BEAUFORT REGIONAL ENVIRONMENTAL ASSESSMENT

Aerial Surveys for Polar Bears in Offshore Areas of the Northern Beaufort Sea

Canada

November 7, 2012

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photo credit: Steven Amstrup

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November 7, 2012

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Executive Summary

- Aerial line-transect surveys for polar bear were conducted in the Northern Beaufort Sea (Figure 1). A total of 7776 km was flown "on-transect" between 21 March and 30 March 2012 in a Turbo Commander fixed-wing aircraft containing 4 observers and 2 pilots. The aircraft operated out of Sachs Harbour for approximately one half of the survey, and Inuvik for the other half.
- A total of 4 polar bears (2 adult females and 2 yearlings) were sighted in two groups on the study area (Figure 1). Outside the study area, an additional 5 bears (2 adult females, 1 yearling, 2 cubs of the year) were sighted.
- Data from this study were not sufficient to estimate a sightability function using standard line transect methods, nor confidence intervals. Instead, the sightability estimated by Evans *et al.* (2003), after adjustment for differences in flight altitude, was used to inflate the number of observed bears into an abundance estimate. The effective strip width used in this study was 0.845 km.
- The number of bears on the study area during the latter weeks of March 2012 was estimated to be approximately 124, which equates to a density of 0.061 bears per 100 km^2. This density is substantially lower than that reported by Evans *et al.* (2003) in nearshore areas of the eastern Chuckchi and western Beaufort Sea (0.87 bears per 100 km^2).
- Many polar bear tracks were sighted during the surveys. In future, it may be advisable to implement a sampling mechanism which allows the aircraft to follow tracks until a bear is sighted or until a maximum distance from the transect line is reached.
- Procurement of aircraft fuel in Sachs Harbour was difficult during the survey and should be considered when planning future surveys. Procurement of fuel was not difficult in Inuvik.
- Many kilometers of transect were flown without polar bear observations. This fact made observing monotonous, which could have led to observer inattention. Future surveys should consider additional training for observers, or frequent crew changes.

1 Introduction

The Beaufort Regional Environmental Assessment (BREA) is a multi-stakeholder partnership led by Aboriginal Affairs and Northern Development Canada. The BREA is designed to simplify project-level environmental assessment and regulatory decision-making for oil and gas activities, while strengthening the relationship between environmental assessment and integrated planning and management in the region. The BREA also engages communities and advances their priorities for oil and gas preparedness.

The potential presence of polar bears in the deep waters of the offshore region of the Beaufort Sea has been a longstanding interest and concern of Inuvialuit communities. This concern has been elevated with the current interest in oil and gas development in the area. Estimates of bear density in the offshore

region of the Beaufort Sea will enable regulators to better understand potential effects of offshore oil and gas development activities on these marine mammals. At the same time, results from this study will help guide further studies into polar bear population structure in the Beaufort Sea, eventually leading to a longer-term understanding of bear biology that benefits all BREA stakeholders.

In winter 2012, the BREA approved support for a preliminary study to estimate the distribution and density of polar bears in a previously under-surveyed offshore area of the Beaufort Sea (Figure 1). This study entailed aerial surveys over multiple days along line-transects in the region and subsequent application of appropriate statistical estimation methods. This report describes the field methods, statistical methods, and estimation results for aerial surveys conducted during the latter weeks of March 2012.

2 Study Area and Transects

Prior to the survey, an explicit definition of the study area was necessary to both logistics planning and to illuminate the region to which inferences will be made. The desire of the study was to make inference to as much offshore area of the Beaufort Sea as efficiently possible given the logistical and time restrictions of the study's staff and aircraft. The stated desire of the BREA was to define the surveyed area based on incidental polar bear sightings by research and seismic vessels, the locations of past polar bear captures in the Beaufort Sea, the known locations of collared bears in the general region surrounding both offshore and inshore areas during March, the location of offshore oil and gas lease blocks, the historical distribution of ice in offshore areas during March over the last 3-4 decades, and maximum flight capability of 300 nautical miles of Sachs Harbour. After consultation with Aboriginal Affairs, biologists, and aircraft pilots, the study area (Figure 1, Offshore Stratum) was defined as being bounded on the east by the 2000 m depth contour (approximately), the 1000 m depth contour on the south (approximately), latitude 76′ N on the north, and the 300 nautical mile limit on the west. The nearshore stratum (Figure 1, Nearshore Stratum) was generally defined as regions between the study area and shore. The nearshore stratum was not surveyed systematically because interest lay in the offshore stratum.

3 Methods

3.1 Aerial surveys - A system of 24 randomly placed transects was defined on the study area (see Figure 1). Due to logistical constraints in Sachs Harbour related to fuel availability for the survey and other aircraft, half the transects ran east-west and were flown out of Sachs Harbour, while the other half ran north-south and were flown out of Inuvik. This system of transects was surveyed on eight of the nine days between 21 March 2012 and 29 March 2012 (no flight occurred on 25 March). Individual flights (delineated by colors in Figure 1) were 4.5 to 5 hours in duration. Each flight surveyed two transects. Two flights were completed on several days because it was possible to refuel and return to the area. Surveys were flown at an approximate air speed of 120 knots per hour and an average altitude of 233 meters (784 feet).

Aerial flights were conducted in a Gulfstream Turbo Commander (AC-690) (`http://www.aoc.noaa.gov/aircraft_turbo.htm`) aircraft containing 4 observers and 2 pilots. In the aircraft, two observers were placed in the front seat (behind pilots, one per side). The remaining two observers were placed in the rear seats (one per side). One observer on each side functioned as the data recorder, while the other observer was responsible for the global positioning system (GPS). Observers rotated positions in the aircraft daily to ensure differences in observation abilities were distributed across all positions in the aircraft.

Observers on the same side of the aircraft operated as a double-observer system. When a polar bear was sighted, the event was not immediately announced. Instead, the observer making the sighting waited an appropriate length of time ($\sim$ 5 seconds) to ensure that the other observer on the same side of the aircraft had adequate time to make the detection. To help ensure independence of the observers, a cardboard divider was erected in the aircraft that reduced visibility between observers. Immediately after a detection, the original observer measured the sighting angle from bear to horizon using an inclinometer. Once the detection was announced, the second observer also measured the sighting angle using a inclinometer. Position of the aircraft, side of aircraft, inclinometer measurements, and observer(s) making the detection were recorded.

Polar bear detections consisted of individuals or groups sighted while flying "on" a designated transect. Bears sighted while flying off–transect, including to and from the airport, were excluded from this initial analysis. When non-family groups were detected (e.g., mating pair, multiple adults near a seal kill), observers determined whether the bears were acting as a group or as independent individuals. If the bears were acting as a group, the sighting was considered one detection. If bears were acting as independent individuals, the sighting was considered multiple detections. Sightings of family groups (female and cubs or female and sub-adults) were considered one detection.

3.2 Analysis - Data collected during aerial surveys were designed to be analyzed using double–observer line transect methods (Buckland *et al.*, 2001, 2004). These double–observer line transect methods would have accounted for imperfect detection on or near the transect line, as well as declining probability of detection as a function of distance from the transect. However, the sightability function that is normally estimated during line transect analysis could not be estimated because an insufficient number of groups (i.e., 2) were detected on–transect. As a result, the sightability function and resultant effective strip width estimated by Evans *et al.* (2003) under similar conditions in the eastern Chuckchi and western Beaufort sea was assumed. The assumed effective strip width was then used to inflate the number of observed bears into abundance using standard line transect methods. Evans *et al.* (2003) estimated the effective strip width for polar bear on ice to be 0.330 km when surveyed at an altitude of 91 m (300 ft). This effective strip width was adjusted upward proportionally to $ESW = 0.845$ km to account for the fact that flights in this study were flown at an average altitude of 233 m (i.e., $0.33 \times 233/91 = 0.845$).

Had a sufficient number of bears been sighted, perpendicular distances from the transect would have been computed from height of the aircraft and the inclinometer readings. Assuming h was the aircraft's altitude at the time of the sighting (in meters), and θ was the average of the two measured angles below horizontal (degrees), the perpendicular off–transect distance (meters) would have been,

$$d = h \tan(90^\circ - \theta).$$

If a sufficient number of polar bear groups had been sighted, a suite of sightability functions (Buckland *et al.*, 2001) would have been fitted to the observed off–transect distances. Had this been possible, the *effective strip width* of the surveys could have been calculated and the density of bears (number per 100 square kilometers) would have been estimated as,

$$D = 100\frac{n}{2L(ESW)}, \tag{1}$$

where L was the total length of transect (kilometers) flown, n was the total number of bears observed, and ESW was the effective strip width calculated from the sightability function, i.e.,

$$ESW = \int_0^w g(x)dx,$$

where w was an assumed maximum sighting distance and $g(x)$ was the estimated sightability function (Buckland *et al.*, 2001). Abundance of bears in the study area would have been computed as,

$$N = (D/100) \times A, \tag{2}$$

where A is size of the study area in square kilometers. As stated before, the number of sightings was insufficient to estimate $g(x)$ and $ESW = 0.845$ was adopted from Evans *et al.* (2003). With the adopted ESW, D and N could be computed because all other variables were known (i.e,. n, L, and A).

Had a sufficient number of bears been sighted, confidence intervals for density and abundance would have been computed by bootstrap resampling transects (Manly, 1997). Transects and all data associated with them would have been randomly selected, with replacement, until the number of observed transects had been (randomly) chosen. Distance functions would have been re-fitted to data from the randomly chosen transects and densities re-estimated. From these, 95% bias-corrected (Manly, 1997) confidence intervals would have been computed.

4 Results

A total of 4 polar bears (2 adult females and 2 yearlings) were sighted in two groups on the study area. Outside the study area, an additional 5 bears (2 adult females, 1 yearling, 2 cubs of the year) were sighted. The locations of all sightings are shown in Figure 1.

Using Equations 1 and 2, and the assumed ESW derived from Evans *et al.* (2003), the estimated density of bears in the study area during the surveys was 0.061 bears per 100 km^2. Multiplying by size of the study area (204,364.864 km^2), the estimated number of bears in the study area during the surveys was 124.

5 Discussion

To assist planning for future surveys, participants and those involved in planning of the study were contacted after the field season to solicit comments and recommendations for the future. A common theme among those polled was admiration at the rapidity with which the surveys were planned and

executed. Weather during the 2012 survey period was uncharacteristically conducive to flying. Such nice stretches of weather can not be relied on in future. All participants acknowledged that basing the surveys out of Sachs Harbour imposed some logistical constraints. In particular, the availability of adequate quantities of aircraft fuel in Sachs Harbour should be checked and assured prior to future surveys. In addition, aircraft maintenance facilities are limited in Sachs Harbour. Assuming the logistical constraints can be overcome, all participants supported basing at least a portion of the overall survey effort in Sachs Harbour in order to adequately represent the northern portions of the study area. Finally, participants acknowledged that the flights were difficult for observers because many hours elapsed between bear sightings. Extra training, and frequent crew changes, will likely be necessary to assure observers remain vigilant throughout the survey.

Many sets of polar bear tracks were seen. Future surveys should consider allowing the aircraft to go off–transect when fresh tracks are sighted in an effort to find the bear. If allowed, it would be important for the aircraft to follow tracks both forward and backward until either the bear is sighted, the tracks disappear, or the aircraft crosses a neighboring transect line. Tracking the aircraft's location during track following would be important. This modification to the survey protocol would likely result in more bear observations. Analysis of such data would likely estimate the probability of including a bear as the probability of seeing a track times the length of the track's perpendicular projection onto the study's baseline. Similar methods have been used in Alaska to survey for moose and wolverine.

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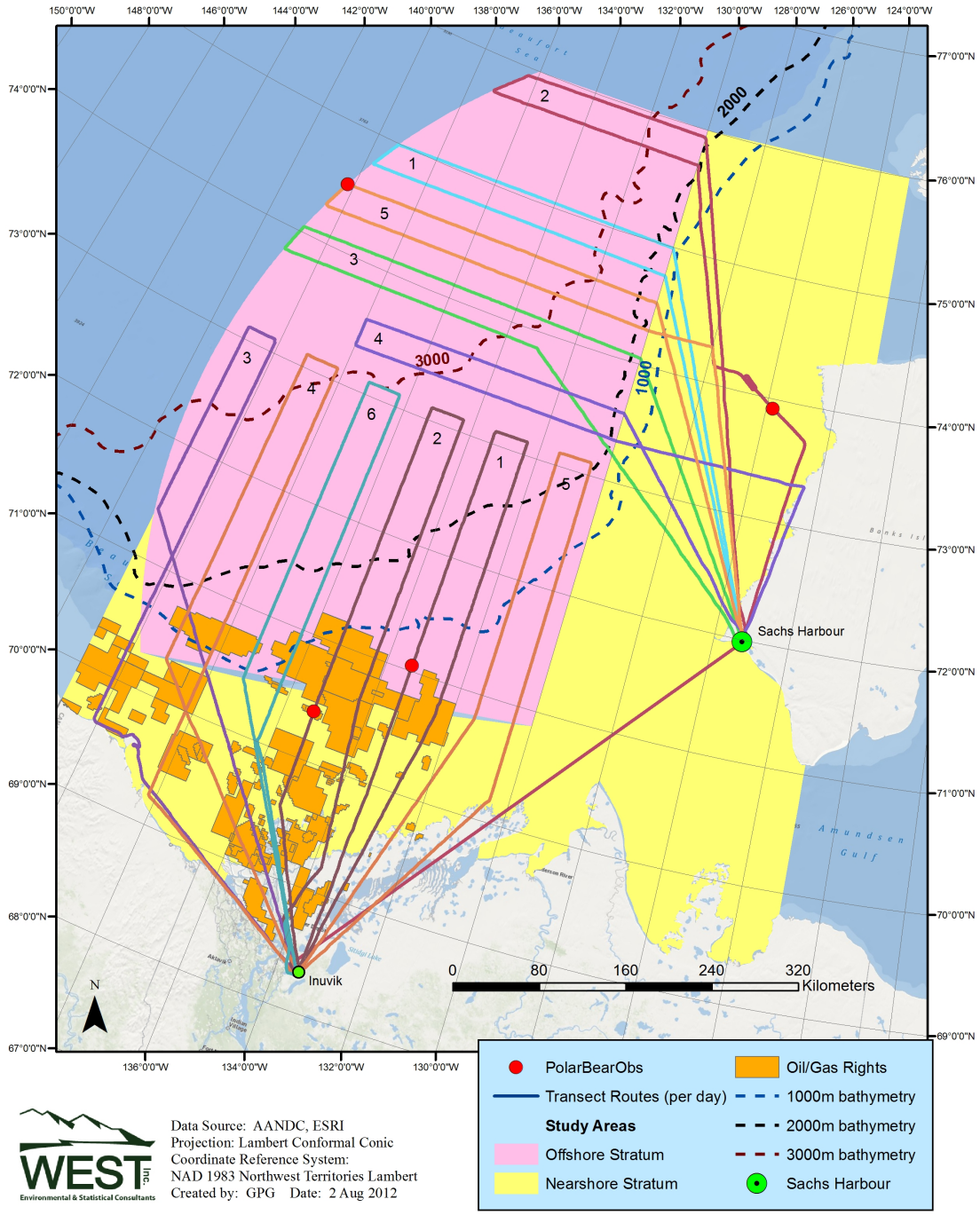

Figure 1: The Beaufort Sea offshore study area surveyed for polar bear (the "Offshore Stratum") was bounded approximately by the 2000 m depth contour on the east, the 1000 m depth contour on the south, a 300 nautical mile limit from Sachs Harbour on the west, and latitude 76′ N on the north. Size of the offshore stratum is 204,364.865 km^2. In total, 7776 km of randomly placed transects were flown in the study area during 21 March to 29 March 2012. Colors identify flights occurring on the same day.