Recent abundance of bowhead whales in Isabella Bay, Canada

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ABSTRACT

An aerial survey of the late-summer distribution of bowhead whales, *Balaena mysticetus*, in Isabella Bay, Nunavut, Canada, was conducted on 19 September 2009. A total of 28 sightings were obtained during 155km of survey effort and >90% of the sightings were detected by both platforms. Corrections were made for whales that were submerged during the passage of the survey plane, resulting in an abundance estimate of 1,105 bowhead whales (95% CI: 532–2,294). No cow-calf pairs were observed confirming earlier observations that east Baffin Island is primarily visited by subadult and adult whales.

KEYWORDS: BOWHEAD WHALE; ABUNDANCE ESTIMATE; SURVEY-AERIAL; BAFFIN BAY; ISABELLA BAY

INTRODUCTION

Isabella Bay, also known as Niginganiq in Canadian Inuktitut, is recognised as a late-summer habitat for the Canada-Greenland population of bowhead whales (*Balaena mysticetus*). Concentrations of whales in Isabella Bay in summer have been observed since the whaling period and it is believed that they feed intensively on copepods that are trapped in the offshore troughs of the area (Finley, 1990). On 28–29 September 1986, Finley (1990) photographed 107 different whales in the vicinity of Isabella Bay. Three whales were identified on photos from both days and the low number of recaptures suggested that the actual number of whales using Isabella Bay may be much larger. Zeh *et al.* (1993) revised the analysis using a mark-recapture method with photos taken from 1986 and 1987 resulting in a negatively biased estimate of ~214 whales in Isabella Bay. Dueck *et al.* (2008) surveyed the east coast of Baffin Island including Isabella Bay on 7 to 15 August 2003 and obtained five sightings of bowhead whales in Isabella Bay however abundance estimates were not generated specifically for Isabella Bay. Here we report on an aerial survey conducted in Isabella Bay on 19 September 2009 with the purpose of developing a fully corrected abundance estimate for the autumn aggregation of bowhead whales in Isabella Bay.

METHODS

Aerial survey

Six east-west going transect lines were surveyed in Isabella Bay, Baffin Island, on 19 September 2009 for detections of bowhead whales. A high-winged twin engine aircraft (*Twin Otter*) with long range fuel tank was used for the survey. Two double observation platforms were established separating the observers so they could not see or hear each other. Each observation platform was equipped with bubble windows allowing the observers to monitor the trackline below the aircraft. Declination angles to sightings were measured with a Suunto inclinometer and all observations were recorded together with GPS positions on a Redhen digital-video-recorder system (*redhensystems.com*).

Each line was placed 0.1 latitudinal degrees apart and therefore the northern and southern border of the stratum were assigned to 0.05 degrees from the most northern and southern lines, respectively. The western border followed the coast and the eastern border was the outline of the eastern end of the transects. The total search effort was 155km and the stratum area was calculated at 2,195km^2 (Fig. 1).

All four observers were dedicated to bowhead whale observations. Sightings were pooled from the right and left side of the plane and all sightings were used to produce a global detection function. An interruption on transect 7 caused the right side observers to only record one sighting although at least ten whales were detected. Therefore the effort on the right side was removed from the analysis and the effort (linear km) on transect 7 halved. The analysis included only sightings from the left platform.

The distances were calculated by multiplying the altitude by tangent to the declination angle measured with inclinometers when the sighting was abeam. Only sightings observed on transect lines were used to estimate the abundance and all analyses were made using the software program Distance 6.0 (Thomas *et al.*, 2010).

Availability correction factor

In April 2009, 11 bowhead whales were tagged with satellite-linked time-depth-recorders in Disko Bay, Greenland. They were tracked across Baffin Bay and four whales were present in Isabella Bay on 19 September, i.e. the time of this survey. Availability bias was corrected for by assuming that bowhead whales could be sighted to a maximum of 2m depth on the trackline. The proportion of time the whales spent at the surface (0–2m) could then be used to correct for availability at the surface using the formula

$$\hat{N}_c = \hat{N} \big/ \hat{\alpha} \qquad (1)$$

Where $\hat{\alpha}$ is the availability correction factor i.e. proportion of time an animal is potentially available at the surface to be seen by the observers. The coefficient of variation (*CV*)

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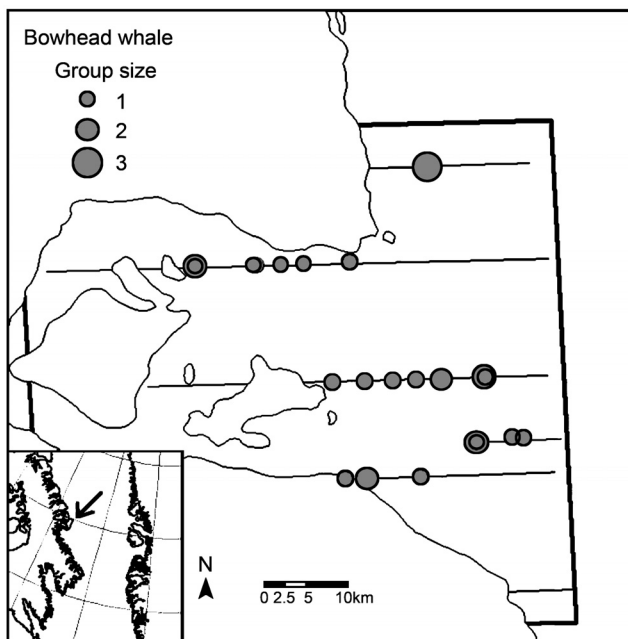
Fig. 1. Distribution of bowhead whales in Isabella Bay (69°34'N, 68°00'W) on 19 September 2009.

calculated as the standard error in proportion to the mean is then:

$$CV(\hat{N}_c) = \sqrt{CV(\hat{N})^2 + CV(\hat{\alpha})^2} \qquad (2)$$

The log-normal 95% confidence intervals were subsequently recalculated as:

Lower confidence interval limit = N/C

Upper confidence interval limit = $N*C$

Where $C =$

$$exp\left[z_\alpha * \sqrt{1 + \left\{ log_e(\frac{varN}{N^2}) \right\}} \right] \qquad (3)$$

RESULTS AND DISCUSSION

A total of 28 sightings of bowhead whales were obtained on effort during the survey. A truncation distance of 2,500m was chosen leaving 24 sightings for analysis and the model fit was consequently assessed based on the q-q plot and lowest AIC (Fig. 2, Tables 1 and 3). The largest contributor to the coefficient of variation was the encounter rate accounting for 75%, followed by the probability of detection (20%) and group size (5%).

Four whales were transmitting data ($n = 132$ 6hr periods) in September 2009 and the average time spent at the surface (0–2m) was 20% (CV 0.19) between 12:00 and 18:00 UTC, i.e. the time of the survey (Table 2). This surface time was used to estimate the abundance corrected for availability bias, i.e. the animals that were submerged during the passage of the survey plane (Table 3). No corrections were applied for sightings missed by the observers since >90% of sightings were detected by both observers and correction for perception bias would only inflate the variance estimates. Both density of sightings and time between sightings was short and so time spent searching for whales ahead of the plane was minimal. Therefore the average observation time

(i.e. the difference between first observation and time when the whales are passing abeam) was considered an instantaneous process and no corrections for search time was applied. The total estimated abundance was then 1,105 animals (CV 0.39, 95% CI: 532–2,294).

This survey confirms that Isabella Bay is an important late-summer concentration ground for bowhead whales in the eastern Arctic (Finley, 1990; Zeh *et al.*, 1993). Aerial surveys on the west coast of Baffin Island, in late-summer 2002 in Prince Regent Inlet and 2003 in Foxe Basin, produced an abundance estimate of 6,344 bowhead whales (95% CI 3,119–12,906) and of 1,525 bowhead whales (95% CI 333–6,990), respectively (IWC, 2008). The survey presented here confirms that there are substantial numbers of bowhead whales on the east coast of Baffin Island in late-summer at the same time as large numbers are found on the west coast of Baffin Island.

A survey in West Greenland in April 2006 produced an abundance of 1,229 bowhead whales (95% CI 495–2,939) in the area around Disko Bay and this abundance is in the same magnitude as estimated for Isabella Bay (Heide-Jørgensen *et al.*, 2007). Satellite tracking of bowhead whales from Disko Bay in West Greenland in 2009 has shown that 7 out of 11 whales moved to Isabella Bay during summer (Greenland Institute of Natural Resources). This indicates that a large proportion of the bowhead whales found in West Greenland in winter move to Isabella Bay during summer

Table 1

Sightings of bowhead whales and estimated group size E(s) with coefficient of variation in brackets.

Transects	Length (km)	No. of sightings	E(s)
1	19.57	1	
2	56.03	7	
3	41.19	10	
4	24.25	4	
5	8.35	0	
7	5.17	6	
Grand total	**154,6**	**28**	**1.35 (7.7)**

Table 2

Mean surfacing time (0–2m depth) for four bowhead whales in the Canadian Eastern Arctic in September 2009. *n* represents the number of 6hr periods that were sampled.

Whale ID/ UTC	00:00– 06:00	06:00– 12:00	12:00– 18:00	18:00– 24:00	**Grand total**
7927 ($n = 11$)	0.22	0.17	0.19	0.17	**0.19**
20169 ($n = 117$)	0.23	0.27	0.27	0.19	**0.24**
20689 ($n = 2$)	–	–	–	0.24	**0.24**
21802 ($n = 2$)	–	–	0.14	0.13	**0.14**
Grand total	**0.23**	**0.22**	**0.20**	**0.18**	**0.20**

Table 3

Density and relative abundance of bowhead whales (CV: coefficient of variation, CI: confidence interval).

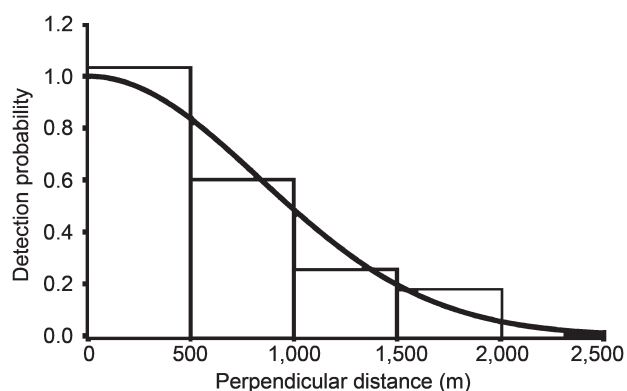| Abundance	Estimate	% CV	95% CI low	95% CI high
Density	0.1	33.6	0.05	2.21
Abundance	221	33.6	105	464
Abundance$_{Corrected}$	1,105	38.6	532	2,294

Fig. 2. Probability of detection, half normal key, for bowhead whales sightings.

and stay there during late-summer (Heide-Jørgensen *et al.*, 2010).

None of the sightings during this survey contained cow-calf pairs or very young (short) bowhead whales. In fall 1976 and 1978 Davis and Koski (1980) conducted aerial surveys of Lancaster Sound and the northeast coast of Baffin Island and found few calves (<3%, *n* = 46). In September 1986 bowhead whales were measured on aerial photographs taken in Isabella Bay (Finley, 1990). Mean length of *n* = 83 whales was 14.4m and only one cow-calf (6m) pair and one sub-adult whale (<10m) were detected. Land-based observations in Isabella Bay during 1984–88 also confirmed that mother-calf pairs and sub-adults were rarely seen (Finley, 1990). A similar low number of cow-calf pairs have been seen in West Greenland (Heide-Jørgensen *et al.*, 2010; Heide-Jørgensen *et al.*, 2006) and this survey confirms that neither the east nor the west side of Baffin Bay are calf-rearing areas.

ACKNOWLEDGEMENTS

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