Preliminary Report of the Spring 2009 Ice-Based Bowhead Whale Census Activities Near Barrow, Alaska

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ABSTRACT
An ice-based survey of bowhead whales was attempted near Barrow Alaska in spring 2009 with the primary objective of obtaining data for estimating detection probabilities and secondarily to obtain an abundance estimate. Four acoustic ("Popup") recorders were successfully deployed in the lead early in the season. Visual watch began on 11 April and continued until 18 May. A total of 429 'new' (not seen before) and 115 'conditional' (possibly seen before) bowheads was seen in 201.0 hours of watch effort from the primary perch. The 2009 survey was hampered by some of the poorest environmental conditions in the 30-year history of the survey; hence, insufficient data were gathered to estimate detection probabilities or an abundance estimate. However, new techniques proved successful by greatly reducing survey logistics (i.e., 'commute watches' and acoustic recorders), which will likely be the standard for future surveys. In 2010, another attempt will be made to estimate bowhead whale abundance using either ice-based methods, photo capture-recapture methods, or both.

INTRODUCTION

Ice-based visual counts to estimate the abundance of the Bering-Chukchi-Beaufort Seas (BCBS) stock of bowhead whales, *Balaena mysticetus,* have been conducted off Point Barrow since the late 1970s. The 2009 survey marks the 19th survey attempt since 1977 when rigorous efforts to estimate population size started.

Whales are counted as they migrate from the Bering to the Beaufort Sea (Braham *et al.*, 1984; Krogman *et al.*, 1989; George *et al.*, 1995). The survey requires maintaining a watch for about six weeks during the migration (~15 April to 1 June). Like other high-latitude cetacean surveys, the ice-based census is very sensitive to environmental conditions and has failed in about half the attempts since its inception.

Simultaneous acoustic surveillance was added to the census in the early-1980s and was maintained via a series of hydrophones set along the lead edge. These data were used to estimate the location of a calling whale by measuring time delays for the arrival of the same call at each hydrophone and calculating intersecting vectors (Clark and Ellison 2000). Visual and acoustic data are currently used in combination to estimate abundance (Zeh and Punt 2005; George *et al*., 2004).

Another technique available to estimate population abundance is the aerial photo capture-recapture (CR) approach (da Silva et al., 2000; Koski et al., In press) used in the 1985-6 and 2003-4 seasons. An advantage of the C-R approach is that it requires fewer personnel than the ice-based census but generally produces higher CVs and requires flying low over the leads and sea ice (which is risky).

Estimating "detection probabilities" of migrating whales is a critical aspect of any survey. In past years, this was conducted using a "single-blind" two-perch design whereby the primary perch would radio sightings to observers on a second perch (Krogman et al. 1989). Observers on the northern perch scored which whales were seen by both perches and which were missed. Counts from the primary census perch (South Perch) are corrected for whales missed during watch by dividing them by the probability p of seeing a whale (detection probability). The probability ($q = 1 - p$) of missing a whale during watch was estimated as a function of visibility, number of observers and distance of the whale offshore using a generalized linear model (George *et al.,* 2004).

Rugh *et al.* (2008) used an independent observer (IO) design to estimate differences in pod size estimates and other correction factors for eastern gray whales counted during surveys at Granite Canyon, CA. In this approach, whale linkages are determined post-season using a mathematical algorithm. Their approach appears to be a more robust method than the single-blind method for estimating p particularly because it is functional at high (> 10 whales/hr) passage rates – which the single-blind method is not. Hence we applied a fully independent observer technique to estimating p and q for bowheads in 2009.

Some significant adjustments were made to the 2009 ice-based survey in an attempt to simplify the survey logistics, improve safety and reduce costs. These were: a) to conduct 16 hr of watch rather than 24 hr as in past years, b) deploy acoustic recorders in the lead rather than maintain a 3 to 5-hydrophone array at the lead edge (as in past seasons) and, c) "commute" to watch on snow machines rather than camp on the sea ice.

The objectives for the 2009 ice-based survey were to: 1) conduct an independent observer (IO) 'experiment' to estimate detection probabilities, 2) test and deploy an array of Popup acoustic recorders in the leads offshore of the perch, 3) estimate population size using 16 hr of watch/day, 4) and train observers for a "full survey" in 2010 (since the last survey was conducted in 2001.)

METHODS

Ice-based census methods have been described in detail in several papers (Krogman *et al*., 1989; Zeh *et al*., 1993; George *et al*., 1995; George *et al.*, 2004). As much as possible, we attempted to conduct the census in a manner consistent with past seasons. This included an intensive training session at the start of the census.

Visual counts are made from the top of high ice ridges (perches) located as near to the lead edge as possible (Figure 1). We attempted to maintain *three* observers on the perch 16 hours a day as daylight allowed. As in past years, one observer operated a theodolite (used for obtaining locations of whales that are seen), another recorded the data, and all three watched for whales.

Shore-based survey experts Bruce Krogman and David Rugh assisted in the field with the design and implementation of the IO experiment. Simultaneous independent observations were conducted from two observation perches constructed about 15 m apart on the same pressure ridge overlooking the lead. A canvas tarp was used as a wind break and visual barrier; an AM radio provided some acoustic isolation between the perches. Watches were started at the same time and verbal communications ceased during IO periods. Theodolites were zeroed on magnetic north. Time was standardized using GPS. Simultaneous shots on the same ice floe were conducted periodically through each watch to calibrate positions from the two perches.

In 2009, rather than maintain a series of hydrophones along the lead edge as in past years, acoustic recorders called "Popups" were deployed (Chris Clark, pers. comm., Cornell University). The units were designed to record for about 90 days and then acoustically released and recovered to download the data.

RESULTS AND DISCUSSION

Four Popup acoustic recorders were deployed on 7 April using a helicopter. Personnel were dropped off on a refrozen lead where they cut holes in the young ice and deployed the recorders using 60 kg gravel bags as ballast. This deployment technique proved to be quite efficient and effective.

A perch was established on a large (12.2 m high) grounded pressure ridge west of Point Barrow in early April (Figure 1). Visual observations began on 11 April and ended 18 May. A total of 429 'new' (not seen before) and 115 'conditional' (possibly seen before) bowheads was seen in 201.0 hours of watch effort at the primary perch (Ivuniq Perch North; Figure 2 and 3). On 15 April, a surprisingly large number of whales (47) were seen in ~10 hrs of watch. This is the highest number (and rate) ever recorded for 15 April - possibly indicating an early migration. Lead conditions and visibility was satisfactory until about 27 April when strong south and west winds forced an emergency evacuation and began closing leads over most of the next 3 weeks.

Independent (simultaneous) observations totaled 44.7 hours of watch from Ivuniq north and a second perch (Ivuniq south) from 25 April to 16 May. A total of 36 new and 6 conditionals whales was seen. Unfortunately, most of the observations were made under poor visibility conditions due to fog and/or clogged leads. When the visibility was scored as 'Fair' or better, very few whales were seen. We speculate this is because whales were mainly using offshore leads due to the predominately closed shore-leads. The general sense of the observers and visiting experts (Rugh and Krogman) was that the isolation between the two perches was good, with the exception that at times observers could hear one another between perches.

A large proportion of the 2009 season was hampered by poor visibility and closed leads making 2009 one of the 'poorest' seasons in the 30 year history of the census (and a very poor year for whale hunting as well). Leads were essentially closed from 1-10 May which is typically the period with the highest whale passage rates (Figure 4). While 429 whale sightings were made from the primary perch, this is a relatively low tally for an ice-based bowhead census. For instance, during the last successful census in 2001 a total of 3,295 new and 532 conditional whales was seen in 1,130 hours of watch effort.

The census was terminated on 18 May when it became clear that: a) insufficient data were gathered to make an estimate, b) most of the whales had likely already migrated past Barrow making simultaneous observations less productive, and c) the long-term forecast for favorable (easterly) winds that would open the leads was unlikely. About 46% of watch periods were scored as fair or better visibility; however, if the ~10 days of closed leads are added then the percent usable watch is substantially less.

Although poor environmental conditions precluded making an estimate in 2009, the logistical adjustments we made were quite encouraging and will likely change how ice-based surveys are done in the future. Specifically: a) the ‘commute watch’ was quite efficient and considerably reduced overall logistics by *not* camping, b) deploying the acoustic recorders reduced the crew by about half (8 people), and c) the overall exposure to hazards (mainly polar bears and ice failure) was reduced relative to past years by not camping. (For background, deploying and maintaining an ice-edge hydrophone array has historically been one of the biggest challenges of conducting the ice-based count and necessitated camping in order to be near the array.

In 2010 we plan to conduct another bowhead abundance survey at Barrow. Depending on funding and scientific advice (from the IWC SC and others), we will conduct an ice-based visual/acoustic survey or an aerial photo-ID survey – or both if funds are available. Additionally, we will likely again conduct simultaneous IO watches to estimate detection probabilities.

The long-term outlook for bowhead abundance surveys (at Barrow) is under examination in light of climate change (reduced ice stability) and technological advances. Beginning in 1977, 19 attempts have been made to conduct an ice-based census. Of these, sufficient data were collected to estimate abundance for only 11 seasons, for a success rate of 58%. Using the aerial photo-ID (C-R) approach, it may be possible to make an estimate by surveying distant offshore leads in ‘poor’ seasons like 2009 when the ice-based census failed. However, even the best aerial photo-ID surveys produce relatively few recaptures between years, so the CV of the estimates are higher than the “good” ice-based censuses (Koski *et al*, In Review). Schweder *et al*. (In Press) present simulations indicating that it is possible to match photos from a single season against the entire photo-ID catalog (since 1980) to make abundance estimates. However, such a matching exercise is a massive effort and given the gaps in the photo catalog, it is advisable that two surveys be flown consecutively to estimate population size (J. Zeh, pers. comm.). This doubles the risk and expense of the C-R method. Given the above arguments and this years’ failure, it remains uncertain what the single best approach is for conducting future bowhead abundance surveys.

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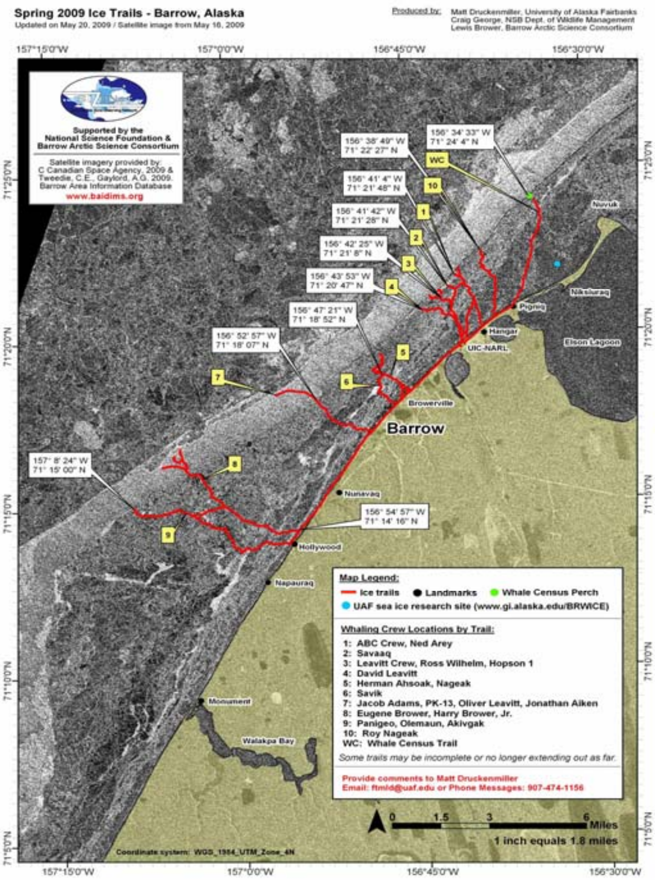

Figure 1. High resolution satellite image of the shorefast sea ice showing trails made by the Inupiat whale hunters. The location of the observation perch (tip of northernmost trail) was about 4 km west of Point Barrow. Map courtesy of Matthew Druckenmiller (University of Alaska Fairbanks; ftmld@uaf.edu), the National Science Foundation, Barrow Arctic Science Consortium, NSB and the Canadian Space Agency.

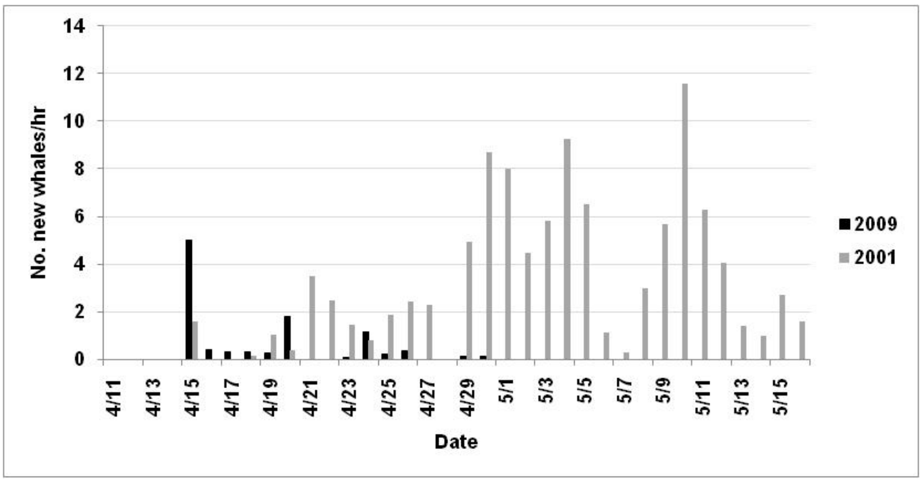

Figure 2. Raw number of whales counted per hour from the primary perch (Ivuniq North; *ivuniq* means “large pressure ridge” in Inupiat Eskimo) compared with sightings on the same Julian day during the 2001 census. There were no bowheads seen (due to closed leads) during May 2009 which is typically the peak of their migration passed Barrow.

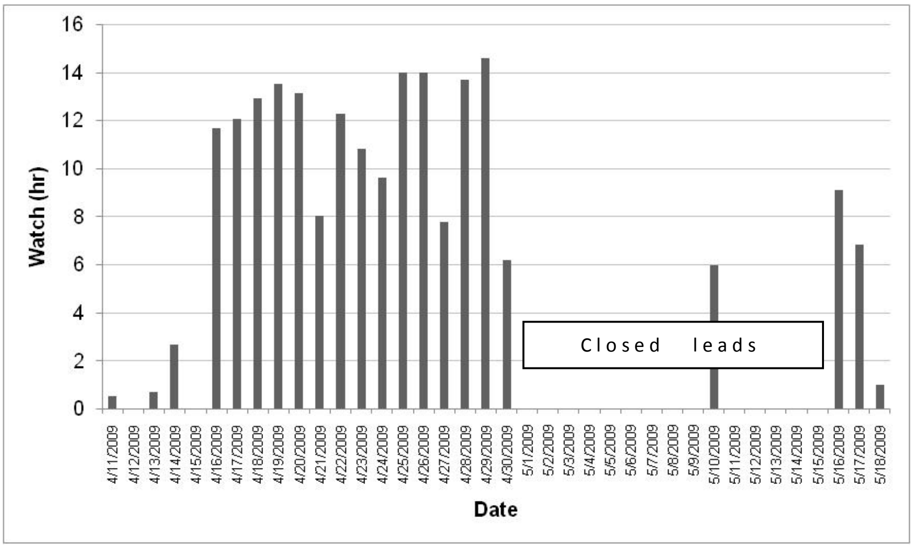

Figure 3. Watch effort (hr/day) for the primary perch (Ivuniq North) during the 2009 ice-based survey. Note the long period in the first half of May with no usable watch effort due to closed leads.

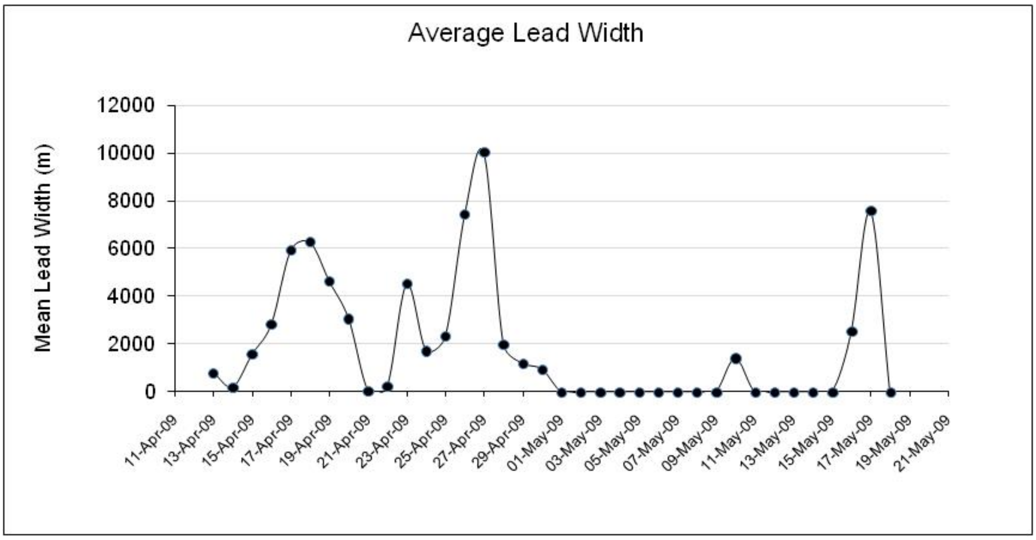

Figure 4. Average daily lead width measured perpendicular to the observation perch. Note that the leads began closing in late April and remained closed for 15 days, except for a brief opening on 10, 16 and 17 May, then closed again. This places the 2009 season among the poorest in terms of acceptable visibility in the 30 year history of the ice-based census.