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

FIELD REPORT TO

DEPARTMENT OF ENVIRONMENT

Pursuant to GN Wildlife Research Permit # WL-2015-002

AND

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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.

PERSON DAYS

Field work during the 2015 field season (24 April – 29 May) involved approximately 107 person days (includes biologist, technician and HTO assistants).

AIRCRAFT HOURS

We flew a total of approximately 116 hours during our field study, of which 17% was ferry time, leaving a total search time of approximately 96.0 hours

FIELD DATES

Biopsy sampling for the Gulf of Boothia (GB) polar bear study took place between 29 April and 26 May 2015. During this time frame, GB was mostly ice-covered and we assumed therefore that all bears were distributed across the study area. Out of a total of 31 days of possible search time, we could only fly on 15 days due to frequent poor weather conditions. The total search times per day also varied a lot according to weather conditions and averaged 6.2 hours (range 2.6 to 10.1 hrs).

FIELDWORK LOCATION

Fieldwork was conducted across the sea ice and smaller islands within the GB study area (Figures 1 and 3). 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. We covered the northwestern part of the study area using Fort Ross as a base camp and completed the southeastern portion of the area working out of Kugaaruk.

BACKGROUND

The most recent demographic study on the Gulf of Boothia (GB) polar bear subpopulation estimated the mean total number for the 1998-2000 study period to be 1,592 (SE = 361) bears (Taylor et al. 2009). York et al. (in review) used PVA methods, survival and recruitment estimates from Taylor et al. (2009) and GN harvest data to estimate the number of polar bears at 2013 to be 2945.7 (SE= 1722.0). The York et al. (in review) PVA estimate incorporates the variance of the population and vital rate estimates from Taylor et al. (2009) and assumes constant (no time trend) rates of survival and recruitment and no density effects.

The geographic bounds of the Gulf of Boothia polar bear subpopulation (Fig. 1) were previously delineated based on movements of radio-collared animals from the Gulf of Boothia and adjacent populations (Taylor et al. 2001). These bounds are supported by mark-recapture and mark-recovery movements (Taylor and Lee 1995) as well as DNA analysis (Paetkau et al. 1999, Peacock et al. 2015). Our study area corresponds to the Gulf of Boothia polar bear population identified in Taylor et al. (2001, Fig. 1).

There have been three previous capture programs in the Gulf of Boothia that could potentially provide data for use in this study (Appendix I). The first effort (1976–1978) was part of a general polar bear study conducted in the Canadian central Arctic in the mid-1970s (Schweinsburg et al. 1981, 1982; Furnell and Schweinsburg 1984) and included only the north and west portion of the Gulf of Boothia. For a brief period from 1986 to 1987, a limited number of polar bears (n = 5) were also captured along coastal areas in the study area (Appendix I) for a conventional (VHF) telemetry study of movements. The most recent capture program was conducted from 1994 to 2000, during which capture effort was directed evenly across the entire study area. From 1994 to 1996 the main priority was uniform deployment of satellite-radio collars on adult females over the study area. Captures of other bears occurred only incidentally to the adult females that were given radio collars. The main capture effort was from 1998 to 2000, during which every bear encountered was captured and marked, and the entire subpopulation area was searched.

This mark-recapture study differs from the studies prior to 2015 that relied on chemical immobilization of all bears and their dependent cubs for capture and marking according to procedures described by Stirling et al. (1989). This study utilizes DNA extracted from tissue sampled from Pneu-Dart® biopsy darts to uniquely identify individuals and to determine sex. We followed the Government of Northwest Territories Wildlife Care Protocol No. NWTWCC 2015-006, and we were under the guidance of the Canadian Council on Animal Care. Bears captured from 1976 to 1987 were mainly immobilized with Sernylan® (Furnell and Schweinsburg 1984); bears captured in later years were immobilized with Telazol® (Stirling et al. 1989). Upon initial immobilization capture, a unique identification number was assigned to each bear which was marked accordingly using a plastic ear tag and permanent lip tattoo. For bears captured up to and including 2000, the bear's age was "known" if the bear was captured as a cub-of-the-year (cub) or yearling, or if its age was estimated by counting annular rings of an extracted vestigial premolar (Calvert and Ramsay 1998). The bear's age for DNA biopsy captures was field estimated as: cub of the year (COYs), yearling, subadult (age 2-5), or adult (age 6+) at the time of darting. The sex, age, family status, and location of polar bears killed by hunters, killed as problem bears, or found dead from any cause has been recorded for all occurrences since 1993, and was recorded for most occurrences since 1972. Tissue samples containing DNA were taken and archived from all polar bears captured in the 1998-2000 study.

Barber and Iacozza (2004) found no trends in Gulf of Boothia sea ice conditions or ringed seal habitat suitability indices in the interval 1980–2000. Similarly Taylor et al. (2009) found no indication of any environmental trends during their study (1998-2000), although they acknowledge that the 3 year time frame was too brief to say anything meaningful about climate change or sea ice trends.

METHODS

The sample design was the same as the 1998-2000 study by Taylor et al. (2009). We searched most of the Gulf of Boothia geographic area using a Bell 206 Long-Ranger (Figure 3) following daily pre-planned routes, designed to cover the entire area and to avoid a potential directional movement of bears out of the subpopulation area due to helicopter disturbance. The pre-planned routes were used to guide our search path, but we often deviated from the planned route depending on the habitat and physical features encountered (ridges, leads, iceberg, coast line, etc.) to maximize our chances of finding polar bears. Due to weather delays, flight routes were spaced wider than originally planned to insure that the whole range of the GB area was covered. Flight path were approximately 10 to 20 km apart in areas where low bear densities were encountered and approximately 7 to 14 km apart in high bear density areas. We also followed bear tracks when they appeared to be very fresh but usually did not invest more than 10-15 minutes on a given set of tracks. We “marked” all individual polar bears encountered, except for cubs of the year, by DNA biopsy sampling. “Marking” in this study did not involve chemical immobilization and physical marking as was done previously. This study used tissue biopsy darts to collect a small skin and fat sample from each bear. These samples were used to establish a unique identity for each bear based on nuclear DNA fingerprinting methods (Chambers et al. 2014, Jefferys 2005). To minimize chances of injuries, , we did not dart cubs of the year but yearlings and two-years old cubs were biopsied.

We used 4 cc PneuDart® biopsy darts (Figure 2) spray painted orange fired from a PneuDart Model 196 capture rifle to collect tissue specimens. We used power setting 1 on all yearlings as well as most bears but occasionally used power setting 2 on adults, especially individuals that appeared more fat, to maximize the chances of obtaining a proper sample. The dart has a small stainless steel cutter located on the tip of an aluminum nose cone. The cutter encompasses a barbed capture claw to ensure sufficient sample retention. Upon impact, the DNA Dart extracts the tissue sample and falls to the ground. Cutter dimensions were 15 mm length and 4 mm diameter. The barbed claw was 17 mm long and extended 2 mm beyond the leading edge of the cutter.

We selected rump shots that were within 5 meters and could be administered such that the dart strike was at 90° to the skin surface. We selected flat pans of ice or

level ground when possible to minimize lost darts. If necessary, a similar PneuDart® biopsy/fur-marking dart was used to allow the capture team to identify individual dependent cubs once biopsied. Once retrieved, each biopsy dart was checked to confirm the presence of an adequate tissue sample. Occasionally, darts did not successfully collect a tissue sample or the dart could not be located; and the darting procedure was repeated. Each biopsy dart was then stored in a pre-labeled envelope with a unique sample ID. The samples were processed each evening to separate the skin from the fat portion of the sample. The skin sample was stored in a paper coin envelope, air-dried for a minimum of 24 hours in a warm and dry location and stored for subsequent DNA analysis. The fat portion of the sample was placed in a 2 cc Cryotube® and kept frozen for subsequent fatty acid, contaminant, or other analysis. DNA samples will be analyzed by Wildlife Genetics International (WGI) Inc. (Nelson, British Columbia, Canada). WGI will amplify DNA extracts at 20 microsatellite loci and the ZFX/ZFY sex identification marker (Aasen and Medrano 1990) using methods and primers as described by Paetkau (2003) and Kendall et al. (2009).

We recorded the following information for each bear encountered: date, time of sighting, time when pursuit began, time when darted, biopsy sample collected or not, biopsy label #, location when bear first seen (latitude, longitude), age class (COY, yearling, subadult, adult), age confidence (low or high), sex, sex confidence, body condition index (1-5), topography (1=flat, 2=flat with pressure ridges, 3= mostly pressure ice and/or multi-year ice), habitat structure (interference with sightability (1=low, 2=medium, 3=high), general habitat description, visibility/weather (1= excellent, 2=reduced, 3=poor), fecal sample collected or not, bear feeding or not, bear tracked or not, and any additional comments. As a convention, individuals field-aged as 2 year olds were classified as subadults because they were either already weaned or would be in the next few weeks. Sexual dimorphism in polar bears is apparent by the time cubs are yearlings and sometimes as COYs. We recorded our impression of sex of COYs and yearlings based on size, but report the field-identification of the sex of COYs and Yearlings as “unknown”. Photographs of polar bears were taken as conditions allowed to support the field age classification. The field sex classification will be confirmed as part of the DNA analysis for all bears that were biopsied. All data records were entered into an Excel file and verified by both biologists each night to ensure that any errors or uncertainties were identified and corrected on the same day the samples were taken. Additionally the number of helicopter hours used for searching was recorded separately from ferry flights.

We also recorded georeferenced habitat type and all seal observations. Habitat type was recorded continuously along our flight path and a GPS position was recorded each time a habitat transition occurred. Reconnaissance sampling of the sea ice suggested that most of the Gulf of Boothia spring polar bear habitat could be classified as four sea ice categories. The four sea ice types were: SF= shore-fast ice, IP= inactive

pack ice (large stable pans with few ridges), AP = active pack ice (many ridges and leads), BR = brash-ice/floe-edge (see Appendix II for photographic examples of these habitat types). The habitat and seal observations were also entered daily. ESRI ArcGIS ©software was used to produce a habitat map and to associate polar bear sightings and seal sightings to habitat types. Flight paths were converted into a series of points 100m apart with associated habitat type. We used supervised IDW (Inverse Distance Weighting) interpolation to create the habitat types layer that was used to estimate habitat preference or avoidance by bears, seals and seal kills. Habitat preference or avoidance was estimated as the ratio of the observed number of individuals in a habitat type to the expected number assuming no preference or avoidance (i.e., total individuals/total area). Fisher's Exact Test was used to determine whether preference or avoidance was significant ($p<0.05$) by rounding the expected number to a whole number. Logistic constraints prevented complete surveying of shorefast ice areas in the backs of some bays and inlets. The unsurveyed shorefast ice areas were mapped as shorefast ice, but not included in the preference/avoidance calculations.

All data collected were archived on multiple GN digital storage devices and all samples that were not sent to commercial laboratories for analysis are archived in the Wildlife Research Section, Polar Bear Research Group tissue bank in Igloolik, NU.

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

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.

LITERATURE CITED

Aasen, E. and J. F. Medrano. 1990. Amplification of the ZFY and ZFX genes for sex identification in humans, cattle, sheep and goats. Biotechnology 8:1279–1281.

Barber, D. G. and J. Iacozza. 2004. Historical analysis of sea ice conditions in M'Clintock Channel and Gulf of Boothia; Implications for ringed seal and polar bear habitat. Arctic. 57:1–14.

Calvert, W. and M. A. Ramsay. 1998. Evaluation of age determination of polar bears by counts of cementum growth layer groups. Ursus 10:449–453.

Chambers G. K., C. Curtis, C. D Millar, L. Huynen2 and D. M. Lambertal. 2014. Investigative Genetics. 5 (3) 1-11.

Furnell, D. J., and R. E. Schweinsburg. 1984. Population dynamics of central Arctic polar bears. Journal of Wildlife Management 48:722–728.

Jeffreys, A.J. 2005. Genetic fingerprinting. Nature Medicine. 11:1035–1039.

Kendall, K. C., J. B. Stetz, D. A. Roon, L. P. Waits, J. B. Boulanger and D. Paetkau. 2009. Grizzly bear density in Glacier National Park, Montana. Journal of Wildlife Management 72:1693–1705.

Paetkau, D., S. C. Amstrup, E. W. Born, W. Calvert, A. E. Derocher, G. W. Garner, Messier, I. Stirling, M. K. Taylor, Ø. Wiig and C. Strobeck. 1999. Genetic structure of the world's polar bear populations. Molecular Ecology 8:1571–1584.

Paetkau, D. 2003. An empirical exploration of data quality in DNA-based population inventories. Molecular Ecology 12:1375–1387.

Peacock, E., Sonsthagen, S.A., Obbard, M.E., Boltunov, A., Regehr, E.V., Ovsyanikov, Aars, J., Atkinson, S.A., Sage, G.K., Hope, A.G., Zeyl, E., Bachmann, L., Ehrich, D. Scribner, K.T., Amstrup S.C., Belikov, S., Born, E.W., Derocher A., Stirling, I., Taylor M.K., Wiig, O. Paetkau, D. and S. Talbot (2015) Implications of the Circumpolar Genetic Structure of Polar Bears for their Conservation in a Rapidly Warming Arctic. PLoS ONE 10(1): e112021. doi:10.1371/journal.pone.0112021.

Schweinsburg, R. E., D. J. Furnell and S. J. Miller. 1981. Abundance, distribution, and population structure of polar bears in the lower Central Arctic Islands. Wildlife Service Completion Report Number 2. Government of the Northwest Territories, Yellowknife, Northwest Territories, Canada.

Schweinsburg, R. E., L. J. Lee and P. B. Latour. 1982. Distribution, movement, and abundance of polar bears in Lancaster Sound, Northwest Territories. Arctic 35:159– 169.

Stirling, I., C. Spencer and D. Andriashek. 1989. Immobilization of polar bears (Ursus maritimus) with Telazol in the Canadian Arctic. Journal of Wildlife Diseases 25:159–168.

Taylor, M. K., S. Akeeagok, D. Andriashek, W. Barbour, E. W. Born, W. Calvert, S. Ferguson, J. Laake, A. Rosing-Asvid, I. Stirling and F. Messier. 2001. Delineating Canadian and Greenland polar bear (Ursus maritimus) populations by cluster analysis of movements. Canadian Journal of Zoology 79:690–709.

Taylor, M.K., Laake, J., McLoughlin, E.W., Cluff, and Messier, F. 2009. Population demography and conservation of polar bears in Gulf of Boothia, Nunavut. Marine Mammal Science. 25(4): 778-796.

Taylor, M. and Lee J. 1995. The distribution and abundance of Canadian polar bear populations: a management perspective. Arctic. 48: 147-154.

York, J., Dowsley, M., Cornwell, A., Kuc, M., and Taylor, M. K. in review. Demographic and Traditional Knowledge Perspectives on the Current Status of Canadian Polar Bear Subpopulations. Submitted for publication in Ecology and Evolution.

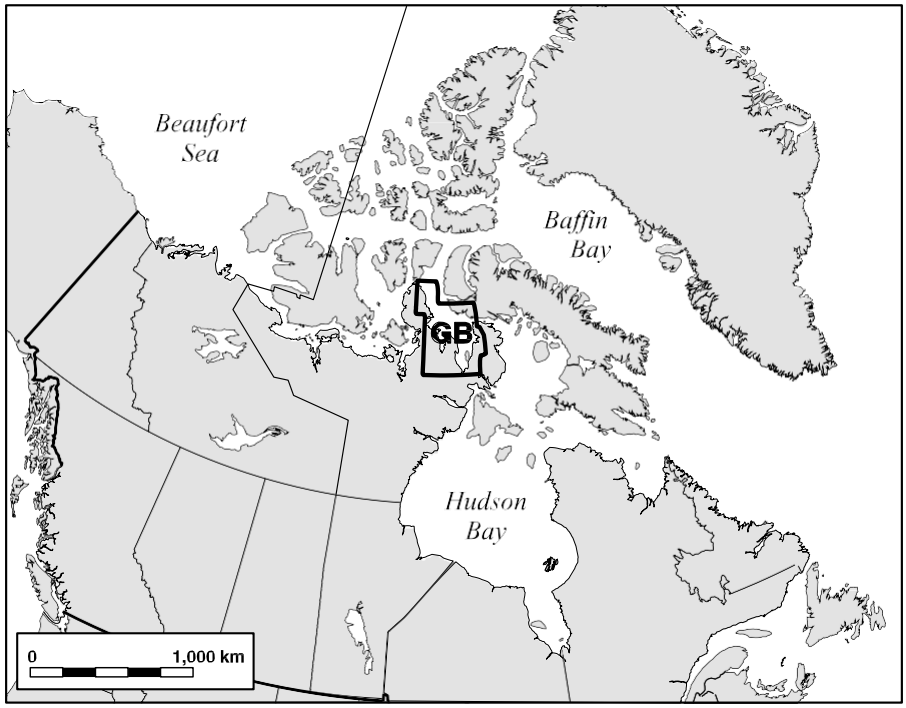


Figure 1. Location of the Gulf of Boothia (GB) polar bear subpopulation, Nunavut. Boundaries are defined as in Taylor et al. (2001).

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

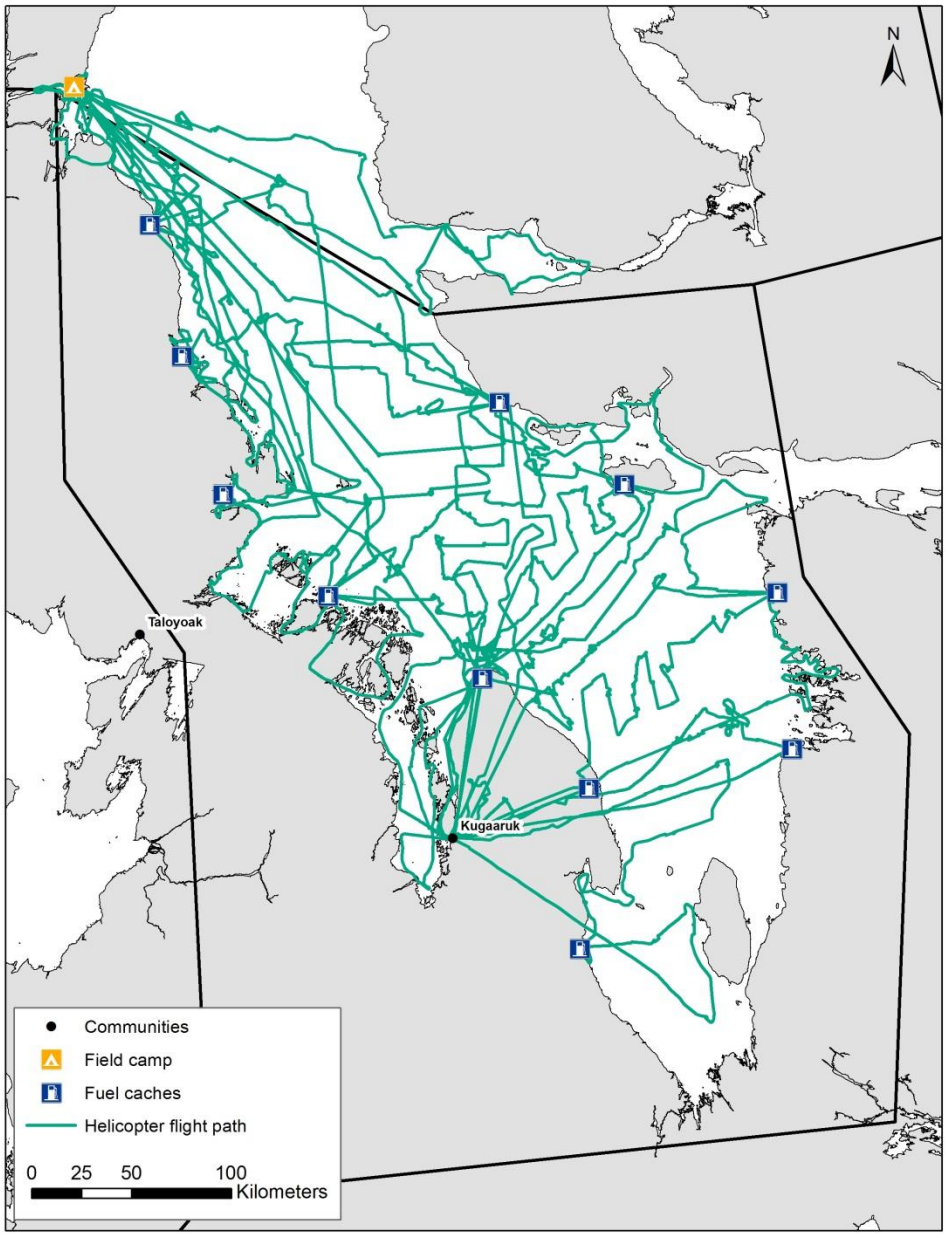


Figure 3. Helicopter track log and location of camp and fuel caches used to search for the entire Gulf of Boothia polar bear subpopulation.

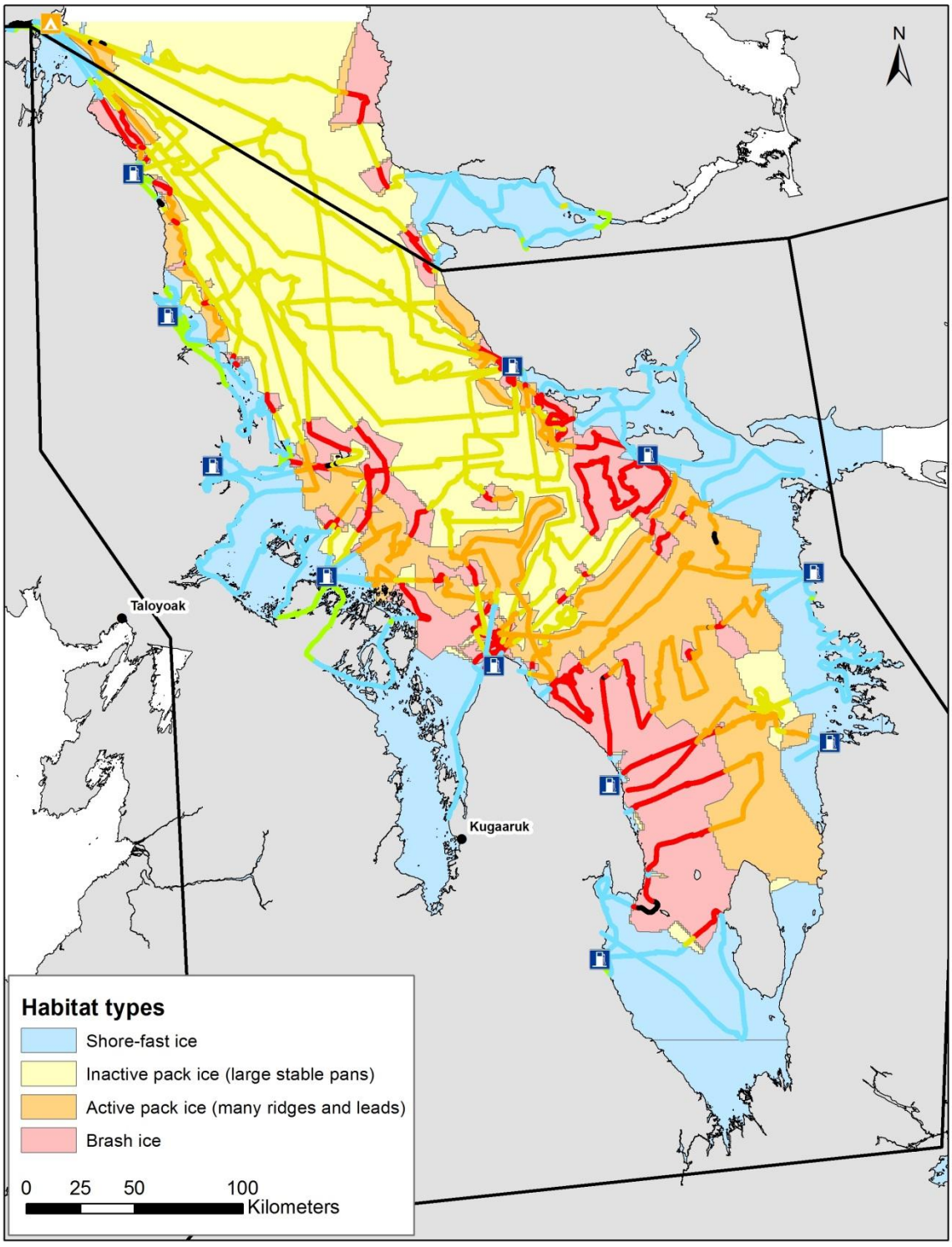


Figure 4. Habitat classification recorded along helicopter flight path (line colors corresponds to habitat types) and resulting habitat classification through the whole Gulf of Boothia subpopulation area using IDW interpolation.

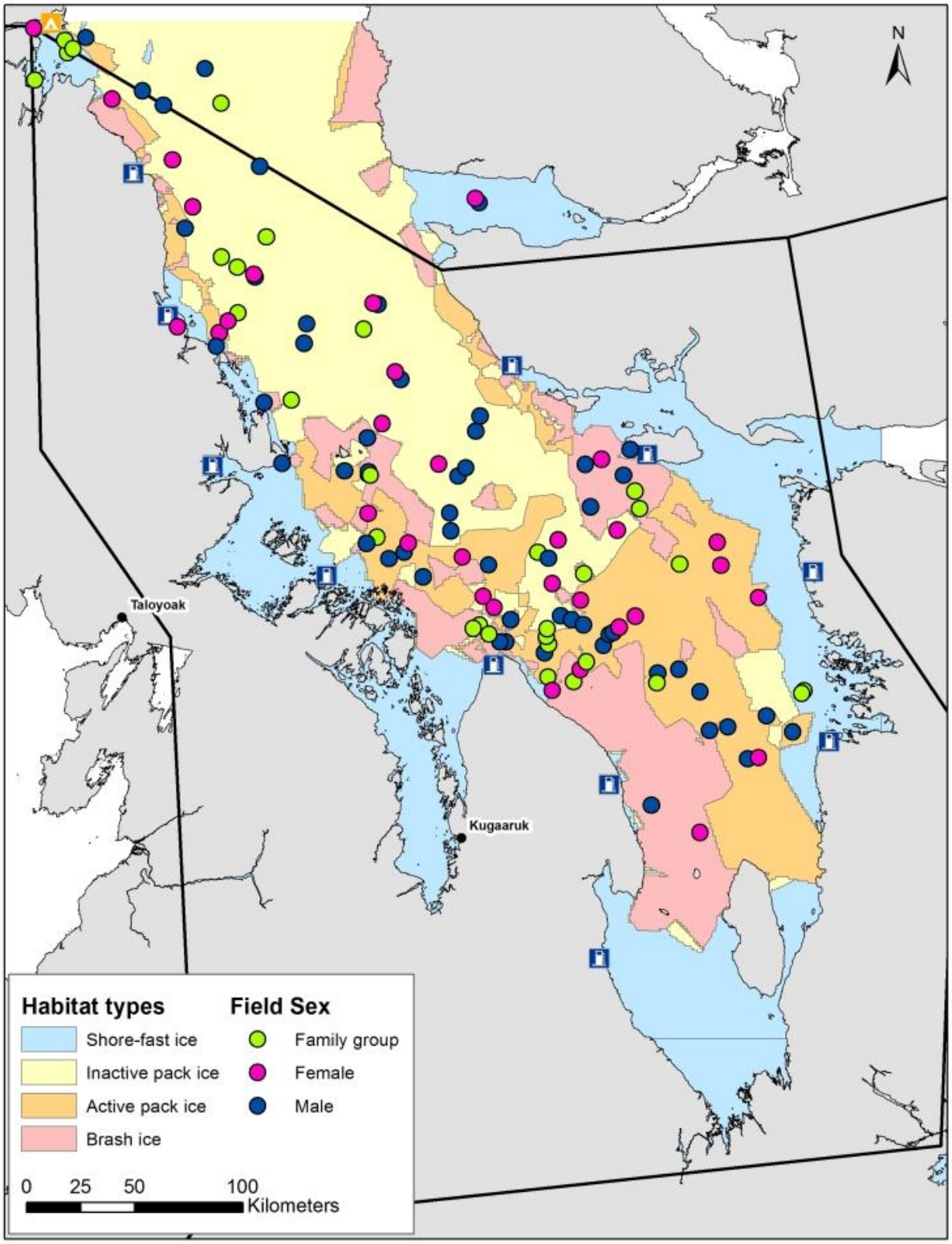


Figure 5. The distribution of habitat type and the locations of polar bear sightings during our 2015 survey of the Gulf of Boothia subpopulation are depicted.

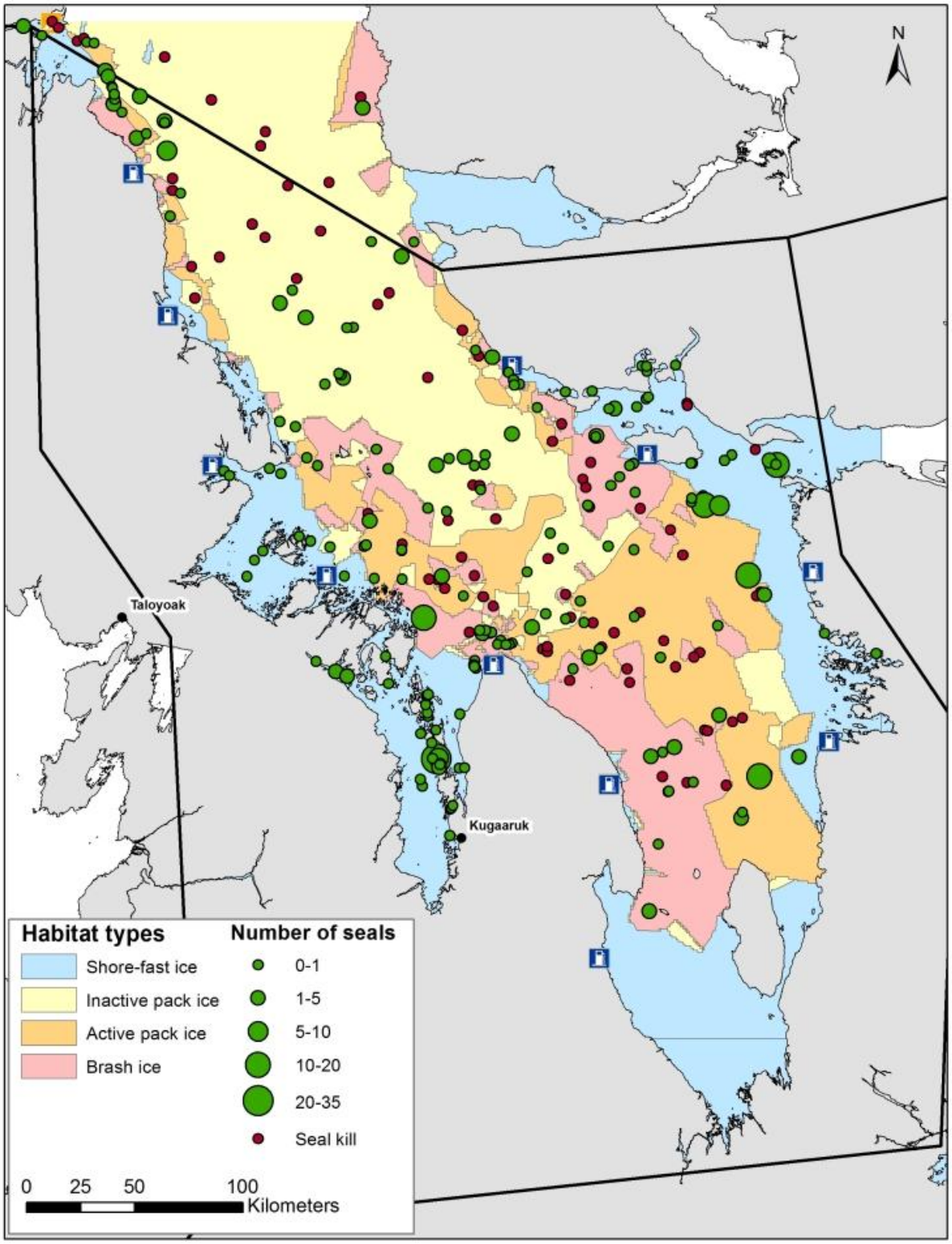


Figure 6. The distribution of habitat type and the locations of seal sightings during our 2015 survey of the Gulf of Boothia subpopulation are depicted.

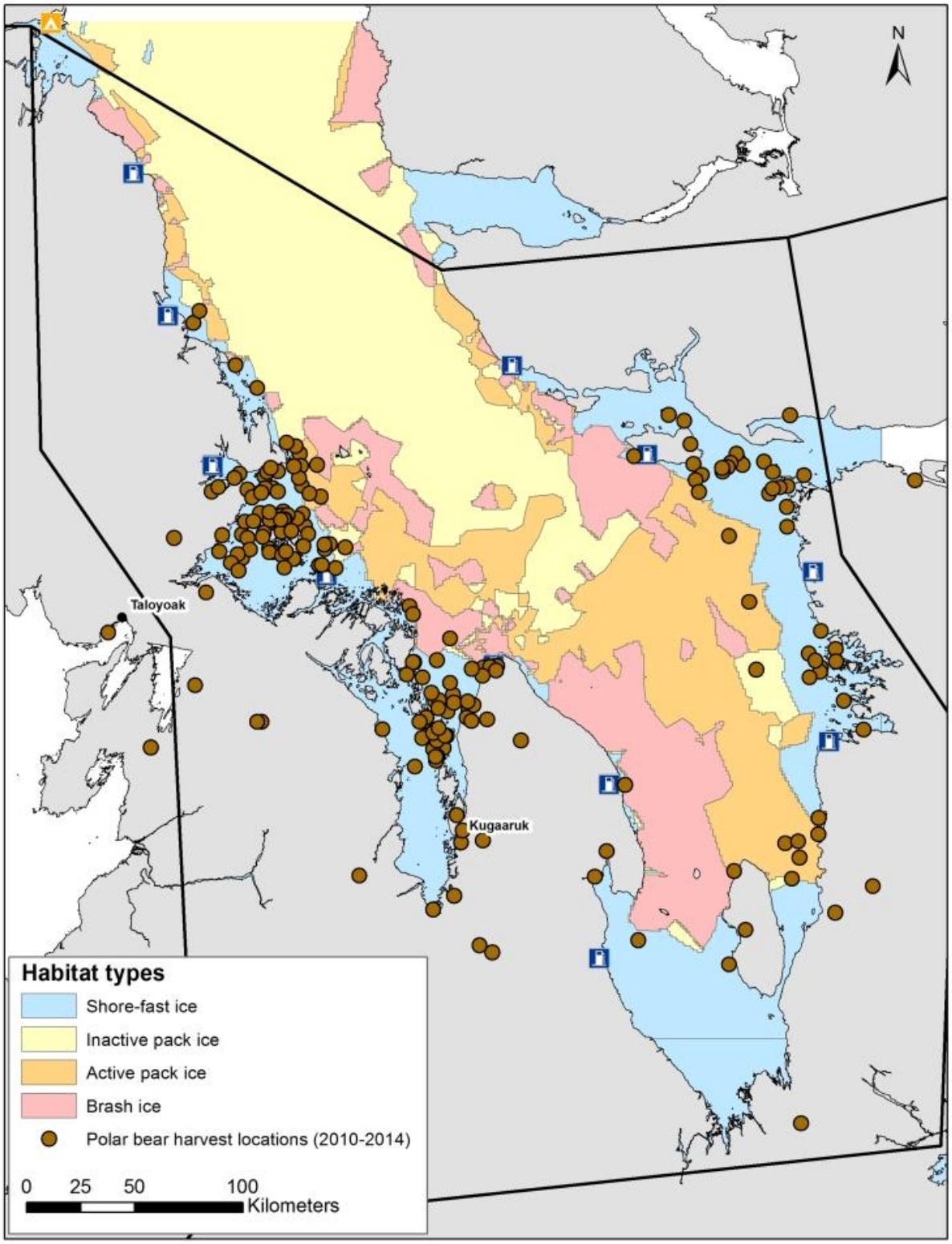


Figure 7. The distribution of polar bears harvested from Gulf of Boothia between 2010 and 2014 is mainly restricted to the shore fast ice.

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)**	

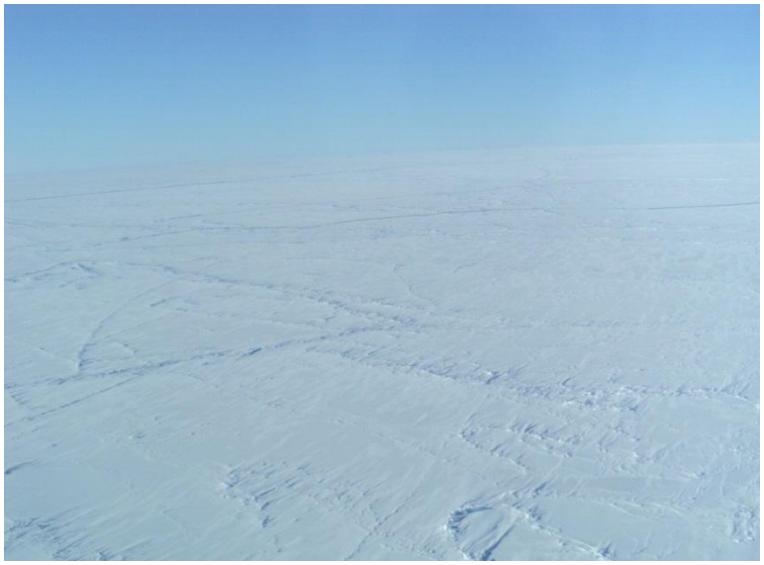
Appendix I. Number of captures and recaptures of bears classified by sex and age for Gulf of Boothia polar bears (1976–2000). Initial captures are shown for each year; recaptures are shown for the period 1998–2000 as "initial captures/recaptures."

	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)