While the majority of bears marked in GB are expected to remain within their respective sub-populations, previous studies of bear movements based on tag recoveries in the harvest and satellite telemetry, and genetics suggest that some bears emigrate from the subpopulation (Stirling et al. 1980; Lee and Taylor 1995; Taylor et al 2001, 2005; Saunders 2005). Sampling of the harvested bears will be carried out for the duration of this project. For each bear, a small tissue sample (e.g., skin, muscle, or plucked hair) will be collected and used for DNA extraction. The extraction will aid in identifying sex and individual identity. Samples from bears harvested in MC, FB, LS, and VM will be collected through the Nunavut polar bear harvest program.

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. In addition to abundance, these models enable the estimation of other parameters of interest, including apparent survival and population growth rate (λ). The study will also include the samples collected during the previous GB study which will facilitate the estimate of vital rates. Additionally, closed population models may be used to generate a preliminary estimate of abundance following completion of the initial 2015

darting session, a harvest recovery period (in 2015) and the second darting session (in 2016).

PROJECT SCHEDULE

The project is currently on track as scheduled.

Output or step	Start date (dd/mm/yyyy)	End date (dd/mm/yyyy)	Person days
Logistical preparations (e.g. fuel caching, cabin prep, field equipment)	Fall 2014 Fall 2015 Fall 2016	Spring 2015 Spring 2016 Spring 2017	65 25 25
Biopsy darting	April 2015 April 2016 April 2017	June 2015 June 2016 June 2017	30 30 30
Harvest sampling	Spring 2015 Spring 2016	Spring 2016 Spring 2017	45 45
Analysis of tissue samples	Summer 2015	Winter 2017	TBD
Final data analyses, preparation of reports and peer-reviewed publications	Winter 2017	Fall 2018	TBD

PRELIMINARY RESULTS

The total number of hours spent searching for polar bears in Gulf of Boothia from April 29th to May 26th of 2015 was 96.0 hours. The total number of polar bears encountered was 185. Of the 185 sighted, 152 were sampled successfully (DNA sample confirmed). Most (26/33) of the bears that were not sampled were COYs, but three bears were not successfully sampled because the dart did not take sufficient tissue, two bears were not sampled because they were originally classified as COYs but later reclassified as yearlings, and three bears were not sampled because they were in an inaccessible area or because darting was discontinued because of habitat or animal fatigue or weather considerations. The sex and age distribution of polar bears seen in the 2015 Gulf of Boothia survey is provided in table1. Table 2 lists the percentage of adult females with COYs, yearlings or unencumbered as well as mean litter size of cubs of the year (COYs) and yearlings and their associated standard error (SE). Table 3 lists the mean body condition and associated standard error (SE) for all sex and age groups.

The distribution of sea ice types by area, and the observed and expected number of adult polar bears, seals and seal kills for each sea ice type are given in table 4. The highest density of polar bears was recorded in the “Active pack ice” habitat where more ridges and leads were present compared to the “Inactive pack ice”. The lowest densities of polar bears were observed on the shore fast ice (table 4). Two bears were observed on land within 2 km of the coastline and two family groups were sighted on an island but these individuals were not included in table 4. Polar bears avoided shore-fast ice and preferred active pack ice (table 4). Seals avoided inactive pack ice, but preferred fast ice (table 4). There were significantly fewer seal kills than expected on shore-fast ice, but both brash ice and active pack ice had more seal kills than expected (table 4).

Figure 3 shows the helicopter search track. Figure 4 maps the distribution of habitat types and also includes the helicopter search track. Figure 5 maps the distribution of habitat types and shows the locations of polar bear sightings during our 2015 survey of the Gulf of Boothia subpopulation. Figure 6 shows the distribution of seal sightings on habitat type during our survey. Figure 7 maps the location of harvested polar bears for the last 5 years.

DISCUSSION

2015 was the first year of a three year study that is planned to conclude field work in spring 2017. Thus no quantitative conclusions on polar bear numbers or the trend of the Gulf of Boothia subpopulation are possible at this time. However, qualitative observations of polar bear densities and sea ice conditions do not suggest a decline in numbers, poor body condition, or discernable loss of spring sea ice in this area this year. Polar bears were generally in good condition (table 3). Females with COYs seemed under-represented in our sample, but the data are currently insufficient to determine if that was due to low capture probability relative to other sex/age groups, if litter production rate was low, or if cub mortality from birth to time of census (April 29th to May 26th) was high.

A qualitative impression of the sea ice dynamics in Gulf of Boothia (Fig. 4) suggests a relatively consolidated sea ice mass that extends from Bernier Bay south to Fury and Hecla Strait, and is bounded east and west by shore fast ice. Movement of the central ice mass against the shore fast ice and a similar central ice mass in Prince Regent Inlet create a shear zone that can vary from a few kilometers in width to a 15-20 km band of brash ice, open water, and small floes. The shear zone provides an effective sanctuary for polar bears on the central ice mass from Inuit hunters because hunters have no possibility to cross the shear zone with a snow-machine or dog team. The northern shear zone between Gulf of Boothia and Prince Regent Inlet may provide a barrier for movements between the Gulf of Boothia and Lancaster Sound

subpopulations (Taylor et al. 2001) Polar bear hunting in Gulf of Boothia occurs almost exclusively on the Gulf of Boothia shore fast ice (Figure 7).

Although polar bears appeared to be abundant and in good condition in Gulf of Boothia, the subjective opinion of the 2015 capture team and the capture rate per hour searching did not suggest that population numbers had almost doubled since the 1998-2000 estimate as suggested by the York (2014) PVA projections. The observed body condition (quite good for polar bears just prior to the hyperphagic period) does not suggest a nutritional limitation to Gulf of Boothia population numbers. However, socially mediated density effects (e.g., increased cub mortality from intra-specific predation) could explain both the low numbers of females with COYs observed and density restricted population growth.

Our identification of sea ice habitat types was qualitative and ad hoc. Certainly other habitat classification schemes could be identified. Our choice of categories was deliberately coarse grain so that observations made during polar bear search operations could be made quickly and accurately, and to maximize the likelihood that we could identify differences in habitat use. This was our first field season, so annual variability in habitat distribution or habitat use by polar bears and seals could not be considered. However, we were able to show that polar bears avoided shore fast ice and preferred active pack ice. Active pack ice had a higher than expected number of seal kills, so the explanation for preferring active pack ice is self-evident. All observed hunter activity occurred on the shore fast ice because it was not feasible to cross the brash ice that separated the shore fast ice from the active pack ice. Polar bears probably avoided the shore fast ice in order to minimize encounters with hunters. Seals (mostly ringed seals) preferred shore fast ice and inactive pack ice, perhaps because it was the most stable sea ice. Seal kills were the least frequent on the shore fast ice, probably because polar bears avoided it. Although Brash Ice was not preferred by bears or seals, brash ice had a significantly higher than expected frequency of seal kills. Perhaps these brash ice kills occurred during an earlier period when the Gulf of Boothia sea ice was more consolidated? We observed that polar bears had difficulty moving in the brash ice because it was so rough and broken and drifted with deep, soft snow. Open water and recently re-frozen leads were common in the unconsolidated brash ice (Appendix II). We wondered why so many kills had occurred in an area that was not preferred by bears or seals, and with so many options for breathing holes and haul-out locations? We hypothesize that seals may use the same breathing holes and haul outs rather preferentially, which would make them more predictable to the bears. The high structural heterogeneity of this habitat might also make it more difficult for seals to detect polar bears. These habitat data are insufficient and too preliminary to resolve these interpretations, but identifying significant habitat preference for both bears and seals suggests that our choice of sea ice categories did identify functional habitat types.

COMMUNITY INVOLVEMENT AND REPORTING

Following consultation meetings in 2013, and presentations on the regional level, the project received support from the Kurairojuark HTA (Kugaaruk), Spence Bay HTA (Taloyoak), Igloolik, Hall Beach and Repulse Bay (Naujaat) and Gjoa Haven through support letters (2015). Three members from Spence Bay HTA and two members from Kurairojuark HTA participated in the fieldwork out of Fort Ross and Kugaaruk respectively.

Community / HTO	Before research	During research	Completion of research
Igloolik HTO	Feb 2013, in-community	Spring 2015, 2016 & 2017, in-community during fieldwork Winter 2015, 2016 & 2017, by correspondence	Fall 2018, in-community
Hall Beach HTO	Feb 2013, in-community (completed)	Spring 2015, 2016 & 2017, in-community during fieldwork Winter 2015, 2016 & 2017, by correspondence	Fall 2018, in-community
Repulse Bay HTO	Feb 2013, in-community (completed	Spring 2015, 2016 & 2017, in-community during fieldwork Winter 2015, 2016 & 2017, by correspondence	Fall 2018, in-community
Taloyoak/Spence Bay HTA	Feb 2013, in-community (completed)	Spring 2015, 2016 & 2017, in-community during	Fall 2018, in-community

		fieldwork Winter 2015, 2016 & 2017, by correspondence	
Kugaaruk HTO	Feb 2013, in-community (completed	Spring 2015, 2016 & 2017, in-community during fieldwork Winter 2015, 2016 & 2017, by correspondence	Fall 2018, in-community
Gjoa Haven HTO	Feb 2013, in-community (completed	Spring 2015, 2016 & 2017, in-community during fieldwork Winter 2015, 2016 & 2017, by correspondence	Fall 2018, in-community

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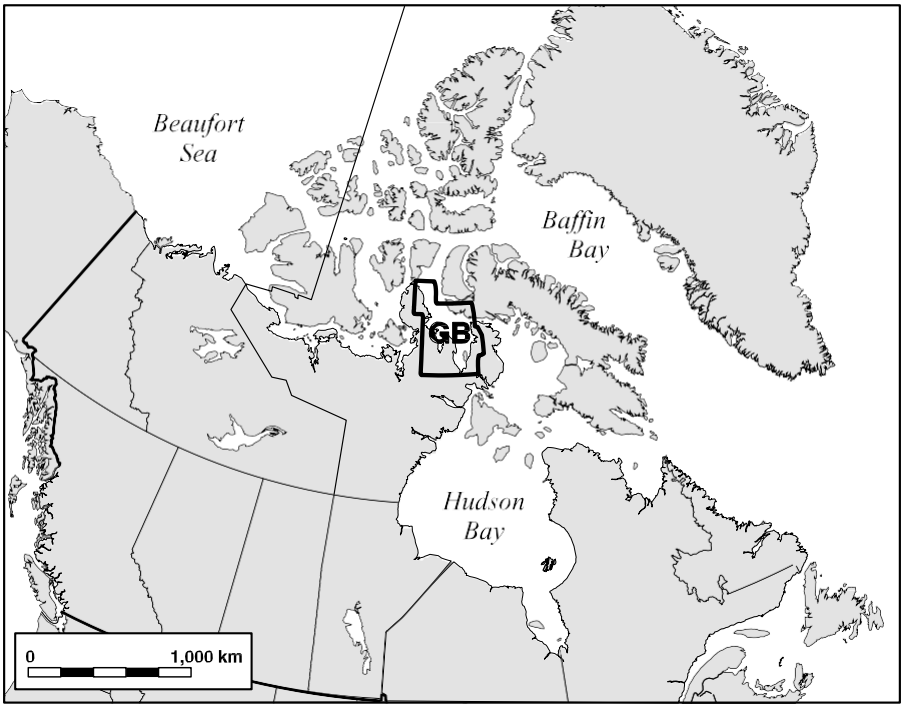


Figure 1. Location of the Gulf of Boothia (GB) polar bear subpopulation, Nunavut. Boundaries are defined as in Taylor et al. (2001).

Figure 2. PneuDart® Biopsy Darts and example of sample collected.

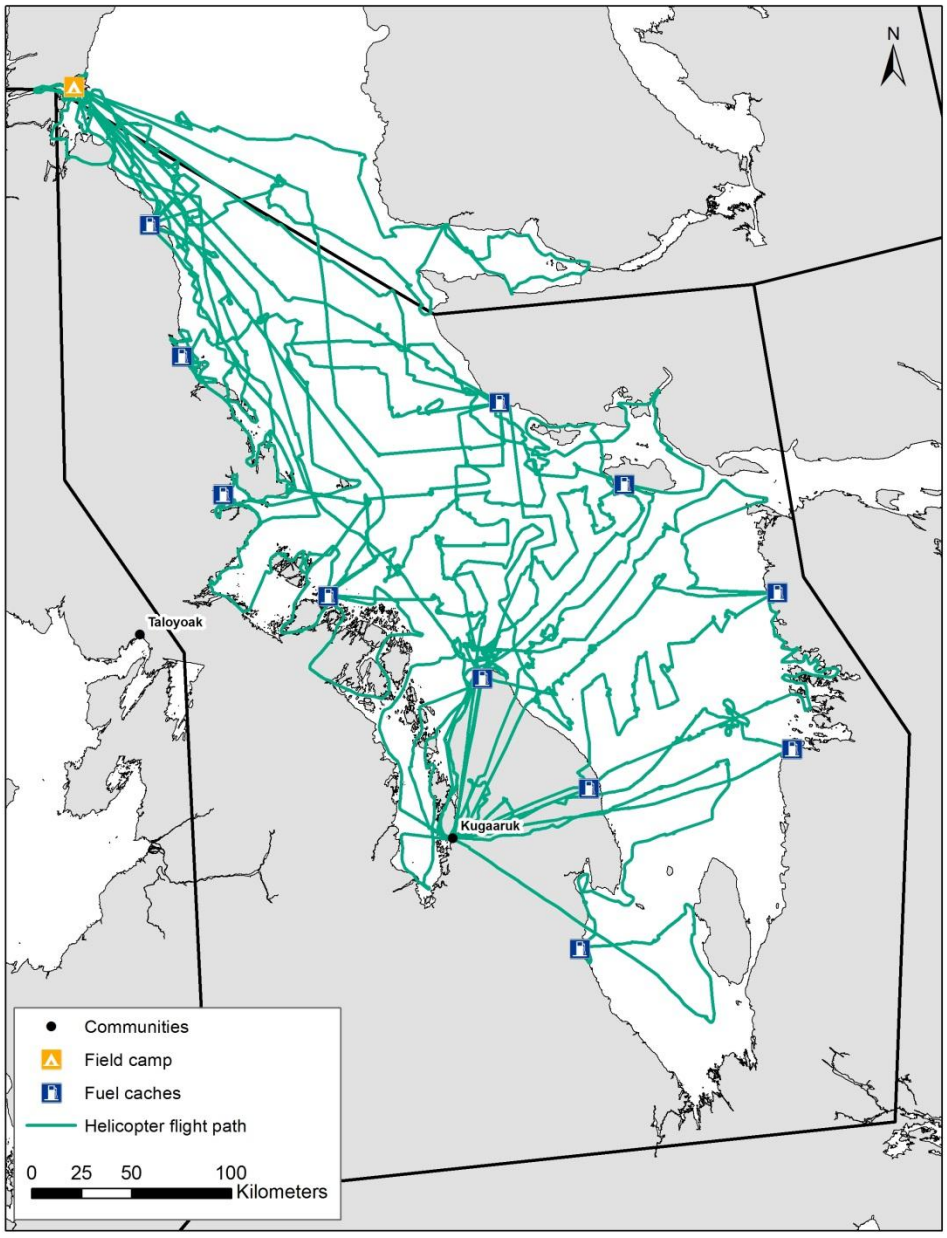


Figure 3. Helicopter track log and location of camp and fuel caches used to search for the entire Gulf of Boothia polar bear subpopulation.

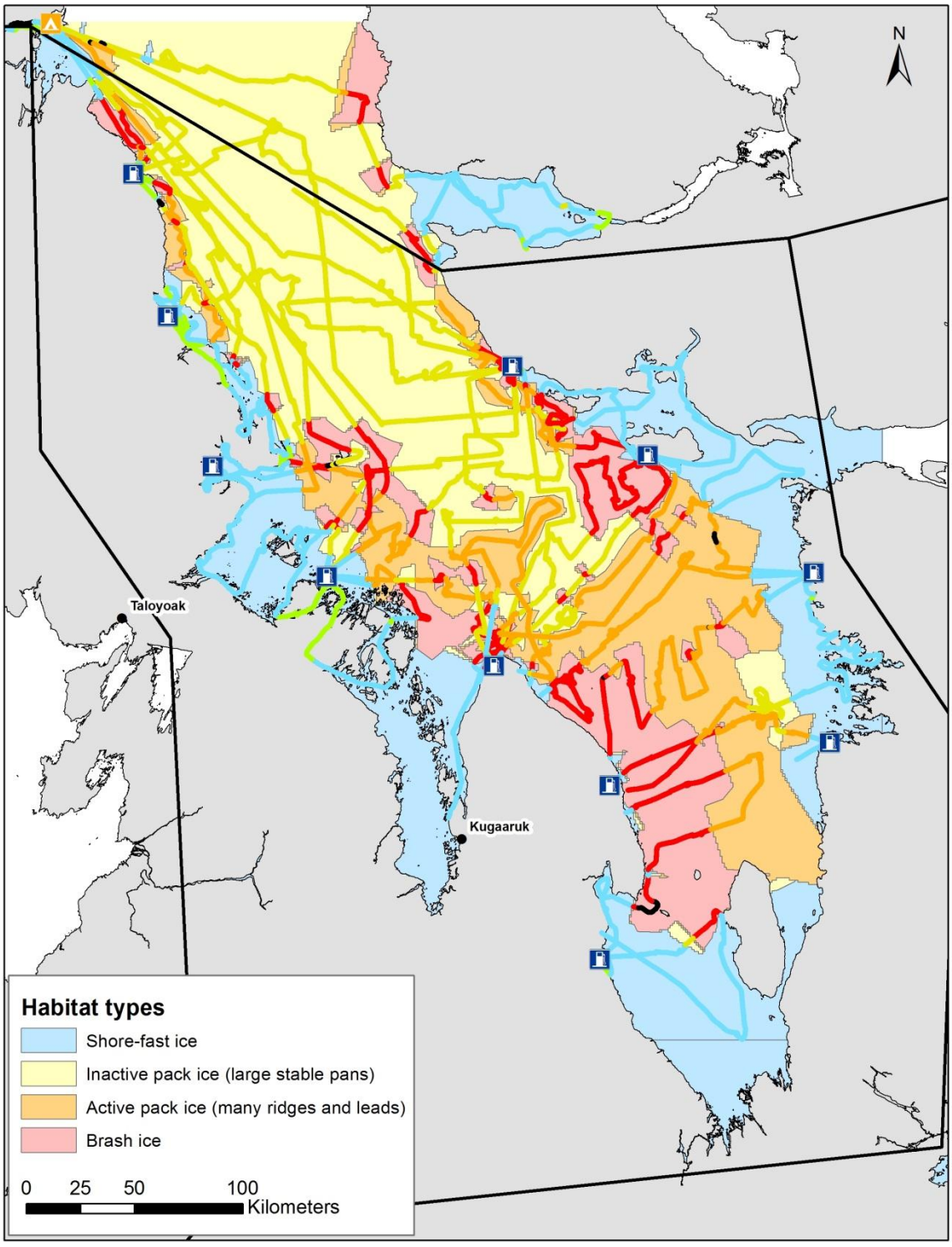


Figure 4. Habitat classification recorded along helicopter flight path (line colors corresponds to habitat types) and resulting habitat classification through the whole Gulf of Boothia subpopulation area using IDW interpolation.

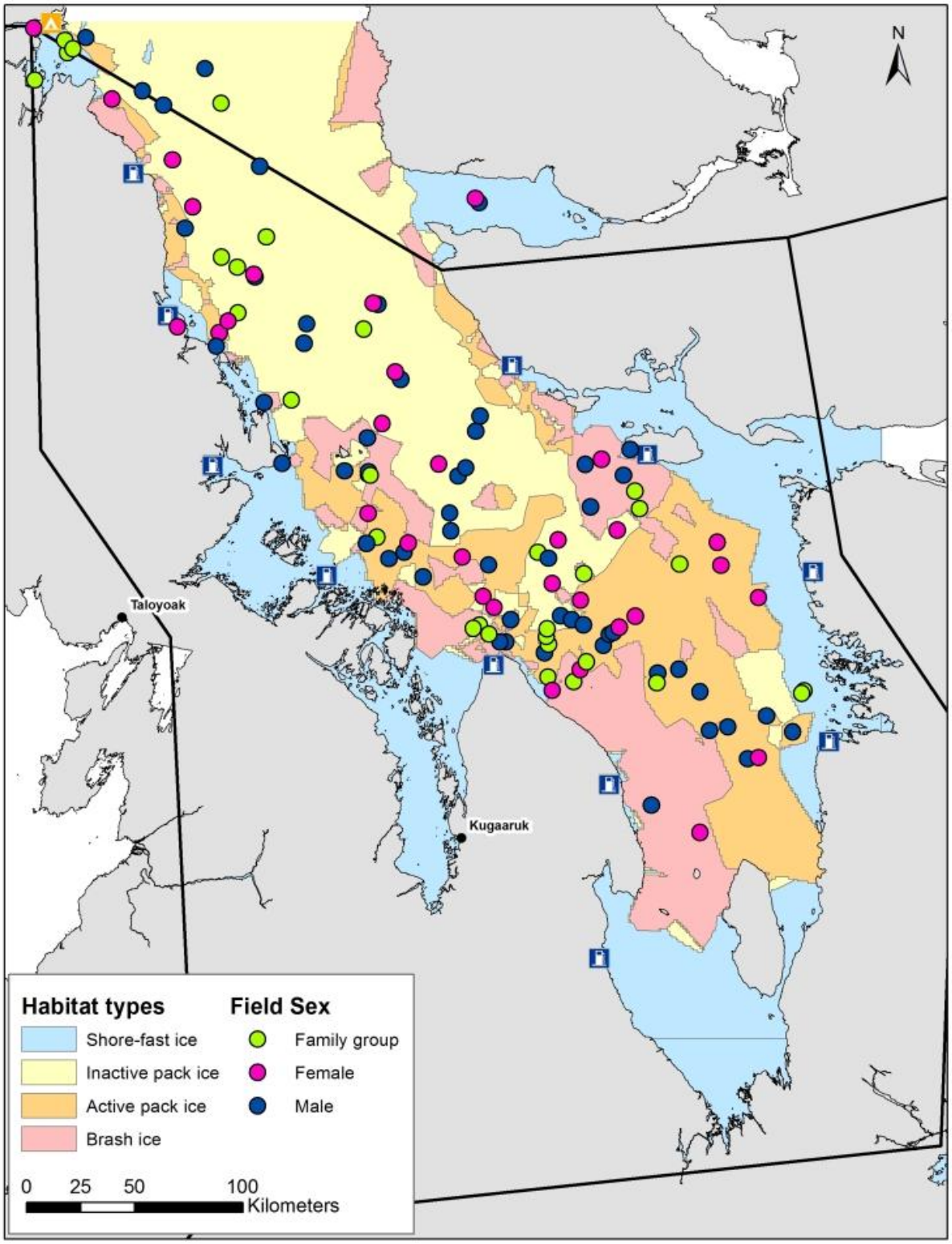


Figure 5. The distribution of habitat type and the locations of polar bear sightings during our 2015 survey of the Gulf of Boothia subpopulation are depicted.

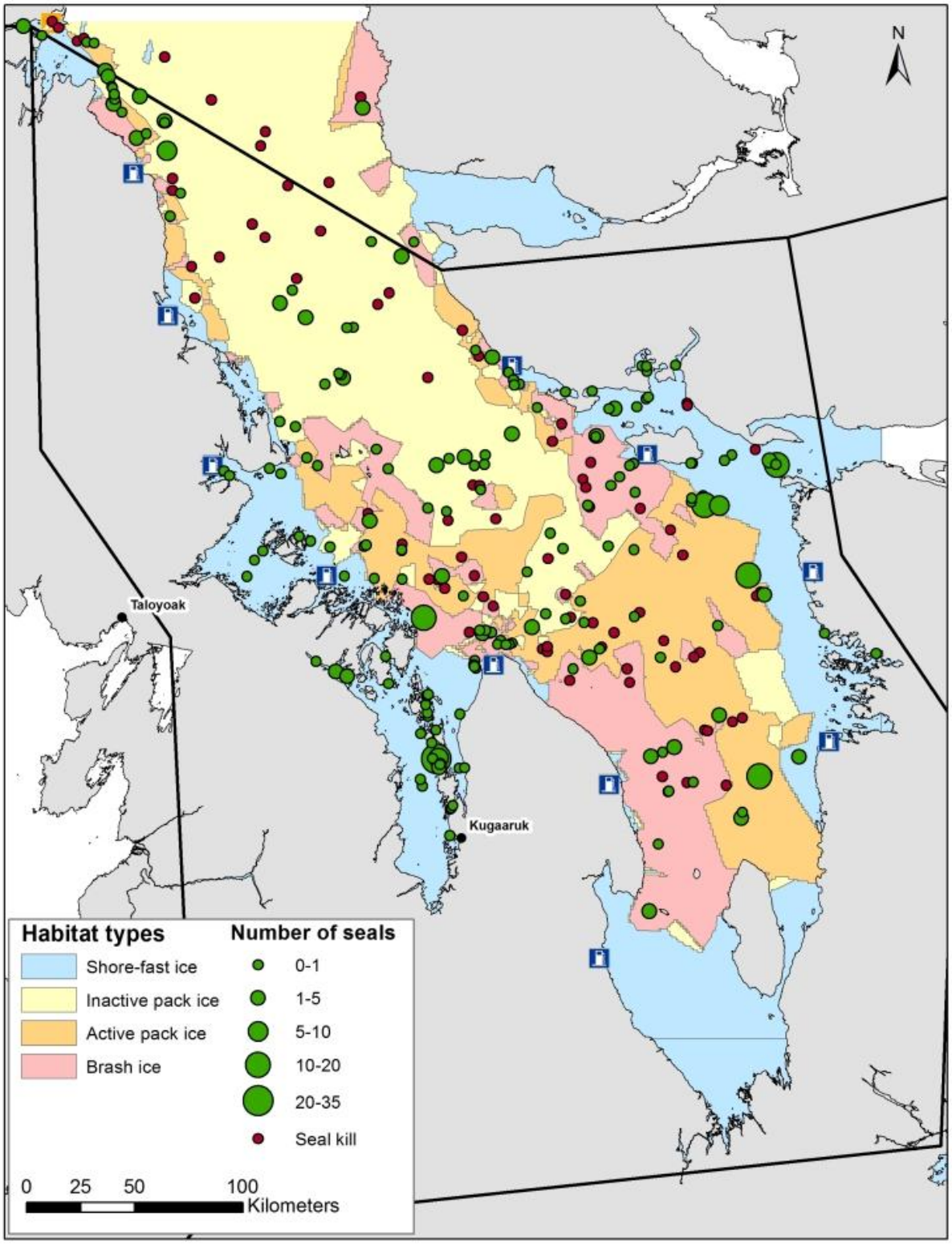


Figure 6. The distribution of habitat type and the locations of seal sightings during our 2015 survey of the Gulf of Boothia subpopulation are depicted.

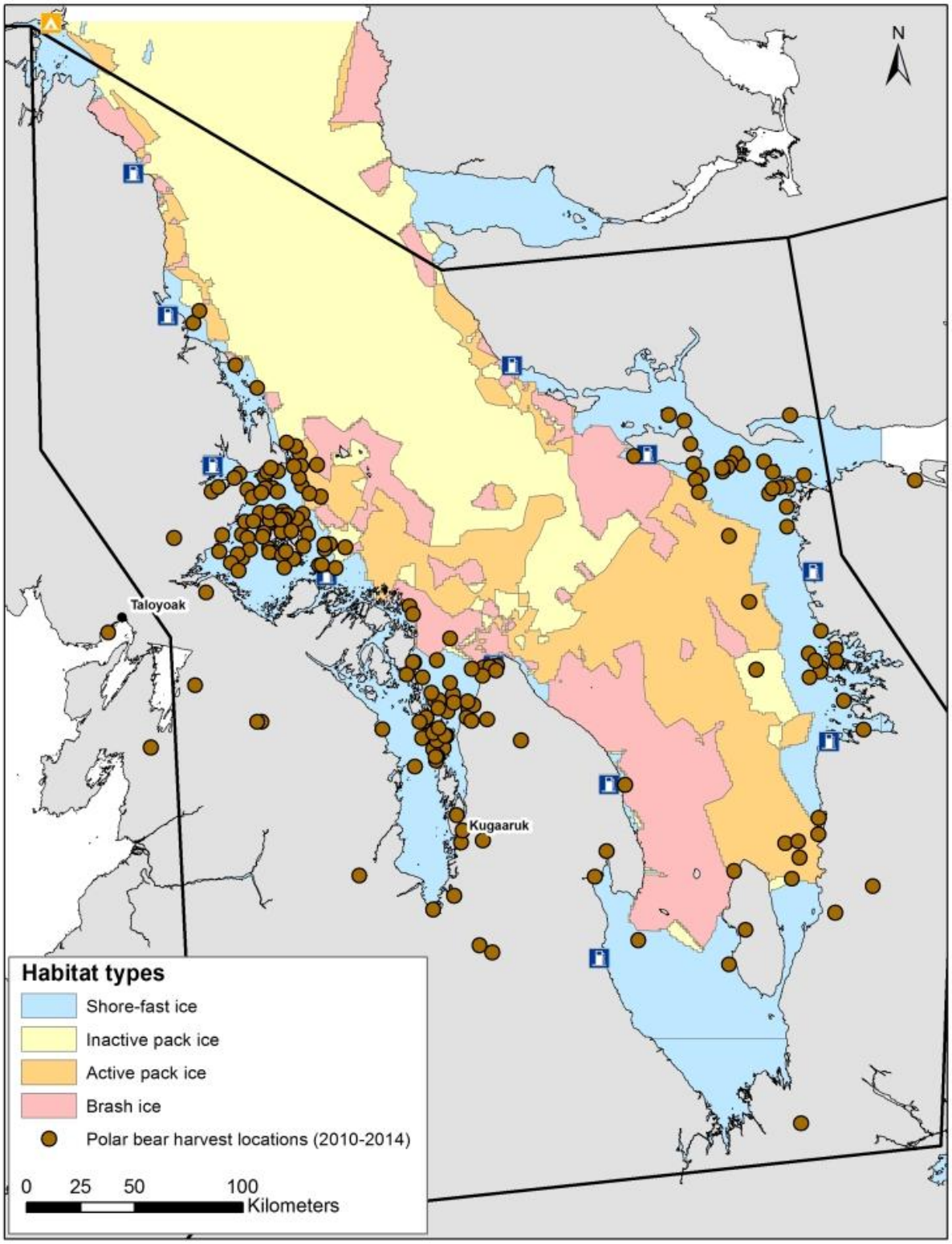


Figure 7. The distribution of polar bears harvested from Gulf of Boothia between 2010 and 2014 is mainly restricted to the shore fast ice.

Table 1. The field-estimated sex and age distribution of 185 polar bears seen in 2015 is listed.

Sex	COYs	Yearlings	Subadults	Adults	All Ages
Male		4	12	49	65
Female		7	6	60	75
Unknown	26	19	2		45
Total	**26**	**30**	**20**	**109**	**185**

Table 2. Total number of adult female with cubs of the year (COY), yearlings and unencumbered adult females seen during the 2015 survey. Also listed is the mean litter size of cubs of the year (COYs) and yearlings and their associated standard errors (SE).

	Female with COYs	Female with Yearlings	Unencumbered adult females	Total
Total number observed	16	19	25	60
Percentage of adult females	26.7%	31.7%	41.7%	
Mean Litter Size (SE)	1.63 (0.12)	1.58 (0.11)	NA	

Table 3. The field-estimated mean body condition and associated standard error (SE) for all sex and age groups and all age groups pooled is listed.

Mean Body Condition	COYs	Yearlings	Subadults	Adults	All Ages
Male		3.0 (0.00)	2.8 (0.11)	3.2 (0.06)	3.1 (0.05)
Female		2.4 (0.20)	2.8 (0.17)	3.1 (0.05)	3.0 (0.05)
Unknown	2.7 (0.09)	2.8 (0.09)	3.0		2.8 (0.06)
Total (M,F, and unk)	2.7 (0.09)	2.8 (0.08)	2.8 (0.08)	3.1 (0.04)	3.0 (0.03)

Table 4. The area of habitat types (SF= shore-fast ice, IP= inactive pack ice (large stable pans), AP = active pack ice (many leads and ridges), BR = brash-ice/floe-edge) in the Gulf of Boothia subpopulation area is listed. Also listed is the observed/expected number of polar bear sightings (excluding dependant COYs and yearlings), seal sightings and seal kills by habitat. Preference/Avoidance was calculated as the ratio of observed to expected, and the Fisher's Exact Test probability (p value) of no preference/avoidance was calculated from the 2X2 contingency table of observed and expected sightings for habitat versus all other habitats pooled. Significant preference (O/E > 1)or avoidance (O/E <1) of habitat types is **bolded**.

Habitat Type	**SF**	**IP**	**AP**	**BR**	**TOTAL**
Habitat Area (km^2)	22,036	26,604	14,822	11,747	26,604
Polar Bear Sightings (O/E)	12/37	48/44	41/25	24/20	126/126
O/E Ratio (p value)	**0.32 (0.0001)**	1.09 (0.6941)	**1.66 (0.0309)**	1.23 (0.6187)	
Seal Sightings (O/E)	141/105	73/126	82/70	61/56	357/357
O/E Ratio (p value)	**1.35 (0.0058)**	**0.58 (0.0001)**	1.17 (0.3146)	1.09 (0.6860)	
Seal Kills (O/E)	6/27	26/32	32/18	27/14	91/91
O/E Ratio (p value)	**0.23 (0.0001)**	0.81 (0.4265)	**1.78 (0.0303)**	**1.90 (0.0325)**	

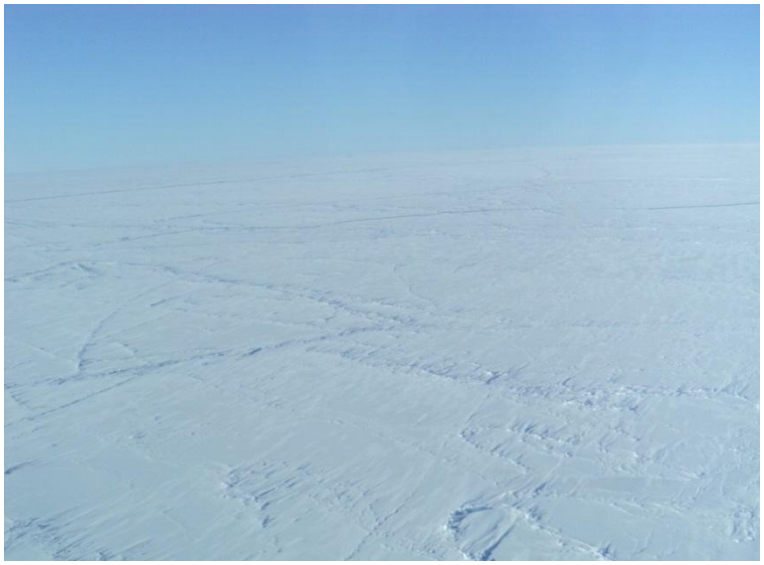
Appendix I. Number of captures and recaptures of bears classified by sex and age for Gulf of Boothia polar bears (1976–2000). Initial captures are shown for each year; recaptures are shown for the period 1998–2000 as "initial captures/recaptures."

	1976	1977	1978	1986	1987	1994	1995	1996	1998	1999	2000	Total
Female												
Cub	6	5	5	1	0	0	2	0	19	10	20	68
Yearling	3	3	0	0	0	0	4	0	10	7/2	11/2	38/4
2 yr	0	2	0	0	0	1	0	0	4	2	0	9
3 yr	2	2	0	0	0	0	0	0	1	10	5/1	20/1
4 yr	2	1	0	0	0	0	0	0	4	9/1	5/2	21/3
5–9 yr	9	10	3	2	0	1	1	0	21	13/5	17/6	77/11
10–14 yr	1	9	0	0	0	0	2	1	16/1	15	17/1	61/2
15–19 yr	2	0	1	0	0	1	1	1	7	12/1	4/4	29/5
20+ yr	1	0	0	0	0	0	0	0	5/1	7/1	4/1	17/3
Total	26	32	9	3	0	3	10	2	87/2	85/10	83/17	340/29
Male												
Cub	5	3	1	0	0	0	2	0	15	10	18	54
Yearling	1	2	0	0	0	0	1	0	6	16/3	6/1	32/4
2 yr	3	6	0	0	0	1	0	1	6	5/1	5/1	27/2
3 yr	1	1	0	1	0	0	0	0	1	4/1	4/1	12/2
4 yr	2	0	2	0	0	0	0	0	4	3	5/1	16/1
5–9 yr	1	4	5	0	1	0	2	0	10	9/4	18/1	50/5
10–14 yr	6	7	3	0	0	0	1	0	14	15/1	10/3	56/4
15–19 yr	4	3	1	0	0	0	0	1	7	4/1	7/2	27/3
20+ yr	1	7	0	0	0	0	0	0	5/1	2/1	1/3	16/5
Total	24	33	12	1	1	1	6	2	68/1	68/12	74/13	290/26

Appendix II. Photographs of the four different sea ice categories recorded during the 2015 Gulf of Boothia polar bear survey. A) = Shore Fast Ice (SF), B) = Inactive Pack Ice (IP), C) = Active Pack Ice (AP), D) = Brash ice/Floe Edge (BR).

A)

B)



C)

D)