BAFFIN BAY POLAR BEAR AERIAL SURVEY, INTERIM REPORT TO NWRT

JANUARY 15TH 2011

NWRT Project Number:

Project Title: Baffin Bay Polar Bear Aerial Survey, 2010 - 2013

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SUMMARY

Recently, the Baffin Bay (BB) polar bear population has been the subject of intense debate amongst government agencies and Inuit. 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 population. In response to this uncertainty, several actions have been taken. Recognizing the need for a precautionary approach to harvest management, the NWMB recently decided to reduce the TAH for BB; phasing in the reduction over a period of 4 years (2010-2014). At the

same time, research has been initiated to gather new information on the size and status of BB. The results of this research will be used to reassess the status of BB and will support future decision-making by the NWMB with respect to the TAH.

New research on BB was initiated in 2010 as a two phase project, beginning with a pilot study to test the feasibility of a spring-time, on-ice aerial survey as an alternative to the mark-recapture method used in previous studies of BB. Based on the success of this pilot work, a full aerial survey in the spring of 2012 is proposed. In addition to a current abundance estimate, the study will yield polar bear demographic and distribution data as well as information on potential prey species. Methods developed in this study will be useful for non-invasive monitoring of other polar bear populations.

OBJECTIVES

In 2010, the Government of Nunavut and collaborators completed the pilot aerial survey (Objective 1) and remains on target to complete the remaining objectives (Obj. 2 – 7 listed below) during 2011 – 2013. Project objectives are to:

1) Conduct pilot research, using fixed-wing aircraft, to evaluate survey methods and the feasibility of a spring-time aerial survey in BB (2010).
2) Design and implement an aerial survey using a combination of fixed-wing aircraft and helicopter to reliably estimate the abundance, composition, and distribution of polar bears in BB during late spring.
3) Obtain a current, reliable estimate of the BB subpopulation size and compare with past estimates to assess population status.
4) Assess changes in BB demographic parameters including sex and age class composition and litter size over the last 2 decades.
5) Evaluate sex- and age class-specific polar bear distribution in BB with respect to environmental variables, particularly ice conditions and seal distribution.
6) Estimate the abundance and evaluate the distribution of ringed seals and other important polar bear prey species in BB.
7) Demonstrate the utility (strength/weaknesses) of aerial survey as a less invasive and potentially more rapid alternative to physical mark-recapture.

MATERIALS AND METHODS

Pilot research was completed in the southern region of Baffin Bay (BB), east and north of the community of Qikiqtarjuaq, Nunavut, using a Twin Otter to systematically survey sea-ice. Although planned transects were oriented in a general east-west direction to minimize poor light conditions for observers, orientation was adjusted according to weather conditions (Appendix 1.). Additionally, transect spacing was reduced on fast ice and near the floe edge to increase encounter rates. Sightings data were collected following both sight-resight (i.e., a double observer platform; Pollock and Kendall 1987) and distance sampling (Buckland et al. 2001) protocols. We maintained an airspeed of

~90 nm/hr and an altitude of ~500 ft (~152 m) during survey flights. We flew off-transect to investigate sightings and capture bears on film via the belly-mounted camera; for each observation, we documented litter and group size and estimated sex and age-class. An inclinometer (to measure sighting angles) and / or GPS were used to record locations and approximate perpendicular distances of bears from the aircraft. A camera system with an integrated GPS, mounted in the underside of the aircraft, was used to monitor the blind spot (termed g(0) in distance sampling) directly beneath the aircraft. We experimented with 2 lenses that captured ~420 and ~590 ft wide swaths beneath the Twin Otter.

PROJECT SCHEDULE

A revised project schedule is presented below. Due to logistical requirements and funding constraints, the full survey of Baffin Bay, originally scheduled for 2011, has been re-scheduled to 2012.

OUTPUT OR STEP	START DATE	END DATE	PERSON DAYS
Community consultations	February 2011	February 2011	10
Logistical preparations (e.g. fuel caching, cabin prep)	Spring 2011	Summer 2011	30
Comprehensive aerial survey	April 15, 2012	May 20, 2012	468 (incl. all observers)
Data analyses, preparation of reports and peer-reviewed publications, and community consultations	Summer 2012	Spring 2013	TBD

PRELIMINARY RESULTS & DISCUSSION

The pilot survey was conducted from 27 May to 4 June 2010 and involved approximately 35 hours of flying (excluding ferrying). We sighted a total of 45 bears, comprising 29 groups and including 12 females with their offspring, during roughly 4,800 km of survey flying (Figure 2, Table 1).

To evaluate bear distribution with respect to the floe edge, the Canadian Ice Service's eastern Arctic sea ice map from 31 May (updated weekly) was used to approximate ice conditions and landfast ice extent during the 27 May 27 to 4 June study period. These maps provide a broad representation and coarse resolution of weekly sea ice conditions, but are useful here to evaluate general bear distribution with respect to sea ice. Bear observations were concentrated and standardized encounter rates were greatest near the floe edge (i.e., within 10 km; Appendix 2). Mean distances from the floe edge for bears spotted on fast ice and pack ice were 8.0 km (n=12) and 14.4 km (n=17), respectively. Maximum observed bear distance from the floe edge was ~49 km, although we surveyed significant areas of drift ice > 50 km from the floe edge. Bears were sighted at distances >1.5 km from the survey transects, though most (62%) observations occurred within 600 meters of the aircraft.

Detection probabilities were modeled in program MARK with closed (sight-resight) population models. The model that best described our data treated capture probability as constant among observers, with an average observer detection probability of p = 0.50. This means that each observer had a 50% chance of seeing a bear on their side of the airplane (including all observations). Since two observers were present on each side of the aircraft, this means 75% of the available bears were observed. Incorporating distance from transect as a covariate yielded a strongly-supported detection function: detection decreased predictably with increasing distance from the aircraft (Appendix 2).

Together with additional analyses (Appendix 3), these results suggest that a springtime aerial survey is technically feasible. Therefore, in accordance with the project's objectives (2 – 7), a proposal for a full aerial survey has been submitted to the NWMB for funding under the NWRT.

SCHEDULE OF CONSULTATIONS

COMMUNTY/HTO	BEFORE	DURING	COMPLETION
Qikiqtarjuaq/Nativak HTO	Winter 2010/11, in-community	Spring 2012, correspondence	Winter 2012/13, in-community
Clyde River/Namautaq HTO	Winter 2010/11, in-community	Spring 2012, correspondence	Winter 2012/13, in-community
Pond Inlet/Mittimatalik HTO	Winter 2010/11, in-community	Spring 2012, correspondence	Winter 2012/13, in-community

REFERENCES

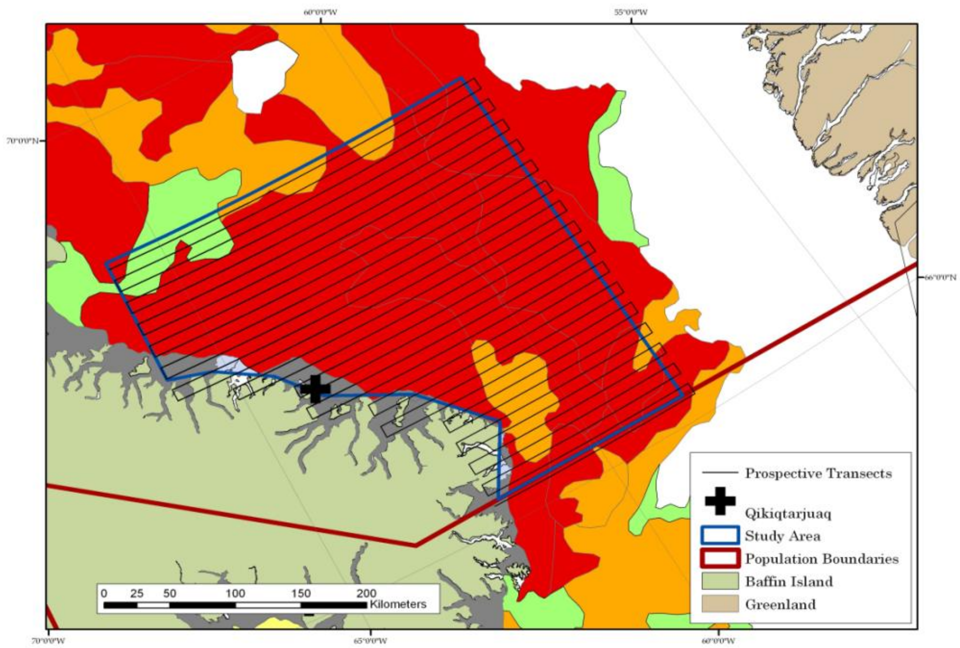
Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance sampling: Estimating abundance of biological populations. Oxford University Press, Oxford, UK. 432 pp.

Pollock, K. and W. Kendall. 1987. Visibility bias in aerial surveys: a review of estimation procedures. Journal of Wildlife Management 51:502-510.

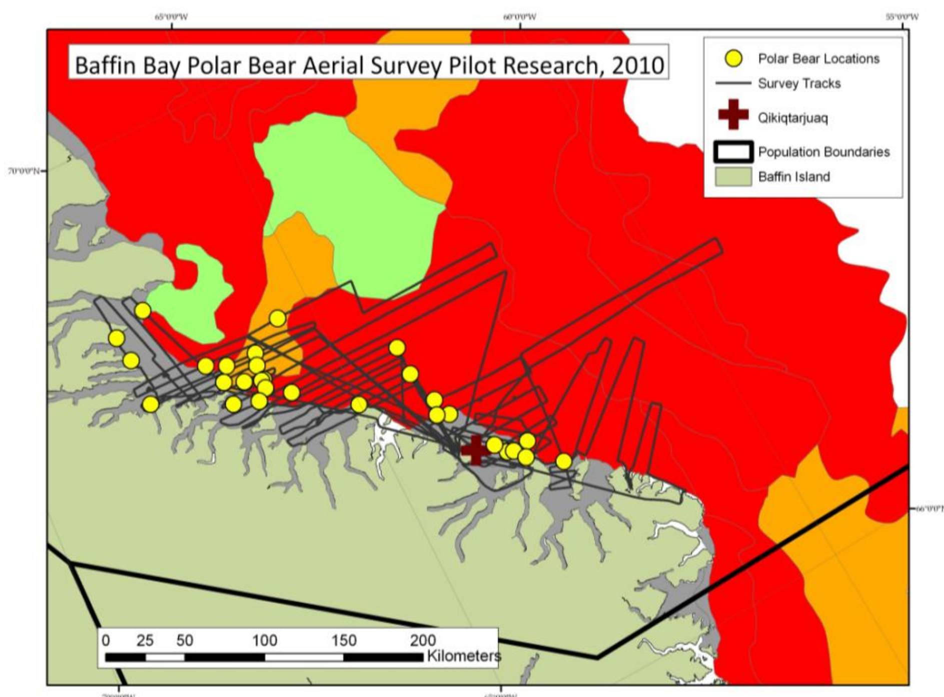
***Appendix 1.* BB Pilot Study Maps**

Figure 1.1. (a) Planned survey transects and (b) actual survey transects and polar bear sightings recorded during BB pilot study, May – June, 2010. Gray denotes landfast ice, red denotes drift ice concentration >90%, orange 60 – 80%, green 10 – 30%, white open water.

(*a)*



(b)



Appendix 2. BB Pilot Survey Results

Table 2.1 Observations and encounter rates recorded during the Baffin Bay pilot survey. Floe edge documented by the Canadian Ice Service sea ice map from May 31, 2010.

	Total groups (Individuals)	Females w/ Young	Survey Distance (km)	Encounter Rate: Groups / 1000 km
Fast Ice (>10 km from floe edge)	3 (4)	1	861	3.5
Offshore Drift Ice (> 10 km from floe edge)	8 (12)	2	2429	3.3
Floe Edge (within 10 km of either side of floe edge)	18 (29)	9	1511	11.9
Fast Ice Side of Floe Edge	9 (10)	1	780	11.5
Drift Ice Side of Floe Edge	9 (19)	8	731	12.3
Total	29 (45)	12	4801	6.0

*A bear spotted on a small island and a family group observed swimming were tallied in fast ice and drift ice habitats, respectively.

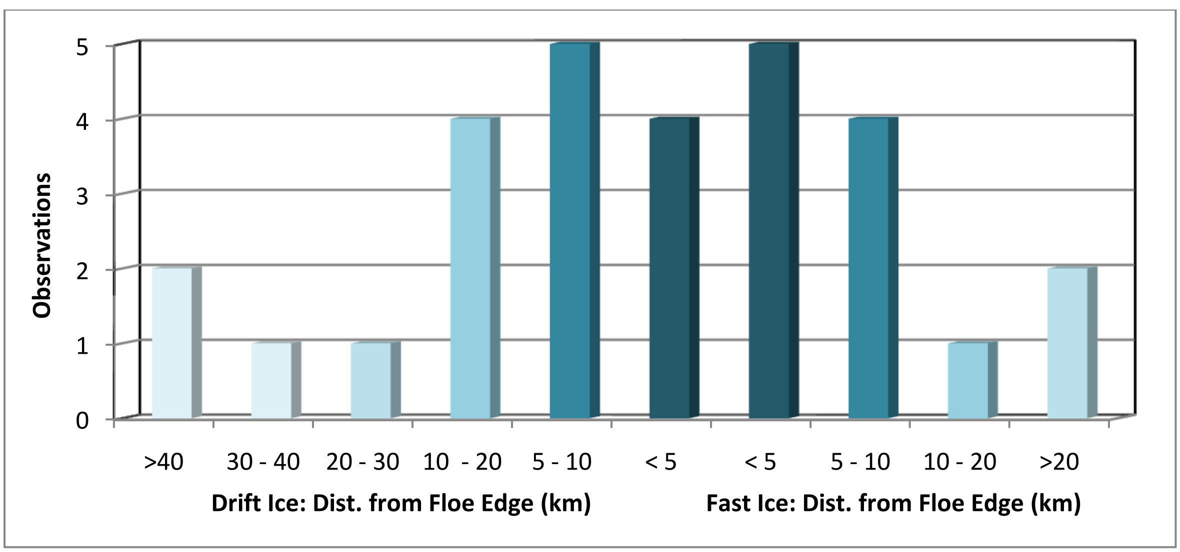


Figure 2.1. Distances of polar bear groups from the floe edge, as documented by the Canadian Ice Service sea ice map from May 31, 2010.

Figure 2.2 Individual detection probability from the 2010 BB pilot study modeled as a function of distance from transect.

Appendix 3 – Additional Aerial Survey Assessment

To more fully evaluate the technical feasibility and expected precision of a comprehensive BB aerial survey, we conducted multiple Monte Carlo simulations (n=100) with a closed population (i.e., sight-resight) model. The prospective BB study area was divided into 2 strata: 1) a fast ice and floe edge stratum, including all landfast ice and drift ice <10 km of the floe edge, to be completed by helicopter; and 2) an offshore drift ice stratum, including all drift ice >10 km from the floe edge, to be surveyed by Twin Otter. (Sight-resight surveys conducted in a sample of fjords were not included here but could serve as an 'add-in' to an aerial survey abundance estimate.) We note that the pilot data suggest that an additional 'very low density' stratum, encompassing drift ice roughly >50 km from the floe edge, may be useful in allocating sampling effort and improving precision. For the purposes here, we estimated the size of the fast ice and floe edge stratum as 1200 km long and 50 km in average width and the offshore drift ice stratum as 1150 km long and 300 km in average width (approximating an average amount of ice for the late May – June survey period).

We explored multiple aerial survey scenarios by altering a single model parameter at a time (i.e., a sensitivity analysis). Input parameters other than the variable of interest were held constant and were approximated, based on pilot data where possible, at: adult population size (number of groups) of 1200 (approximated from Canadian PBTC 2008 Status Table); effective half strip width of 1 km (approx. from pilot results); detection probabilities of 0.6 and 0.4 in the fast ice / floe edge and offshore drift ice strata, respectively (approx. from pilot results); 30 : 70 ratio of bears in the fast ice / floe edge : offshore drift ice strata (approx. from pilot results and strata size); and 5 : 15 km ratio of survey transect spacing in the fast ice / floe edge : offshore drift ice strata.

Simulation results are presented in Figure 3.1. With the fixed parameter values above (the baseline scenario), we anticipate a coefficient of variation (CV) for our abundance estimate of ~13.6%. Estimated precision improves with increasing population size and greater effective half strip width, and it varies according to presumed bear distribution among strata and allocation of sampling effort (Figures 3.1a – 3.1d).

Although a survey conducted in the early spring (i.e. April) would require flying greater distances over a larger ice sheet and therefore encountering lower densities of bears, we believe that detectability would be greater on less-fractured ice. We modeled this scenario by assuming that detection probability would increase from 0.4 to 0.5 in the drift ice stratum, and we increased stratum width to an average of 400 km. These simulations yielded a more precise result (Figure 3.2). Conversely, a survey during the late spring and early summer may reduce the study area size (average drift ice stratum width reduced to 250 km for simulations). However, the likely reduction in detectability due to more fractured drift ice (offshore drift ice: simulation detection reduced from 0.4 to 0.3) significantly inflated estimate variance and reduced expected precision (Figure 3.2).

If real detection probabilities are low and few bears are available for observation in aerial survey strips, our estimates of detection probability will be poor, leading to imprecise estimates of overall population size (Figure 3.3). (We acknowledge, however, that presumed differences in seasonal detection were based on our experiences and are guesstimates.) This information is helpful when considering allocation of sampling effort relative to bear densities and presumed distribution among strata. Notably, the simulation used here can incorporate a ‘sampling effort optimization’ function (see Figure 3.1c) for allocating effort among strata. If true detection probabilities are near 0.5, as suggested by our pilot data, then a sampling effort that is large enough to include approximately 150 bears would yield an estimate of detection probability CV of 10%. However, if detection probabilities are as low as 30%, as we believe they might be on highly fractured ice, similar survey effort would yield an estimate of detection probability that is only accurate to ± 20% CV (Fig. 3.3). If a larger proportion of BB bears occur on drift ice and their detection probability is low, it will be important to have adequate survey effort to allow accurate estimation of their detection probability.

Additionally, Buckland et al. (2001) present a distance sampling equation to calculate survey effort required to achieve a target precision level. Input parameters include the number of encounters recorded and distance traveled during the pilot survey. Here, we considered the strata outlined above and the ‘baseline’ scenario. Strata were evaluated independently, since Twin Otter and helicopter sighting platforms would presumably require the estimation of separate detection functions. After adjusting for relative flight speeds and distance traveled, the results of these calculations are relatively consistent with the results of the above aerial survey simulations, particularly for the offshore drift ice stratum (Table 3.1). However, the distance sampling predictions project poorer precision for the fast ice and floe edge stratum than the simulations (a difference of ~5%).

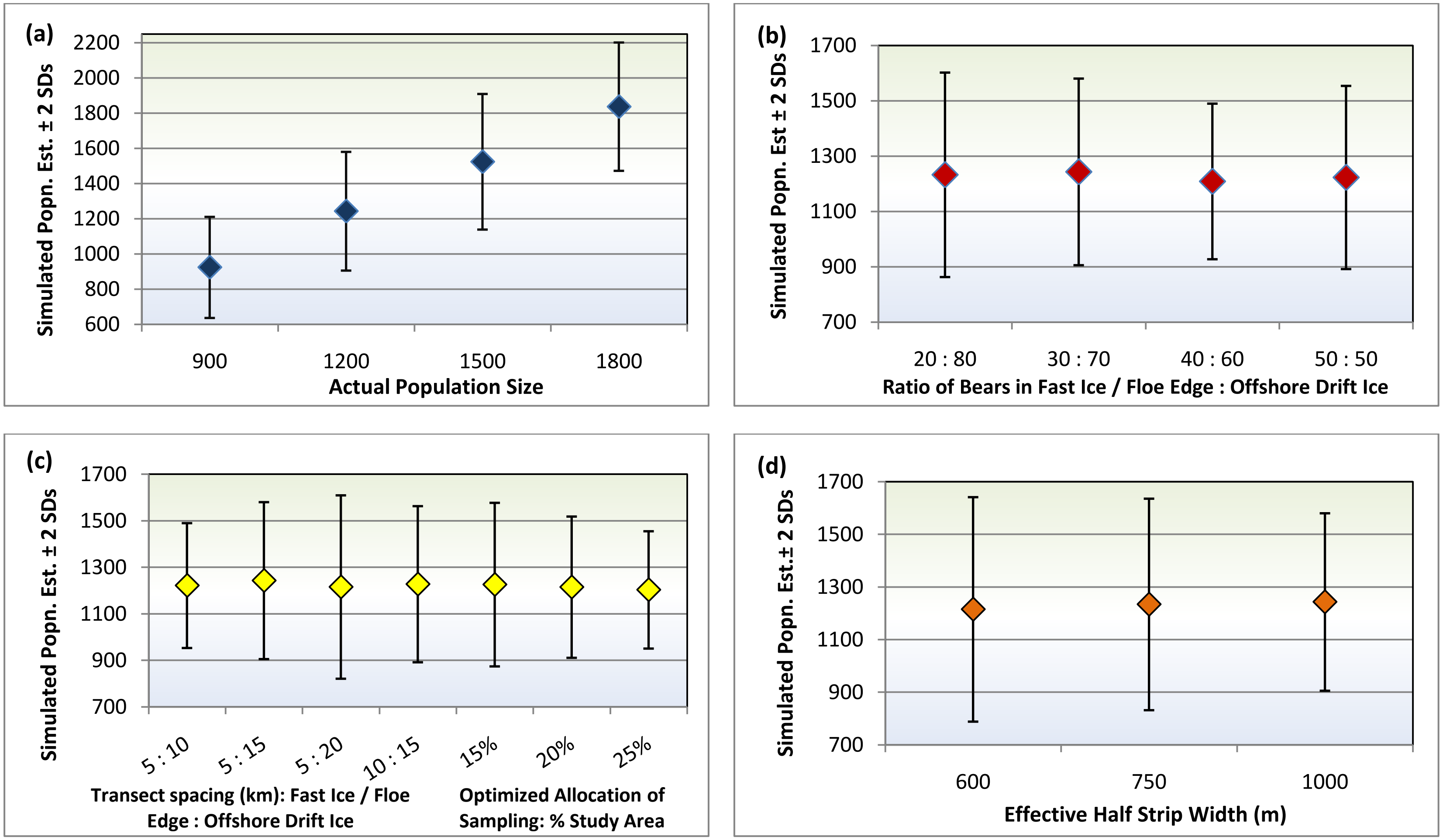


Figure 3.1. Results from Monte Carlo simulations examining potential outcomes of a Baffin Bay springtime aerial survey. Scenarios include variable (a) population sizes, (b) bear distribution among prospective strata, (c) sampling effort allocation, and (d) effective half strip width. Parameters other than the variable of interest were held constant at: population size of 1200; effective half strip width of 1 km; detection probabilities of 0.6 and 0.4 in the fast ice / floe edge and offshore drift ice strata, respectively; 30 : 70 ratio of bears in the fast ice / floe edge : offshore drift ice strata; and 5 : 15 km ratio of survey transect spacing in the fast ice / floe edge : offshore drift ice strata.

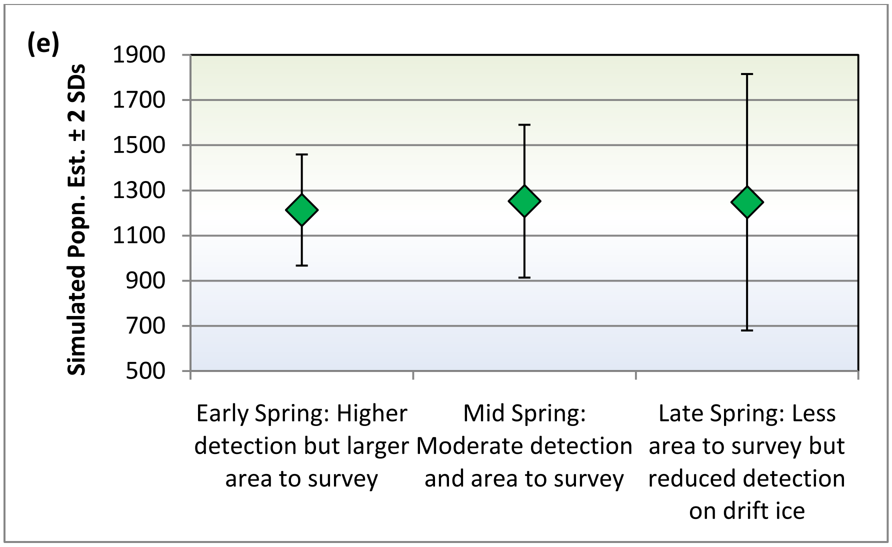


Figure 3.2. Results from Monte Carlo simulations examining potential outcomes of different Baffin Bay springtime aerial survey scenarios. For the early spring scenario, detection probability in the offshore, drift ice stratum was increased to 0.5 and average stratum width was increased to 400 km. For the late spring scenario, detection probability was decreased to 0.3 in the offshore, drift ice stratum, and the average stratum width was reduced to 250 km.

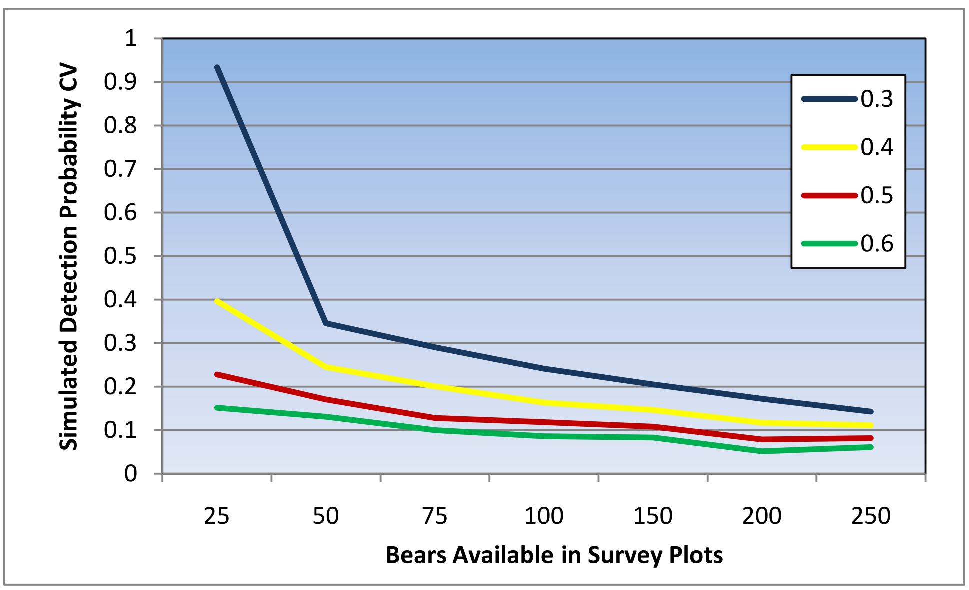


Figure 3.3. Simulated detection probability CVs relative to the total number of bears available for detection in all aerial survey strips.

Table 3.1. Approximate survey distances (km) and flight hours required to achieve target coefficients of variation with distance sampling, based on encounters and distances traveled during 2010 pilot research in Baffin Bay. Estimates based on Buckland et al (2001). Shaded cells indicate approximate survey hours required, by strata, to complete the aerial survey baseline scenario used in simulations. For comparison, the baseline scenario sight-resight simulations project a CV of 10 – 11% in the fast ice / floe edge stratum and ~19% in the offshore drift ice stratum.

	Target CV								
	0.10	**0.12**	**0.14**	**0.15**	**0.16**	**0.18**	**0.20**	**0.22**	**0.25**
Fast Ice / Floe Edge Stratum: All fast ice and drift ice within 10km of floe edge	33,885	23,532	17,289	15,060	13,237	10,459	8,471	7,001	5,421
Offshore Drift Ice Stratum: >10 km from floe edge	91,088	63,255	46,473	40,483	35,581	28,113	22,772	18,820	14,574
Helicopter hours[1]: Fast Ice / Floe Edge Stratum	261	181	133	116	102	80	65	54	42
Twin Otter hours[2]: Offshore Drift Ice Stratum	607	422	310	270	237	187	152	125	97

[1] Estimated survey speed of 130 km / hr, including flights off-transect to investigate sightings. Does not include ferries, positioning, etc.

[2] Estimated survey speed of 150 km / hr, including flights off-transect to investigate sightings. Does not include ferries, positioning, etc.