

BAFFIN BAY POLAR BEAR GENETIC MARK RECAPTURE

INTERIM REPORT TO THE NUNAVUT WILDLIFE RESEARCH TRUST

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SUMMARY

The Baffin Bay (BB) polar bear subpopulation has been the subject of significant debate amongst government agencies, Inuit and other stakeholders. Differing perspectives on population size, trend and the sustainability of harvest levels, combined with a lack of current research, has generated uncertainty about the status of this sub-population. In response to this uncertainty, the Government of Nunavut in collaboration with the Greenland Institute of Natural Resources initiated a study in 2011 designed to provide updated information on the size and status of the sub-population. Taking into account Inuit concerns regarding capture and handling of polar bear in addition to a broader interest in the development of alternative monitoring techniques for polar bears, the study was designed as a 3-year genetic mark-recapture program. Unlike methods previously used to study polar bears in BB, the study design does not require the capture of polar bears. Instead biopsy darting is being used to obtain samples of DNA which are then analysed in-order to identify individuals; in essence a genetic tag equivalent to the ear-tags and lip tattoos applied during previous capture-based studies.

Data collection for year 3 (2013) of the study took place in late August to early October along the eastern coastline of Baffin Island. In total, 420 polar bears were biopsy darted. An additional 66 bears were encountered but not biopsied; 37 of these being cubs-of-the-year. Preliminary review of data on the distribution and body condition of bears encountered in 2013 suggests possible differences in comparison to other years of the study. In 2013, a greater proportion of bears were found in the southern part of Baffin Bay (south of 70 degrees latitude) and body condition tended to be poorer than in 2011. In addition to activities on the Nunavut side of Baffin Bay, biopsy darting took place on the Greenland side in 2013 to sample bears summering in this region. Since September 2011, tissue samples have also been collected from bears harvested in Baffin Bay and surrounding sub-populations in-order to monitor recovery of genetically tagged animals by hunters in both Nunavut and Greenland.

Genetic analyses of biopsy samples collected in Nunavut in 2011 and 2012 have been completed. Samples from bears harvested in Nunavut from BB and surrounding sub-populations between September 2011 and July 2012 have also been analysed. The 2013 biopsy samples and remaining harvest samples collected in Nunavut are currently undergoing analyses. Biopsy and harvest samples collected in Greenland during the study have been submitted for analyses.

OBJECTIVES

- 1) To estimate the current abundance and composition of polar bears in BB.

- 2) To compare a new estimate of abundance with those derived from past study in-order to gain insight into population trend and status in BB.
- 3) To estimate survival and reproductive parameters (to the extent possible) in-order to facilitate population viability analyses.
- 4) To evaluate polar bear distribution during the period of minimum sea-ice with respect to environmental variables, particularly ice conditions, topography and food availability distribution.
- 5) To demonstrate the utility of genetic mark-recapture as a less invasive alternative to physical capture for the purpose of population monitoring.

The objectives of the project remain unchanged from those originally proposed.

MATERIALS AND METHODS

The basic study design was similar to that of the previous physical mark-recapture study conducted in BB (Taylor et al. 2005) but did not involve the immobilization and handling of bears. Instead, DNA extracted from a small sample of skin and hair collected via a biopsy dart was used to identify each bear; effectively genetically 'marking' each individual (and permitting future identification) without the need for ear-tagging or lip-tattooing. The 'recapture' event occurred when a bear was either biopsy darted on a later occasion or when a DNA sample was recovered from a polar bear harvested by hunters in either Nunavut or Greenland.

From 2011-2013, biopsy darting was being carried-out along the coast of Baffin Island in the fall (between August 20 and October 15th) coinciding with the time of minimum sea-ice extent in each year. During this period, most bears in BB are distributed on land or on the remaining pack-ice along the coastline of Baffin Island and associated islands (Ferguson et al. 1997, 2000; Taylor et al. 2001). Two helicopters, each operating in different sections of the study area, are used to search for bears. To reduce potential bias in sampling resulting from the non-random distribution of bears within the study area, including previously documented segregation by sex and age-class (Ferguson et al. 1997; 2000), the study area was stratified into high, medium and low density areas using satellite telemetry data on polar bear locations collected from collared bears in 1993-1997 and 2008-2010 (figure 1). Search effort was concentrated within the high density strata along the coastline (up to 5 km inland) and offshore islands where bears are known to congregate (Ferguson et al. 1997, 2000; Taylor et al. 2001, 2005). However, effort was also allocated to conduct searches of medium and low density inland areas up to 10 and 30 km from the coast, respectively in-order to

sample bears further inland and at higher elevations¹. Potential sampling bias was also minimized through the use of a multi-year sampling design and by the addition of biopsy sampling efforts along the Greenland side of Baffin Bay in the fall of 2012 and 2013; concurrent with the main sampling effort along Baffin Island. Finally sampling heterogeneity associated with bears that may occupy pack-ice that is inaccessible by helicopter, was reduced by using sea-ice data and telemetry data from collared bears to time fieldwork to coincide with the period of minimum ice when the vast majority of bears are on land.

Once a bear was located, a small sample of tissue (<5 mm diameter), mostly skin, was taken using a biopsy dart fired from a dart rifle from the helicopter. 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 were recorded. DNA extracted from biopsy and harvest tissue samples was analyzed in-order to assign each bear sampled (and re-sampled) during the study a unique genetic identity and determine its sex.

PROJECT SCHEDULE

The project remains on schedule as originally proposed with final results expected in winter 2014/15.

OUTPUT OR STEP	START DATE	END DATE	PERSON DAYS
Logistical preparations	Spring 2011	Summer 2011	65
	Spring 2012	Summer 2012	20
	Spring 2013	Summer 2013	20
Biopsy darting	September 2011	October 2011	80
	September 2012	October 2012	80
	September 2013	October 2013	80
Harvest sampling	Fall 2011	Fall 2013	75
Analysis of tissue samples	Winter 2011/12	Winter 2013/14	-
Final data analyses, preparation of reports and peer-reviewed publications	Winter 2013/14	Winter 2014/15	-

PRELIMINARY RESULTS & DISCUSSION

¹ Based on the frequency of telemetry locations occurring within each stratum, approximately 85, 10 and 5% of search effort is allocated to searching in the high, medium and low density strata respectively; subject to limitations imposed by weather and terrain which do not always permit inland searching.

Sampling Effort:

In 2013 (year 3 of the project), biopsy sampling was carried out along the east coast of Baffin Island from August 20th to October 11th. During this interval, Canadian Ice Service charts indicated Baffin Bay was virtually ice-free and all satellite-collared bears present in the study area were located on land. It was thus assumed that a majority of bears in the sub-population were available for 'capture' at the time of biopsy sampling². The timing and length of this sampling period differed slightly from previous years (figure 2) due to availability of aircraft and weather conditions. In comparison to the 2011 and 2012 sampling sessions, weather conditions were poor in 2013 resulting in extension of the sampling window in-order to adequately cover the study area and obtain sufficient samples.

Two Bell 206L helicopters operating in different sections of the study area were used to search for and biopsy dart polar bears. The helicopters were initially positioned at the community of Pond Inlet and the Cape Dyer DEW line site to cover the northern and southern halves of the study area, respectively. Both helicopters were tasked with working towards Clyde River. HTO members from the communities of Qikiqtarjuaq, Clyde River and Pond Inlet assisted in the field. In addition to sharing their knowledge of polar bears and the local terrain, these individuals worked as observers helping to locate and in some cases biopsy dart bears. Parks Canada staff (Sirmilik National Park) also served as observers.

In total, 486 bears were encountered during field operations of which 420 (86%) were biopsied (Table 1). Of the 66 bears that were not biopsied, 56% were cubs-of-year for which biopsy darting was considered an unsuitable/unsafe practice based on size, risk of separation from mother or risk of injury from pursuit. The remaining individuals were those encountered in situations where biopsy darting was impractical or unsafe (i.e. narrow ledges, insufficient fuel, within dens, open water in high waves etc). Ninety-three percent of encountered bears 1 year of age or older were biopsied.

To the extent possible, search effort was distributed systematically across the study area according to previously established strata but was modified as necessary in response to terrain and weather conditions that constrained access to some areas. Flight paths during searches were recorded via GPS and will allow post-hoc assessment of the distribution of search effort. Concerted effort was made to search inland and at high elevations. All fiords, with the exception of 3, and most (>95%) islands within the study area were searched. Inland flights extended up to 30 kilometers inland.

² As is normal in Baffin during this period, icebergs were present offshore drifting in a southerly direction along the coast of Baffin Island. However, ice-cover was less than 1/10th according to Canadian Ice Service data.

Similar to 2011 and 2012, encounter rates varied significantly across the study area and amongst sampling days depending on the distribution of bears, terrain and weather conditions. Average overall encounter rate was approximately 1.6 bears per hour of flying compared to 2 and 2.6 bears per hour in 2011 and 2012 respectively³. The encounter rate during active search effort has not yet been calculated but is expected to be approximately 2 bears per hour. Based on our perceptions, the lower encounter rate in 2013 was the result of poor weather conditions, which limited access to some parts of the study area and the visibility of bears, combined with lower densities within searched areas and/or differing distribution amongst the strata.

Because biopsy darting leaves no visible marks, the sample of 420 biopsied bears may include individuals that were sampled more than once during the 2013 field season. However, the number of duplicate samples is expected to be low and can be determined once genetic analyses are completed. Several measures were taken to avoid repeated biopsy of individual bears. Daily searches were limited to areas not previously searched. Whenever possible, natural barriers to movement were used to delineate neighbouring search areas. In situations where multiple bears were encountered at the same location duplication of sampling was avoided by distinguishing individuals based on size, sex or visible marks (e.g. scars, stains on fur etc.). When distinguishing amongst individuals was not possible, some bears were sampled using a dart (Pneudart Inc.) that simultaneously biopsied and marked bears with a temporary dye spot.

The biopsy darting was found to be quick and minimally invasive. The time between spotting a bear and obtaining a sample was typically less than 2 minutes. Since the bears were not being chemically immobilized they could be safely darted in locations that would have been unsuitable for capture due to the risks of drowning or falling. The only exception was for bears found in the water. These individuals were moved to land before darting since the biopsy darts do not float.⁴ Bears showed little or no reaction to the impact of a dart and no visible marks were left following darting in almost all cases. Immediately after being darted, each bear was allowed to safely move away from helicopter before the dart was retrieved. Darts were coated in fluorescent paint to aid retrieval. A length of flagging tape was also rolled around the shaft. This tape unrolled during flight and allowed darts to be easily located especially when they sank into the snow. Following retrieval each sample was divided into two parts. The subsamples intended for DNA analysis were dried and stored in individual envelopes.

Anecdotal observations (Born et al. 2011) and recent satellite telemetry studies of bear movements (2009-2013: Born & Laidre unpublished data) indicate that

³ Includes non-search (ferry) time.

⁴ It was discovered part way through the season that the DNA/dye marking darts sometimes floated thus allowing retrieval from water under calm conditions. Two bears were successfully darted while in the water.

some polar bears summer along the coast of Greenland, in particular in the Melville Bay area of north-eastern Baffin Bay. Although probably small, the fraction of the Baffin Bay population summering in this region is unknown. Furthermore, it is unclear whether these bears show year-over-year fidelity to Greenland. If bears do show seasonal fidelity to Greenland, reliance on biopsy sampling along Baffin Island could lead to underestimation of population size. To address this potential source of bias, biopsy sampling of bears took place on the Greenlandic side of Baffin Bay in 2012 and 2013. In 2013 a total of 17 bears were encountered in this region during fieldwork in the early September, fourteen of which were biopsied (E. Born pers comm.). In comparison to biopsy darting activities along Baffin Island, encounter rates in Greenland were very low (e.g. 0.4 bears per hour of active searching in 2012). This finding is consistent with previous evidence suggesting densities are low in this part of Baffin Bay during the open water season.

Distribution:

The distribution of biopsy sampling in 2013 is illustrated in figure 3a. As expected, and similar previous years, encounter rates were highest close to the coast and on islands. A significant number of bears were encountered in the long, steep sided fiords of eastern Baffin Island often at the head of fiords around the outflows of glaciers and rivers. Bears were found in a wide variety of habitats including coastal plains, beaches, boulder fields, scree slopes, cliff faces, vegetated hillsides, mountain tops, glaciers, ice-bergs. At time of first observation some bears were found occupying shallow pits along shorelines or in snow dens at higher elevations. Five percent (23) of encountered bears were found swimming and were successfully biopsied.

Based on clustering of polar bear movements and sea-ice dynamics, Taylor et al. (2001) describe a boundary at approximately 70 degrees latitude dividing Baffin Bay into two sub-units; Northern Baffin Bay (NBB) and Southern Baffin Bay (SBB). Using the same delineation of north and south to summarize the distribution of polar bear encounters in Baffin Bay during biopsy darting (Table 2) suggests that the distribution of encounters in 2013 was similar to that of 2012 but significantly different from 2011 ($\chi^2 = 90.27$, d.f. = 2, $p < 0.01$). In 2011, sampled bears were relatively evenly distributed between northern and southern Baffin Bay. In contrast, during 2012 and 2013 a majority of bears (70%) were encountered in SBB. Since the effort allocated to searching in these two regions was approximately the same within and between years, these differences in distribution are likely real rather than the result of sampling bias. However, it is noted that there were also differences amongst years in terms of timing of sampling and personnel conducting the sampling that may have influenced encounter rates in these two regions. For example, in 2011 a majority of the sampling effort in both regions was conducted by the same field team. In contrast sampling effort in 2012 and 2013 was more evenly split between two field teams with each team focusing a majority of their effort in NBB or SBB.

Whether there are interactions between factors such as observer, timing of sampling, timing of sea-ice break-up and capture probabilities across the study area is unclear at present but will be examined during analysis. Future analyses will also examine data on distribution of bears during the ice-free season in greater detail in relation to environmental variables (objective #4) and the movements of instrumented bears.

Reproductive Indices:

During the 2013 sampling session, 80 family groups were encountered including 49 adult females with cubs-of-the-year (COY), 30 with yearlings and 1 with 2-year-olds. Litter size ranged from 1 to 3 offspring; including 1 group of triplet COYs. Mean litter size for yearlings was 1.37 (S.E. = 0.09); the lowest recorded in the 3 years of sampling (Table 3). Litter size amongst COYs was 1.63 (S.E. = 0.08); the highest recorded in the 3 years of sampling. COYs and yearlings made up 16% and 8% of the sampled bears respectively; similar proportions to 2011 and 2012 sampling in BB and comparable to recent sampling in other seasonal sea-ice populations with the exception of Western Hudson Bay (2011) and Davis Strait (2005-2007). Anecdotally, some (4 individuals) of the COYs encountered in the fall of 2013 were noted to be unusually small; about the size typical of a COY in the spring. Similarly undersized cubs were observed in 2012 but not in 2011.

Body Condition Indices:

Bears were assigned a body condition score on a scale of 1 to 5 based on visual assessment with those in the poorest and best condition being rated as 1's and 5's respectively (Stirling et al. 2008). Data for 2011-2013 are summarized in tables 4 to 6. In all years, most (75%) of the bears encountered were rated as being in average body condition (i.e. score of 3). A cursory examination of these data suggests possible differences in body condition between years with bears in 2011 tending to be in better condition than in 2012 and 2013. Further analyses of body condition data will be conducted.

Foraging Observations:

Observations on foraging by polar bears were collected opportunistically during fieldwork in 2013. Similar to 2012, forty-two (9%) bears encountered exhibited evidence of feeding (Table 7). Evidence of feeding ranged from direct observations of feeding at the time of encounter (9 individuals), and indirect signs of recent feeding activity including: Oil stained fur (6); blood stains around the mouth (4); distended abdomens (23); the production of feces during pursuit characteristic of bears feeding on marine mammals (11), proximity to char runs (6).

Bears were encountered feeding, or showing signs of having recently fed, on walrus, ringed seal, narwhal and fish. At two locations, congregations of bears were encountered along streams where char were observed running. Fish carcasses found at these sites and the presence of bears standing in close quarters along these watercourses suggest bears were actively fishing.

Genetic Analyses:

Genetic analyses of biopsy samples collected in Nunavut in 2011 and 2012 have been completed. Samples from bears harvested in Nunavut from BB and surrounding sub-populations between September 2011 and July 2012 have also been analysed.

The following samples are currently being analysed or are pending submission for analyses:

- Samples from bears biopsied in Nunavut in 2013 and from bears biopsied along the west coast of Greenland in 2012 and 2013.
- Samples from bears captured along the west coast of Greenland for the period 2009-2013.
- Samples from bears harvested in Nunavut from BB and surrounding sub-populations for the period August 2012 to October 2013.
- Samples from bears harvested in Greenland for the period September 2011 to September 2013.

REPORTING TO COMMUNITIES/RESOURCE USERS

Following consultation meetings in 2011, the project received unanimous support from all 3 affected HTO's. Consultation prior to the 2013 fieldwork took place via correspondence as planned. A version of this progress report will be distributed to HTO's in 2014. Consultations regarding project results will take place in each community in late 2014.

COMMUNITY/HTO	BEFORE	DURING	COMPLETION
Qikiqtarjuaq/Nativak HTO	Feb 2010, in-community (completed) Feb/March 2011, in-community (completed)	Fall 2011 & 2012, in-community during fieldwork Winter 2011, 2012 & 2013, by correspondence	Fall 2014, in-community
Clyde River/Namautaq	Feb 2010, in-community	Fall 2011, in-	Fall 2014, in-

HTO	(completed) Feb/March 2011, in- community (completed)	community Winter 2011, 2012 & 2013, by correspondence	community
Pond Inlet/Mittimatalik HTO	Feb 2010 (completed) Feb/March 2011, in- community (completed)	Fall 2011/12, in- community Winter 2011, 2012 & 2013, by correspondence	Fall 2014, in- community

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Table 1. Summary of biopsy sampling in Baffin Bay (Nunavut) 2013 according to age-class and sex as estimated by distance examination.

Age Class	Sex	Biopsied	
		Y	N
COY	Unknown	43	37
Yearling	Unknown	34	7
2-Yr-Old	Unknown	1	0
Sub-adult	Male	45	5
	Female	14	0
	Unknown	55	0
Adult	Male	97	4
	Female	131	7
	Unknown	0	0
Unknown	Unknown	0	6
TOTAL		420	66

Table 2. Number of polar bears encountered in Northern and Southern Baffin Bay during biopsy sampling in 2011 to 2013. Proportion of observations within each year are in parenthesis.

Year	Northern Baffin Bay	Southern Baffin Bay
2011	278 (0.553)	225 (0.447)
2012	216 (0.302)	499 (0.698)
2013	154 (0.317)	332 (0.683)

Table 3. Polar bear litter sizes and number of dependent offspring observed (as proportion of total observations) during recent ice-free season studies in central and eastern Canada. Litter size data presented as mean (standard error).

Subpopulation	Litter Size		Proportion of Total Observations		Source
	<i>Cubs of the year</i>	<i>Yearlings</i>	<i>Cubs of the year</i>	<i>Yearlings</i>	
Baffin Bay (2013)	1.63 (0.08)	1.37 (0.09)	0.16	0.08	GN (unpublished data)
Baffin Bay (2012)	1.47 (0.06)	1.53 (0.08)	0.13	0.10	GN (unpublished data)
Baffin Bay (2011)	1.57 (0.06)	1.51 (0.09)	0.19	0.10	GN (unpublished data)
Western Hudson Bay (2011)	1.43 (0.08)	1.22 (0.10)	0.07	0.03	Stapleton et al. (2012)
Southern Hudson Bay (2011)	1.56 (0.06)	1.54 (0.08)	0.16	0.12	M. Obbard (unpublished data)
Foxe Basin (2009-2010)	1.54 (0.04)	1.48 (0.05)	0.13	0.10	Stapleton et al. (2011)
Davis Strait (2005-2007)	1.49 (0.15)	1.22 (0.28)	0.08	0.09	Peacock et al. (2013)

Table 4. Summary of body condition scores (BCS) for polar bears encountered during biopsy sampling in Baffin Bay (Nunavut) 2012. Age and sex estimated by distance examination. Body condition score rated 1-5; poorest condition = 1, best = 5.

		1	2	3	4	5	
COY	Unknown	1	4	66	9	-	80
Yearling	Unknown	-	5	35	2	-	42
2-Yr-Old	Unknown	-	-	1	-	-	1
Sub-adult	Male	-	14	38	-	-	52
	Female	-	2	13	-	-	15
	Unknown	-	8	44	3	-	55
Adult	Male	1	22	69	10	-	102
	Female (with offspring)	1	5	64	5	-	75
	Female (without offspring)	-	3	28	27	1	59
	Unknown	-	-	2	-	-	2
TOTAL		3	63	360	56	1	483

Table 5. Summary of body condition scores (BCS) for polar bears encountered during biopsy sampling in Baffin Bay (Nunavut) 2012. Age and sex estimated by distance examination. Body condition score rated 1-5; poorest condition = 1, best = 5.

Age Class	Sex	Body Condition Score					TOTAL
		1	2	3	4	5	
COY	Unknown	2	6	85	1	-	94
Yearling	Unknown	-	6	63	-	-	69
2-Yr-Old	Unknown	-	-	10	1	-	11
Sub-adult	Male	3	15	31	1	-	50
	Female	-	5	15	-	-	20
	Unknown	2	10	94	1	-	107
Adult	Male	6	39	86	19	-	150
	Female (with offspring)	-	18	93	4	-	115
	Female (without offspring)	-	9	56	20	6	91
	Unknown	0	1	-	-	-	1
TOTAL		13	109	533	47	6	708

Table 6. Summary of body condition scores (BCS) for polar bears encountered during biopsy sampling in Baffin Bay (Nunavut) 2011.

Age Class	Sex	Body Condition Score					TOTAL
		1	2	3	4	5	
COY	Unknown	-	4	78	12	-	94
Yearling	Unknown	-	-	46	5	-	51
2-Yr-Old	Unknown	-	2	-	-	-	2
Sub-adult	Male	-	5	32	5	-	42
	Female	-	-	9	-	-	9
	Unknown	1	4	29	-	-	34
Adult	Male	-	20	80	22	1	123
	Female (with offspring)	-	7	79	9	-	95
	Female (without offspring)	-	-	21	24	2	47
	Unknown	-	-	4	-	-	4
TOTAL		1	42	378	77	3	501

Table 6. Evidence of feeding by polar bears encountered during biopsy sampling, 2013

Class	Evidence of Feeding		Food Source (Known or suspected)			
	Yes	No	Marine Mammals	Fish	Berries	Unknown
COY	1	79	-	1	-	-
Yearling	4	37	1	-	-	3
2-Yr-Old	0	1	-	-	-	-
Sub-adult	14	105	7	3	-	4
Adult Female (with offspring)	10	70	6	1	-	3
Adult Female (alone)	6	52	2	1	-	3
Adult Male	12	89	5	-	-	7
TOTAL	47	433	21	6	0	20

Figure 1. Stratification of the study area

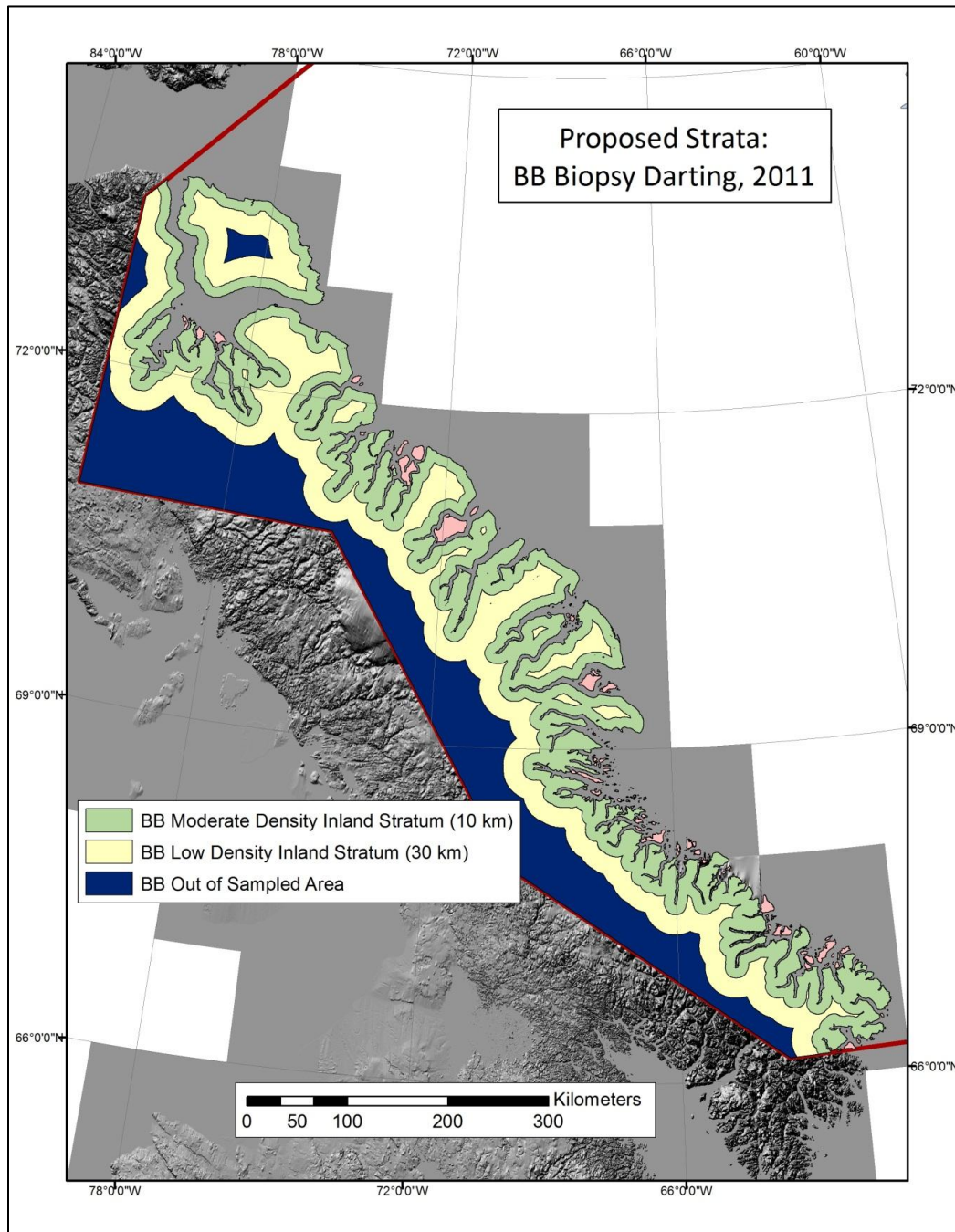


Figure 2. Timing of biopsy sampling along Baffin Bay during 2011, 2012 and 2013.

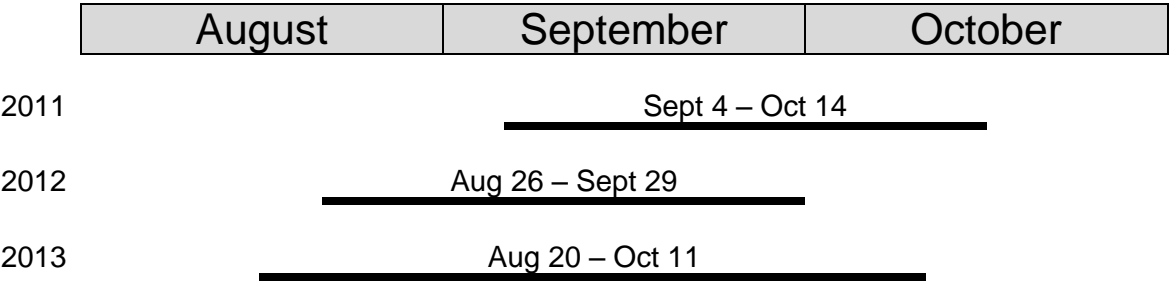
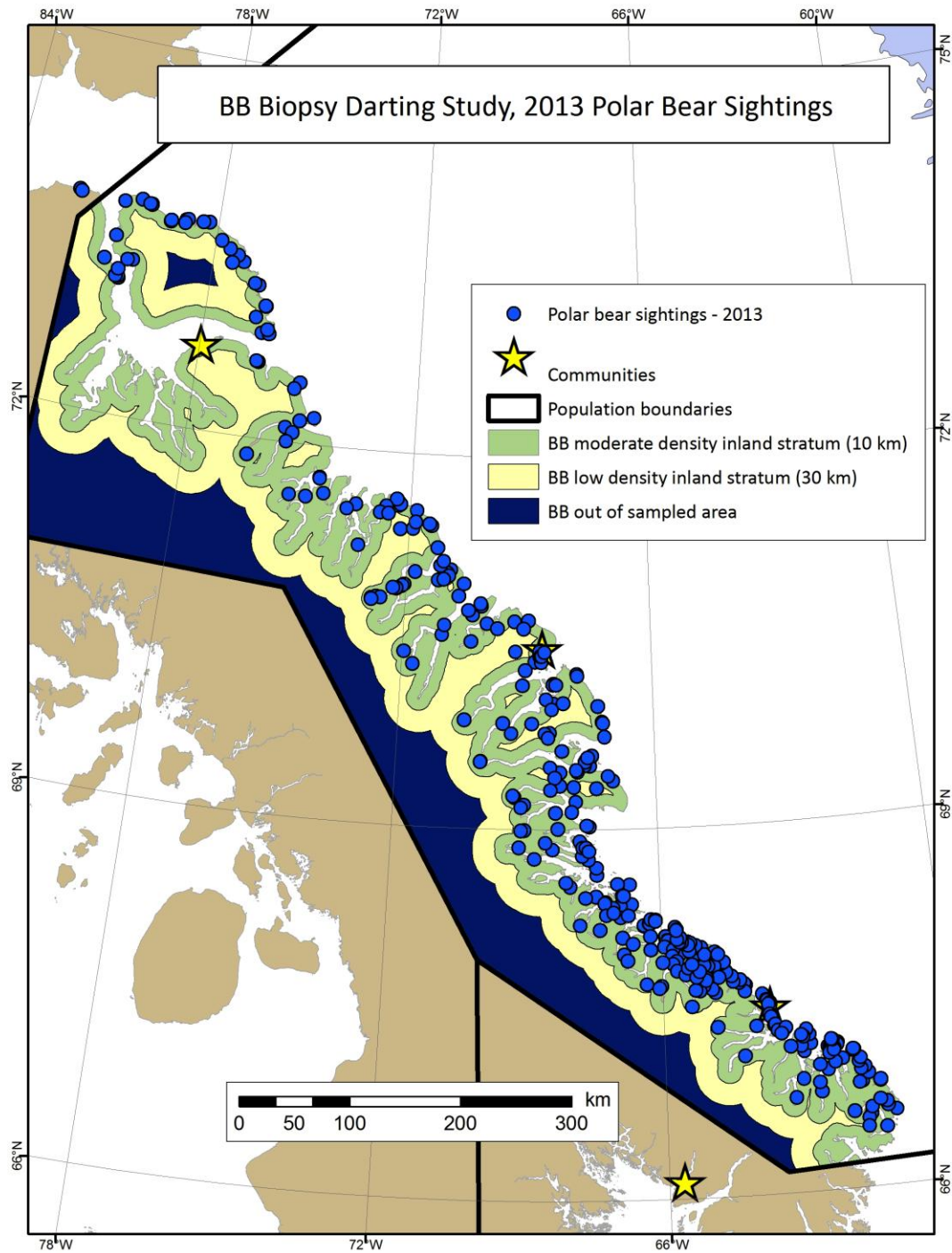
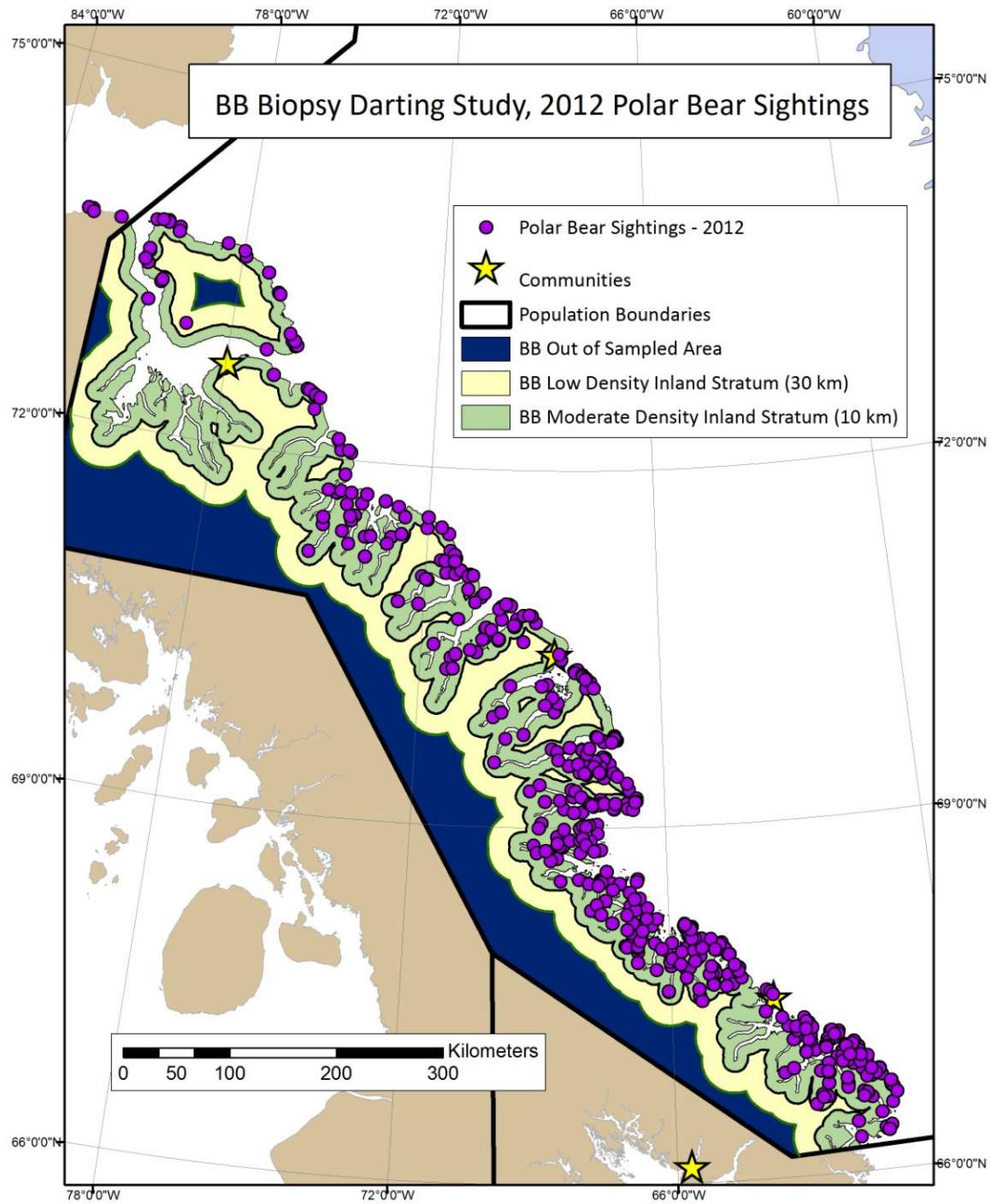


Figure 3. Distribution of polar bear encounters along Baffin Bay during biopsy darting activities in (a) 2013; (b) 2012; (c) 2011 and (d) capture operations, 1993-1997. Circles represent location of one or more polar bears.

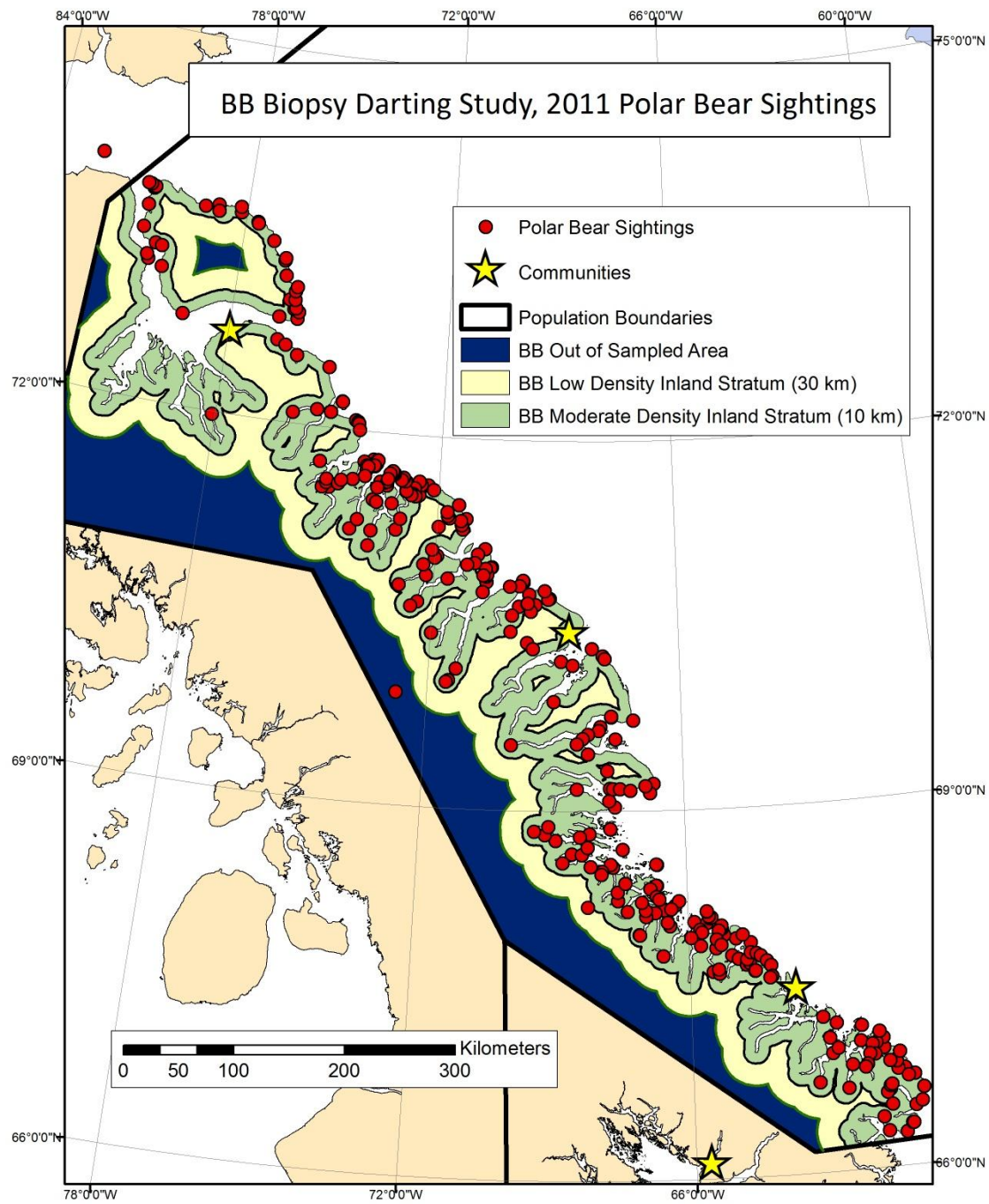
(a)



(b)



(c)



(d)

