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## **Polar Bears of western Hudson Bay: Survey extension investigation**

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### **Summary**

Coastal and some inland areas of the western Hudson Bay (WH) population were surveyed for polar bears (*Ursus maritimus*) by helicopter from Chesterfield Inlet, Nunavut to the Seal River, Manitoba. Twenty-five polar bears were sighted and captured. Of the 22 non-cubs captured, 10 were previously marked by Canadian Wildlife Service (CWS) or Manitoba Department of Conservation (MDOC). The proportion of marked individuals in our capture sample ( $p=0.46$ ,  $SE=0.11$ ) did not differ from the proportion of marked animals in the CWS capture sample ( $p=0.59$ ,  $SE=0.01$ ) or the [MDOC capture sample ( $p=0.59$ ,  $SE=0.01$ ) or the Nunavut harvest of CWS captured bears from 1984-2003 ( $p=0.48$ ,  $SE=0.11$ )]. All of the marked individuals that we recaptured were also

included in the CWS-MDOC mark-recapture analysis (Regehr *et al.* 2007), suggesting that the polar bears we encountered north of the Seal River are not a spatially distinct sub-group of the WH population during the time of year when most of the sampling reported in Regehr *et al.* (2007) occurred. There was no significant difference in latitude between marked and unmarked bears, rejecting the hypothesis that polar bears which summered north of the CWS study area in 2007 were less likely to be captured in the CWS-MDOC study.

We also examined the proportion of marked individuals by CWS in the harvest between 1984 and 2004 for the communities of Arviat, Whale Cove, Rankin Inlet, and Chesterfield Inlet. The harvest mainly occurs later (November-December) than when the CWS capture teams are active (August-September). The harvest data do not support the notion of an under-sampled component of the WH population summering north of the CWS study area.

The indication of WH polar bears located north of the CWS study area was confirmed. However, these bears did not appear to be distinct from polar bears summering in the CWS study area. The failure to sample the entire area may have introduced some unexplained capture heterogeneity that could have caused population numbers and survival rate to be under-estimated by Regehr *et al.* (2007). The degree of bias cannot be quantified. Because the bears in the unsearched area appear to be well mixed with those within the study area boundary, the degree of bias is probably minor. The actual WH population numbers and annual survival rates could be slightly higher than those estimated by Regehr *et al.* (2007), but even if this is true, our results still support the population decline and significantly reduced population productivity reported for WH polar bears (Regehr *et al.* 2007). We recommend that in future years, CWS capture teams work north to Arviat, Nunavut to capture polar bears in the entire area where polar bears summer.

## **Introduction**

Polar bear numbers (Regehr *et al.* 2007) and polar bear survival and body condition (Regehr *et al.* 2007, Stirling *et al.* 1999) have declined in the western Hudson Bay population (WH). Based on this information the Government of Nunavut Minister of the Department of Environment (DoE) asked the Nunavut Wildlife Management Board (NWMB) to consider a range of options to change harvest levels. The NWMB decision to reduce Nunavut total allowable harvest (TAH) from 56 to 38 in the 2007/2008 harvest year, and from 38 to 8 in 2008/2009 and subsequent years was accepted by the DoE.

Regehr *et al.* (2007) based their results on mark-recapture data collected mainly between the community of Churchill, Manitoba and the Nelson River to the south (Figure 1). The authors asserted that the results they developed from sampling their study area applied to the entire population, although the northern boundary of the population is Chesterfield Inlet more than 300 miles north of the community

of Churchill. Regehr *et al.* (2007) cite Derocher and Stirling (1990) and N.J. Lunn and I. Stirling, CWS (personal communication) as indicating that polar bears were “rarely seen along that (*Churchill to Chesterfield Inlet*) section of coast until freeze-up begins in late autumn”. This information was in conflict with Inuit knowledge from five hunters and elders indicating that polar bears were common north of Churchill, and could be found in both coastal and inland areas (Nunavut Tungavik Incorporated, 2007).

Inuit reports of a significant number of polar bears summering north of the CWS study area (Nunavut Tungavik, 2007; Dowsley and Taylor, 2006) raised questions about the validity of the study findings. Failure to sample the entire demographic unit can result in unaccounted for capture heterogeneity, which causes both survival and population numbers to be underestimated. Additionally, the failure to sample the entire summer retreat area left open the possibility that the decline identified by Regehr *et al.* (2007) was actually due to a permanent emigration of bears north out of the areas searched by capture teams.

The CWS researchers indicated that they had searched coastal areas north of Churchill in most years, however relatively little search effort was expended north of the Seal River, about 64 km north of Churchill. Our survey was undertaken to evaluate reports of WH polar bears located north of the Seal River.

### **Project Objectives**

- I. Survey the coastline and some inland areas for polar bears from the northern boundary of the WH population (Chesterfield Inlet) to approximate northern limit of search effort by CWS capture teams (Seal River).
- II. Immobilize and tag all polar bears seen according to standard protocols.
- III. In collaboration with CWS, to evaluate the predictions of Regehr *et al.* (2007) indications of a population decline

### **Materials and Methods**

Polar bear search and capture operations from Chesterfield Inlet to the Seal River occurred 01-05 September 2007, however most of the searching and all of the captures occurred between 02-04 September 2007. Independent capture operations were also conducted by CWS in the Churchill study area in September 2007. All polar bears seen were immobilized with a dart gun (Pneudart) from a Bell 206L helicopter. Zoletil (tiletamine hydrochloride and zolazepam hydrochloride) at 200mg/ml was administered at approximately 5mg/kg. Immobilized bears were measured (auxiliary girth, zygomatic width, total straight length), ear tagged, lip tattooed, and sampled (the tissue from the ear hole punch was taken for DNA analysis, a tooth was taken for aging, a claw tip was taken for stable isotope analysis, and a hair sample was collected for contaminant analysis). The sex, field age, body condition, and any physical abnormalities were recorded. Individuals were placed in a recovery position with

their eyes out of the sun and their abdomen downhill. All mark-recapture data collected during this survey were archived as part of the Canadian National Database for polar bears. This study had access to all previous capture records from the WH, including CWS captures made within the study area in summer 2007. This methodology was reviewed by Nunavut and Manitoba permit authorities, is consistent with the best practices of the federal/provincial polar bear technical committee, and is the only accepted scientific method for obtaining this information.

We compared the fraction of non-cubs marked in our survey sample to the fraction of non-cubs marked reported by Regehr *et al.* (2007). We compared the fraction marked in the Nunavut harvest of CWS bears to the fraction marked in the CWS-MDOC captures for the interval 1984 - 2004. We also compared the time (years) to last capture for the 2007 CWS non-cub captures to our survey non-cub captures.

Statistical analyses were conducted using SPSS software (SPSS 14.0 for Windows, SPSS Inc., Chicago, Ill., USA).

We used the demographic data from Regehr *et al.* (2007) and the WH harvest to simulate population trajectory from a starting population of  $741 \pm 53.5$  in 2007 (projected population estimate using RISKMAN PVA from  $935 \pm 35$  in 2004).

## Results

Coastal and some inland areas were surveyed by helicopter from Chesterfield Inlet to the Seal River (Figure 1). Twenty-five polar bears were sighted (Table 1) and captured. Two of these bears likely belonged to the Foxe Basin population, due to the significant geographic separation between these and the rest of the bears captured south of Arviat. Of the 22 non-cubs, 10 were previously marked during the CWS-MDOC study. The proportion of marked individuals in our capture sample was 0.46 (0.50, if the two bears near Foxe Basin are not included). These proportions did not differ from the annual proportion of marked animals in the CWS capture sample ( $p=0.59$ ,  $SE=0.01$ ) or the MDOC capture sample ( $p=0.59$ ,  $SE=0.01$ , in the Churchill area; Regehr *et al.* 2007) or the Nunavut harvest from 1984-2003 ( $p=0.55$ ,  $SE=0.02$ ). Our assessment of animals marked in the harvest from Nunavut WH communities from 1984 – 2004 is 0.48 ( $SE = 0.11$ ; extraction from Polar Bear National Database, November 2007), however this only includes harvests of CWS captured animals (not MDOC). All of the marked individuals that we recaptured were also included in the CWS mark-recapture analysis (Regehr *et al.* 2007), suggesting that the polar bears we encountered north of the Seal River are not a spatially distinct sub-group of the WH population during the time of year when most of the sampling reported in Regehr *et al.* (2007) occurred. There was no significant difference in latitude of capture locations between marked and unmarked bears, which rejected the

hypothesis that polar bears which summered north of the CWS study area were less likely to be captured.

The mean annual proportions of marked individuals in the harvested bears between 1984 and 2004 in the community clusters of: **Arviat+Whale Cove** and **Rankin Inlet+Baker Lake+Chesterfield Inlet** had relatively wide confidence intervals relative to the annual fraction marked in the Manitoba capture sample. The harvest mainly occurs later (November-December) than when the CWS capture teams are active (August-September). The proportion of all captures pooled from 1984 to 2004 (the duration of study of Regehr *et al.* 2007) that were marked by CWS (does not include MDOC- captures) was 0.48 (SE=0.113). The proportion of the harvest that was marked in the **Arviat+Whale Cove** cluster was 0.59 (SE=0.11), and the proportion marked in the **Rankin Inlet+Baker Lake+Chesterfield Inlet** cluster was 0.31 (SE=0.17).

The observed level of significance associated with an unequal sample t-test comparison of the time to last capture was  $p = 0.087$ . The mean time to last capture for the 2007 CWS non-cub captures ( $n = 42$ ) was 3.6 years (SE = 0.396), and the mean time to last capture for bears captured between Chesterfield Inlet and the Seal River ( $n = 10$ ) was 7.4 years (SE = 1.9).

## Discussion

Our survey did corroborate the Inuit observations that polar bears existed north of the CWS-MDOC study area, and were existed north of the Seal River which was the most northern area searched by CWS-MDOC capture teams.

Our examination of the harvest data from 1984 to 2004 does not support the suggestion of a substantive under-sampled component of the WH population summering north of the CWS study area. The proportion marked in the harvest sample from 1984 to 2004 does not support the hypothesis that there is a substantive un-sampled component of the WH population summering north of the CWS study area. Alternative explanations exist for the lower fraction marked in the **Rankin Inlet+Baker Lake+Chesterfield Inlet** cluster. The lower fraction marked in the northern harvest sample could have been due to overlap harvesting from the unmarked Foxe Basin population at the boundary between the two areas. Durner *et al.* (2004) show that captures in the vicinity of population boundaries are best viewed in a probability context rather than just assigned to one population or another. The Foxe Basin population is mostly unmarked. Most harvest sampling in WH occurs in late November and early December (Lee and Taylor, 1994) when WH polar bears migrate up the coast during freeze-up from the core summer retreat area near Churchill. Thus it would be expected that the proportion marked in the harvest would be similar to the proportion marked in the majority of the population, even if there were a distinct group of relatively un-sampled bears north of the Seal River. Taylor and Lee (1995) document limited exchange between WH and adjacent populations based on recapture and

recovery of marked animals. More recent analysis including harvest data until 2004 also confirms that there is limited exchange of bears within the Hudson Bay – Davis Strait – Foxe Basin group of polar bear populations (Figure 3).

The comparison most relevant to evaluation of the population decline demonstrated by Regehr *et al.* (2007) is the comparison between the proportion marked in their study and the proportion marked in our northern survey capture sample. The proportion marked in our northern survey (0.46 or 0.50) was numerically less than the proportion in the CWS capture sample (0.59) and the Manitoba Conservation capture sample (0.59), but the difference was not statistically significant. What is clear is that a relatively large fraction of the individuals encountered in the northern area survey were marked in the Churchill study area at some point in their lives, and that only 25 bears were encountered between the Seal River, Manitoba and Chesterfield Inlet. This suggests that a geographically distinct and numerically significant group of bears that were not excluded by Regehr *et al.* (2007).

The most likely explanation for the difference in the mean time to last capture for bears north of the Seal River vs. bears in the CWS-MDOC study area is heterogeneity in recapture probabilities associated with seasonal fidelity to local areas coupled with under-sampling of some areas. In other words, polar bears that tended to reside in summer retreat areas north of the Seal River would tend to be captured less frequently because CWS capture crews rarely searched these areas. This phenomenon must not be significant, as the proportion marked indicates that mixing is sufficient to suggest that the entire population was sampled during CWS efforts. However, a slight under-sampling may have occurred, and therefore we suggest that CWS-MDOC crews expand their survey in future years northward to Arviat, Nunavut (Figure 2).

The failure to sample the entire area may have introduced some unexplained (un-modeled) capture heterogeneity that could have caused population numbers and survival rate to be under-estimated by Regehr *et al.* (2007). The bears in the unsearched area appear to be well mixed with those within the study area boundary. Additionally, the mark-recapture data analyzed by Regehr *et al.* (2007) was long term (1984-2004) and a relatively large fraction of the population was marked. The actual WH population numbers and annual survival rates could be slightly higher than those estimated by Regehr *et al.* (2007), but the degree of bias in survival and population estimates is probably minor (Pollock *et al.* 1990, Pledger and Efford 1998). Our results are consistent with the population decline and significantly reduced population productivity reported for WH polar bears by Regehr *et al.* (2007).

### **Management Implications**

The recent decision to reduce the Nunavut TAH for WH polar bears from 57 to 38 in 2007/2008 and to 8 in 2008/2009 is an equitable division of removals based on

the long term removal average for Manitoba. In addition, an allocation of 8 would incorporate likely defense kills, which have averaged  $9.8 \pm 3.5$  in Nunavut WH communities over the last five years. However, population viability simulations (Figure 3), predict a likely decline even with no harvest. These declines are conservative as they use survival and recruitment rates fixed at 2004 rates, yet rates are likely to decline as the open-water season becomes longer (Stirling *et al.*, 1999)

The IPCC climate models predict that ice conditions in western Hudson Bay will continue to deteriorate (Parkinson 2000, Comiso 2003, Arctic Climate Impact Assessment 2004, Holland *et al.* 2006), however these models vary in their predictions of how fast this will occur (Serreze *et al.* 2007, DeWeaver 2007). Indeed, real-time ice metrics are outpacing the IPCC models, as synergistic and positive feedback mechanisms are often not modeled. The central result from Regehr *et al.* (2007) that the WH population has declined in both numbers and productivity is not in doubt.

A variety of management options can be identified for WH TAH. An option that is risk averse (no regular harvest) is rational given the uncertainties that exist in the relevant population data for WH polar bears and the concern that continued climate change may cause further reductions to population productivity.

## **Reporting to Communities**

This report will be summarized and translated for distribution to the WH Kivalliq communities and HTOs, and both intra-jurisdictional and inter-jurisdictional co-management partners. Two meetings involving the HTO representatives have been held in 2006 and there was an additional NWMB meeting in Arviat in April, 2007 where these issues were discussed.

This final report to the Nunavut Wildlife Management Board will be available from the Government of Nunavut archive in the shared conservation library.

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Table 1. Tabulation of the sex/age/and family status of polar bears captured between Chesterfield Inlet, Nunavut and Seal River, Manitoba from on 02-04 September 2007.

<b>Sex/Age/Family Status</b>	<b>Number</b>	<b>Frequency by Sex</b>	<b>Frequency by Number</b>
Female cubs of the year	3	0.27	0.12
Female yearlings	3	0.00	0.00
Female Subadults (2-5)	4	0.27	0.12
Female Adults w/1 COY	1	0.27	0.16
Female Adults w/2 COY	1	0.09	0.00
Female Adults w/1 Yrl.	0	0.09	0.40
Female Adults w/2 Yrl.	0	0.00	0.00
Total Females	11	1.00	0.44
Male cubs of the year	0	0.00	0.00
Male yearlings	0	0.00	0.00
Male Subadults (2-5)	5	0.36	0.20
Male Adults	9	0.64	0.36
Total Males	14	1.00	0.56
Total Captures	25		
Total Captures - COYs	22		
Total Marked Bears	10		
Frequency of marked	0.455	SE = 0.11	
# COY in 1 cub litters	1		
# COY in 2 cub litters	2		
# COYs	3		
# COY litters	2		
Mean COY litter size	1.5		
# Yrl. in 1 cub litters	0		
# Yrl. in 2 cub litters	0		
# Yrl.	0		
# Yrl litters	0		
Mean Yrl. litter size	0		

Table 2. Non-cub recaptures of marked polar bears in September 2007 by CWS and GN capture teams. CWS captures were in Churchill study area only. DoE captures were north of Seal River, Manitoba to Chesterfield Inlet, Nunavut. Bears that had not been captured until after the final year of the CWS mark-recapture study (*i.e.*, captured after 2004) were not included in the comparison of CWS and GN years to last handling for recaptures.

<b>Bear</b>	<b>September 2007 Handled By</b>	<b>Year Last Handled</b>	<b>Years to Last Handling</b>	<b>Comment</b>
X32480	CWS	2006	1	1st handling after M-R study
X33111	CWS	2006	1	1st handling after M-R study
X33112	CWS	2006	1	1st handling after M-R study
X17708	GN	1994	13	spring capture only
X10801	GN	1988	19	spring capture only
X19351	CWS	2001	6	spring capture only
X03393	CWS	2006	1	
X03419	CWS	2004	3	
X03437	GN	1994	13	
X03458	CWS	2003	4	
X09472	CWS	2004	3	
X10561	CWS	2002	5	
X11477	CWS	2005	2	
X11512	CWS	1999	8	
X11519	CWS	2002	5	
X12003	CWS	2002	5	
X12206	CWS	1998	9	
X12263	CWS	2003	4	
X12273	CWS	1997	10	
X12468	CWS	1999	8	
X12553	CWS	2006	1	
X12606	CWS	2006	1	
X12613	CWS	1997	10	
X12702	CWS	2003	4	
X12732	CWS	2005	2	
X12765	CWS	2005	2	
X12770	CWS	2005	2	
X17004	CWS	2003	4	
X17032	CWS	2005	2	
X17042	CWS	2006	1	
X17045	CWS	2006	1	
X17106	GN	1997	10	
X17123	CWS	2004	3	
X17132	CWS	2006	1	
X17208	GN	2002	5	
X17211	CWS	2004	3	
X17214	CWS	2004	3	
X17325	CWS	2003	4	
X17352	GN	2004	3	
X17370	CWS	2004	3	
X17437	CWS	2006	1	
X17794	CWS	1999	8	
X19212	CWS	2006	1	
X19279	CWS	2002	5	

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<b>Bear</b>	<b>September 2007 Handled By</b>	<b>Year Last Handled</b>	<b>Years to Last Handling</b>	<b>Comment</b>
X19300	GN	2000	7	
X19319	CWS	2003	4	
X19344	CWS	2006	1	
X19778	CWS	2003	4	
X19878	CWS	2005	2	
X32401	GN	2006	1	
X32412	CWS	2005	2	
X32413	CWS	2005	2	
X32415	CWS	2005	2	
X32422	GN	2006	1	
X32457	GN	2005	2	

Figure 1. The Western Hudson Bay polar bear population (WH) retreats onshore between the Manitoba-Ontario border in the south and Chesterfield Inlet, Nunavut to the north. A DoE polar bear capture crew searched from Chesterfield Inlet, Nunavut to the Seal River, Manitoba to determine polar bear use of the area north of the Churchill study area from September 03-05, 2007. The search path and capture sites are indicated.

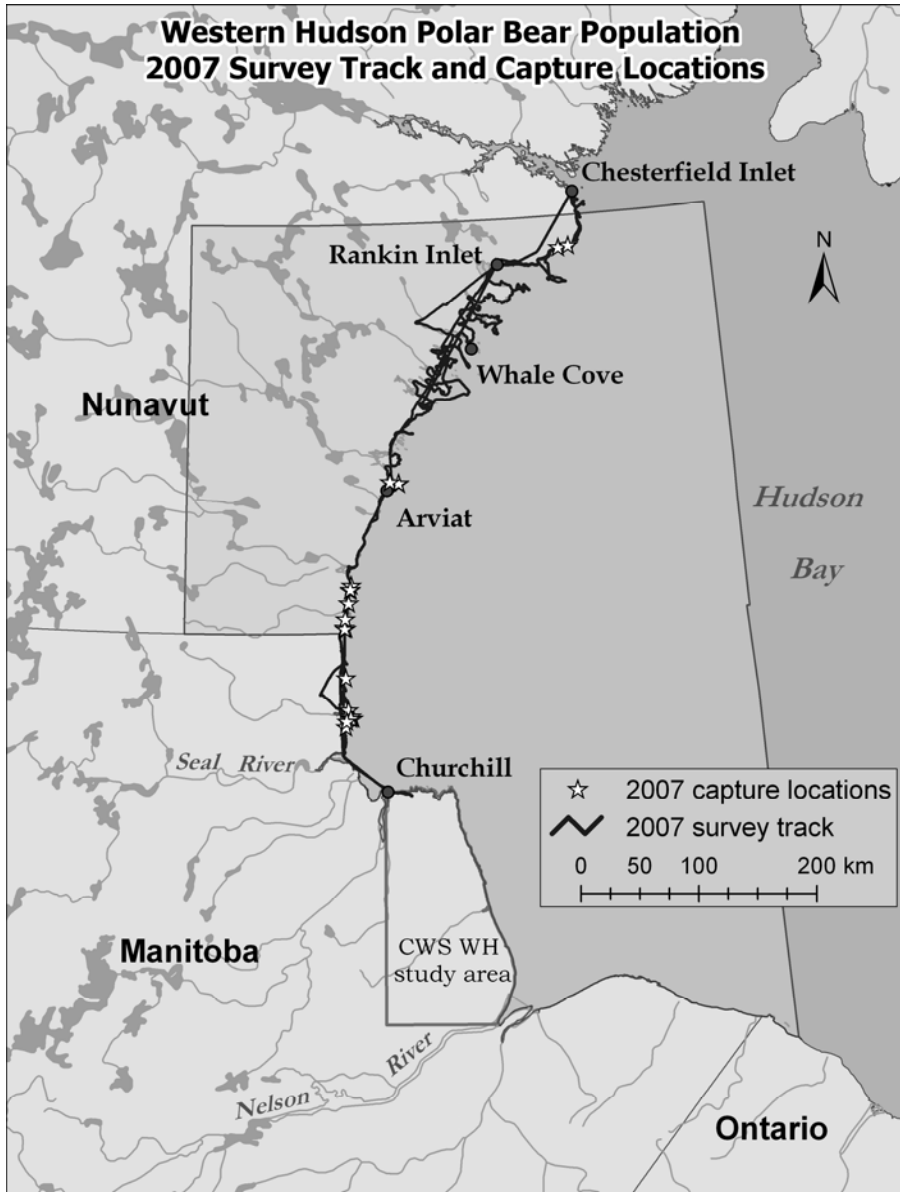


Figure 2. The proportion of marked bears in the Canadian Wildlife Service and Manitoba Department of Conservation capture sample from 1984 – 2003 (Regehr *et al.* 2007) and the proportion of marked bears (only by CWS) in the Nunavut harvest for two community clusters, and the entire western Hudson Bay Nunavut harvest from 1984 to 2004.

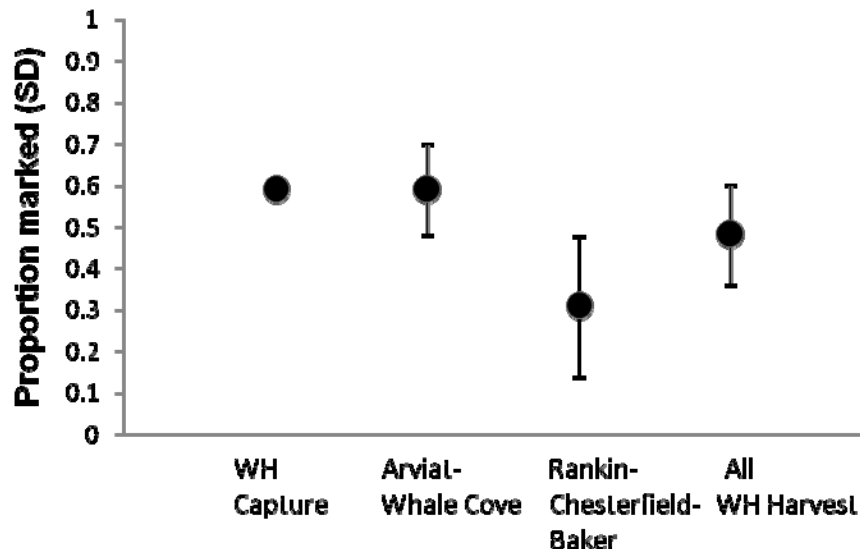


Figure 3. Harvest of marked polar bears in the Foxe Basin – Hudson Bay – Davis Strait cluster of populations (1984 – 2004).

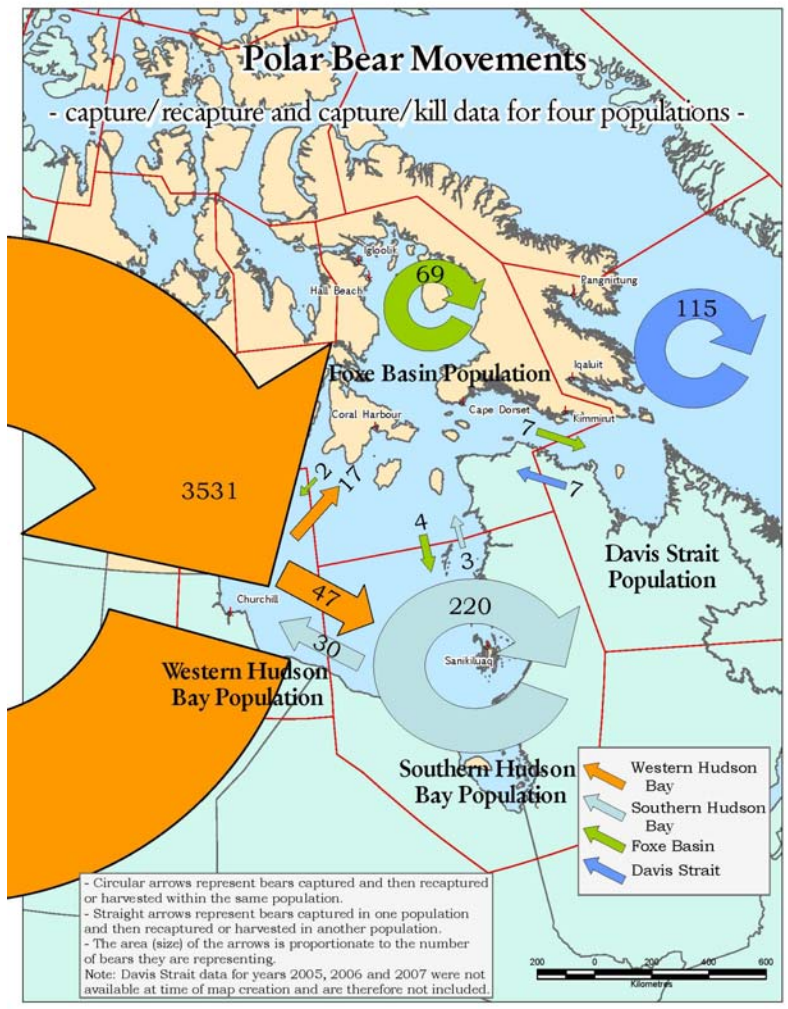


Figure 4. Population viability analysis (PVA, RISKMAN) projections of the western Hudson Bay polar bear population, based on survival rates in Regehr *et al.* 2007). Black squares represent no polar bear harvest in both Manitoba and Nunavut. Open circles represent a harvest of 16 bears annually (8 bears per year in Nunavut, and expected 8 defense-killed bears per year in Manitoba). Upper symbols of each pair of symbols represent survival rates based on CWS captured-bears, lower symbols of each pair represent survival rates based on both CWS and MDOC captured-bears (MDOC captured-bears have lower subadult and senescent bear survival rates).

