NWRT Final Report

NWRT Project Number: NWRT-2023-0000000019

Project Title: Baffin Island Regional Aerial Survey (South Baffin)

Project Leader:

John Ringrose
Baffin Regional Wildlife Biologist
Department of Environment
Government of Nunavut
Box 569 Pond Inlet, NU, X0A 0S0
(867)899-1426
Jringrose@gov.nu.ca

Summary:

The following report is an exert of the draft report that is still pending due to ongoing analysis. However, upon its completion will present the results of a research effort designed to estimate the abundance of barren-ground caribou occupying south Baffin Island ancillary Islands using aerial survey methods.

Caribou are circumpolar in their distribution and occur in northern parts of Eurasia and North America. In Canada, caribou are represented by four subspecies; Peary (*R. t. pearyi*), Woodland (*R. t. caribou*), Grant's (*R. t. granti*), and Barren ground (*R. t. groenlandicus*). Of the four, barren-ground caribou are the most abundant and can be further divided into two ecotypes, the taiga wintering migratory, and the tundra wintering types (Nagy et al. 2011). All Baffin Island caribou groupings fall into the tundra wintering ecotype generally occurring in smaller aggregations, have less dramatic migratory behavior, and are confined to tundra environments. Movements of Baffin Island caribou are not completely understood though limited scientific knowledge and IQ suggest that it varies amongst the groupings, including but not limited to both altitudinal as well as smaller scale geographically driven migratory behavior when compared with mainland migratory taiga wintering barren-ground caribou.

The Department of Environment, Government of Nunavut, previously recognized three (3) caribou populations across Baffin Island. These populations included the South, North and Northeast Baffin Populations (Ferguson and Gautier 1992, Department of Environment, 2005). The paucity of demographic and movement studies on Baffin Island over the last 20 years has made divisions that may exist between these populations difficult to verify. Early survey study areas (1940-1970) did not assess subpopulation structure and as a result were unable to provide reliable abundance estimates due to limited coverage. Small, widely dispersed herds, poor weather over the survey period, and rugged terrain over portions of the range further compounded these issues (Hall 1980).

Early survey efforts generally focused on discrete portions of caribou range and were almost exclusively limited to South Baffin. The first completed Baffin Island caribou abundance survey took place in March 2014 at which time 4,872 caribou (95%CI=3,462-6,484; SE=712.23; CV=0.15) were estimated Island wide. Prior to this whole Island estimate Williams and Heard (1986) suggested that in excess of 100,000 caribou likely inhabited Baffin Island in 1985. The status was updated in 1991 when it was suggested that populations were stable with 60,000 -180,000 in South Baffin, greater than 10,000 in Northeast Baffin, and between 50,000-150,000 in North Baffin (Ferguson and Gauthier, 1992). These earlier estimates were not the result of robust demographic studies but rather best guesses based on qualitative observations and Inuit Qaujimajatuqangit (IQ) of the time and various incidental aerial observation and movement data. During the mid to late 1990s, local hunters across Baffin Island have reported decreasing caribou numbers, and currently many hunters have to travel further from their communities to locate caribou (Jenkins et al. 2012; Goorts and Ross, 2013). Since the 2014 whole Island estimate and associate harvest restrictions applied for the first time in 2015, hunters have reported steadily increasing numbers across the Baffin Island complex.

Project Objectives:

The project objectives were:

1) Determine caribou distribution and abundance.
2) Determine the accuracy of collared caribou locations and how representative these caribou are for the distribution and movement of Baffin Island caribou.
3) Build a database with which to estimate the current population trend through demographic.
4) Collect predator abundance and distribution data (if possible).
5) Inform management discussions regarding TAH and NQLs.

Materials and Methods:

For the 2024 survey, distances of caribou groups from the survey planes were binned into intervals (0-200m, 201-400m, 401-600m, 601-1000m, and 1001m-1500m) based upon markers on wing struts of the survey plane as was done in the 2014 Baffin Island caribou survey (Campbell et al. 2015) and 2019 South Hampton Island survey (Campbell et al. 2020) and the 2020 Dolphin Union survey (Campbell. et al. 2021) .

In addition, a dependent double observer pair was used to assess sightability of caribou. The double observer method involves one "primary" observer who sits in the front seat of the plane and a "secondary observer" who sits behind the primary observer on the same side of the plane (**Figure 1**). The method adhered to five basic steps; ***1 -*** The primary observer called out all groups of caribou (number of caribou and location) he/she saw within the 400-meter-wide strip transect before they passed halfway between the primary and secondary observer (approximately at the wing strut). This included caribou groups that were between approximately 12 and 3 o'clock for right side observers and 9 and 12 o'clock for left side observers. The main requirement was that the primary observer be given time to call out all caribou seen before the secondary observer called them out; ***2 -*** The secondary observer called out whether he/she saw the caribou that the first observer saw and observations of any <u>additional</u> caribou groups. The secondary observer waited to call out caribou until the group observed passed half way between observers (between 3 and 6 o'clock for right side observers and 6 and 9 o'clock for left side observer); ***3 -*** The observers discussed any differences in group counts to ensure that they are calling out the same groups or different groups and to ensure accurate counts of larger groups; ***4 -*** The data recorder categorized and recorded counts of caribou groups into "primary only", "secondary only", and "both", entered as separate records; ***5 -*** The observers switched places approximately half way through each survey day (i.e. at lunch) to monitor observer ability. The recorder noted the names of the primary and secondary observer.

The sample unit for the survey was "*groups of caribou*" not individual caribou. Recorders and observers were instructed to consider individuals to be those caribou that were observed independent of other individual caribou and/or groups of caribou. If sightings of individuals were influenced by other individuals, then the caribou were considered a group.

A combined distance sampling and mark-recapture approach was then used to estimate abundance. The basic approach involved using mark-recapture approach to also estimate sightability across the various survey bins. Due to heterogeneity variation in detection probabilities, it has been found that using just a mark-recapture approach overestimates sightability as distance from the survey plane increases, however, this approach was useful for estimation of sighting probability near the plane. This approach ensured a more robust estimate than using distance sampling methods alone which assume that the probability of detection of caribou groups at 0 distance from the plane is 1 (Borchers et al. 1998, Buckland et al. 2004, Laake et al. 2008a, Laake et al. 2008b, Buckland et al. 2010, Laake et al. 2012).

Covariates were used to describe and model factors influencing the sightability of caribou (**Table 1**). These included observer pair (given that the sample unit for dependent methods is the pair of observers as opposed to single observers). If observers were not paired, then they were pooled into a single multi-observer group.

In some cases, both observers missed a group of caribou, but the group was seen by the data recorder. It is expected that observer pairs may miss some caribou and naïve inclusion of data recorder observations could cause bias in estimates. However, in some cases a substantial number of caribou groups were missed by observer pairs indicating that they were weak observers. The concern in this case is that a substantial number of caribou would have 0 detection probabilities solely due to poor observer performance (in comparison to other observers), however, the dependent observer approach would not provide a valid estimate of the reduced detection probabilities. Graphical approaches were used to identify weak observer pairs and, in extreme cases, the weak observers were pooled as a single observer with the second observer being the data recorder. A covariate was used to model this modification of observer pairing. A sensitivity analysis was conducted to determine the effect of inclusion of data recorder observations.

Group size, snow cover, and cloud cover were also considered as covariates as with other surveys. Aircraft type was also considered.

Table 1. Covariates used to model variation in sightability for dependent double observer pair analysis.

Covariate	Acronym	Description
Aircraft type	AirType	Helicopter vs fixed wing
Observer pair	obs	each unique observer pair
	Paired	Whether a pair switched places during survey
Data recorder observations	weakobs	Pairs who were assisted by the data recorder
Group size	size	size of caribou group observed
	Log(size)	Natural log of group size
Snow cover	snow	snow cover (0,25,75,100)
	snowc	continuous
Cloud cover	cloud	cloud cover (0,25,75,100)
	cloud	continuous
Snow patchyness	SnowPatch	Continuous ordinal scale

The *MRDS* R package (Laake et al. 2012) was used to build mark-recapture and distance sampling models. The general approach used was to initially build distance sampling models with the mark-recapture model parameters held constant and vice-versa for the double observer models. A composite model was then built using the most supported covariates from each of the component analyses. Estimates for strata were derived based on transect lengths and strata areas for the best fitting detection model. Estimates of variance were derived using estimators for a systematic sampling layout (Fewster 2011).

The fit of models was evaluated using the Akaike Information Criterion corrected for small sample size (AIC_c). The model with the lowest AIC_c score was considered the most parsimonious, thus minimizing estimate bias and optimizing precision (Burnham and Anderson 1998). The difference in AIC_c values between the most supported model and other models (ΔAIC_c) was also used to evaluate the fit of models when their AIC_c scores were close. In general, any models with a ΔAIC_c score of less than 2 between them were considered to have equivalent statistical support. Overall model fit was also assessed using goodness of fit tests (Buckland et al. 1993, Buckland et al. 2004) as well as graphical comparison of detection functions with histograms of frequencies of observations from the survey.

Estimates were also derived using the Jolly strip-transect estimator (Jolly 1969, Krebs 1998) with the survey strip defined at 400 meters from the plane. This approach, which allows inclusion of all survey data (i.e. data recorder etc) provided a useful comparison with distance sampling estimates. The 2024 estimates was initially compared to the 2012/2014 estimates using a t-test to determine if the two estimates were significantly different (Gasaway et al. 1986). Confidence limits on yearly change were estimated assuming log-normal distributions of abundance estimates.

Analyses were conducted in program *R* (R Development Core Team 2009) with plots being produced using the *ggplot* (Wickham 2009) R package with GIS analyses conducted in QGIS (QGIS Foundation 2020) and the *sf* (simple features) (Pebesma 2018) R package. In addition, the *AICmodavg* (Mazerolle 2016), *lubridate* (Grolemund and Wickham 2011), and *ddply* (Wickham 2011) R packages were used in the analysis

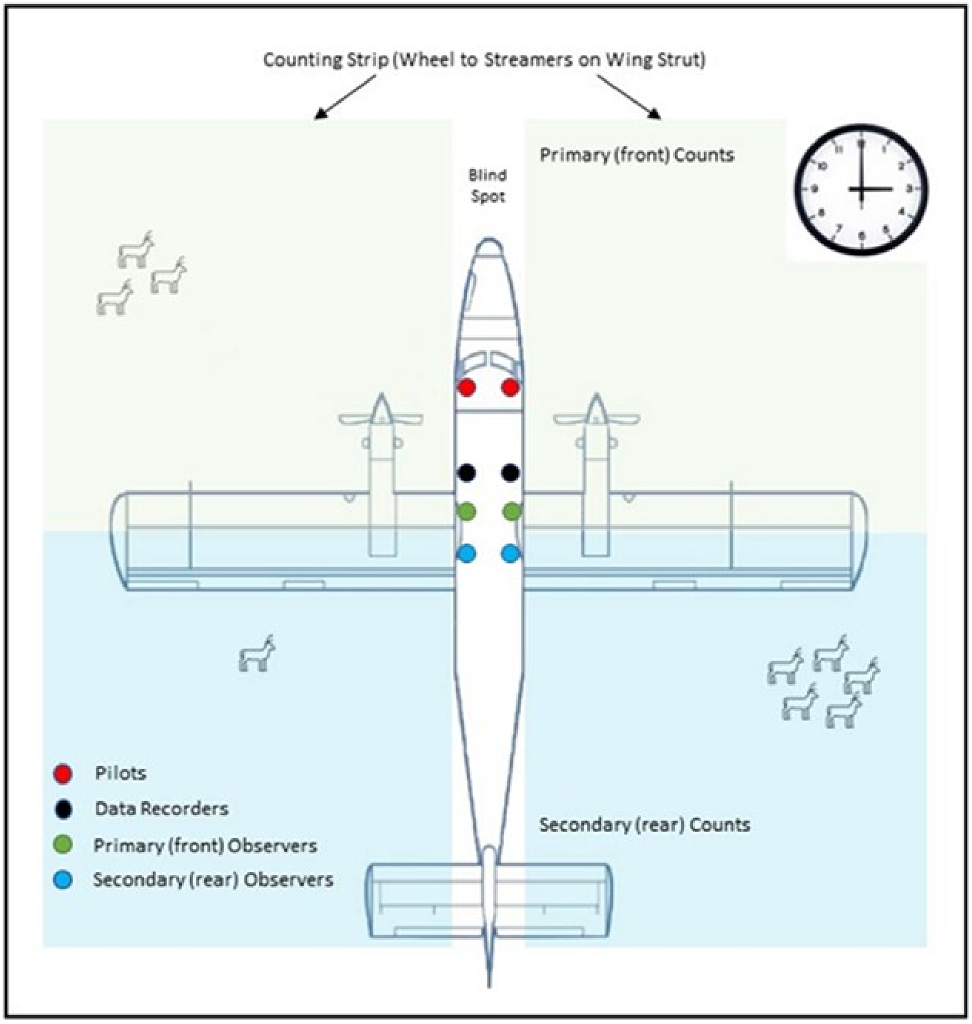

Figure 1. Observer position for double observer methods. The secondary observer calls caribou not seen by the primary observer after the caribou have passed the main field of vision of the primary observer. Time on a clock is used to reference relative locations of caribou groups (e.g. “Caribou group at 1 o’clock”).

Results:

<u>Analysis still ongoing. No results available at this time.</u>**

Discussion/Management Implications:

<u>Final report not available due to ongoing analysis.</u>

Any further management discussions will include all co-management partners and will follow the processes outlined in the Nunavut Agreement.

Reporting to communities/resource users:

In person HTO/ consultations took place prior to the survey and will take place after the results are available.

References:

Bachl, F. E., F. Lindgren, D. L. Borchers, and J. B. Illian. 2019. inlabru: an R package for Bayesian spatial modelling from ecological survey data. Methods in Ecology and Evolution 10:760-766.

Borchers, D. L., W. Zucchini, and R. M. Fewster. 1998. Mark-recapture models for line-transect surveys. Biometrics 54:1207-1220.

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance Sampling. Estimating Abundance of Biological Populations. Chapman & Hall, London.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2004. Advanced Distance Sampling - Estimating abundance of biological populations. Oxford Press.

Buckland, S. T., J. Laake, and D. L. Borchers. 2010. Double-observer line transect methods : levels of independence Biometrics 66:169-177.

Burnham, K. P., and D. R. Anderson. 1998. Model selection and inference: A practical information theoretic approach. Springer, New York, New York, USA.

Campbell, M., J. Boulanger, and D. Lee. 2020. Long-term trends in abundance and distribution of the Southampton Island caribou herd: 1978 – 2019 Government of Nunavut, Department of Environment.

Campbell, M., J. Goorts, D. S. Lee, J. Boulanger, and T. Pretzlaw. 2015. Aerial Abundance Estimates, Seasonal Range Use, and Demographic affiliations of the Barren-Ground Caribou (Rangifer tarandus groenlandicus) on Baffin Island – March 2014. Department of Environment, Nunavut Wildlife Research Division, .

Campbell., M., J. Ringrose, J. Boulanger, A. Roberto-Charron, K. Metheun, C. Mutch, T. Davison, and C. Wray. 2021. An Aerial Abundance Estimate of the Dolphin and Union Caribou (Rangifer tarandus groenlandicus x pearyi) herd, Kitikmeot Region, Nunavut – Fall 2020, Government of Nunavut, Technical Report Series No 01-2021. 146 pp. .

Fewster, R. M. 2011. Variance Estimation for Systematic Designs in Spatial Surveys. Biometrics 67:1518-1531.

Gasaway, W. C., S. D. Dubois, D. J. Reed, and S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biological Papers of the University of Alaska No 22:1-108.

Grolemund, G., and H. Wickham. 2011. Dates and Times Made Easy with lubridate. Journal of Statistical Software 40:1 - 25.

Jolly, G. M. 1969. Sampling methods for aerial censuses of wildlife populations. East African Agricultural and Forestry Journal 34:46-49.

Krebs, C. J. 1998. Ecological Methodology (Second edition). Benjamin Cummins, Menlo Park, California.

Laake, J., D. L. Borchers, L. Thomas, D. Miller, and J. Bishop. 2012. Mark-recapture distance sampling (MRDS) 2.1.0. R statistical package program.

Laake, J., M. J. Dawson, and J. Hone. 2008a. Visibility bias in aerial survey: mark-recapture, line-transect or both? Wildlife Research 35:299-309.

Laake, J., R. J. Guenzel, J. L. Bengtson, P. Boveng, M. Cameron, and M. B. Hanson. 2008b. Coping with variation in aerial survey protocol for line-transect sampling. Wildlife Research 35:289-298.

Laake, J. L., and B. A. Collier. 2024. Understanding implications of detection heterogeneity in wildlife abundance estimation. The Journal of Wildlife Management 88:e22516.

Mazerolle, M. J. 2016. AICcmodavg: Model selection and multimodel inference based on (Q)AIC(c). . R package version 2.1-0.: https://cran.r-project.org/package=AICcmodavg.

Pebesma, E. 2018. Simple Features for R: Standardized Support for Spatial Vector Data. The R Journal 10:439-446.

QGIS Foundation. 2020. QGIS Geographic Information System. QGIS Association. http://www.qgis.org.

R Development Core Team. 2009. R Foundation for Statistical Computing, Vienna, Austria.

Wickham, H. 2009. ggplot2: Elegant graphics for data analysis. Springer, New York.

Wickham, H. 2011. The Split-Apply-Combine Strategy for Data Analysis. Journal of Statistical Software 40:1 - 29.