Caribou & wild reindeer (*Rangifer tarandus*): a terrestrial Focal Ecosystem Component in the Arctic – update for CBMP writing workshop March 2017

Anne Gunn and Don Russell, CARMA

Introduction

Caribou and wild reindeer are going through rapid and far-reaching changes in abundance and distribution especially in arctic Canada. While natural cycles in abundance are known, the extent of some current declines may exceed the amplitude of previous changes and recovery may be compromised by habitats changing in response to a warmer climate and greater human presence.

The Arctic Terrestrial Biodiversity Monitoring Plan's goal for Arctic mammals is to track and report observed changes in abundance, productivity, and distribution, and to monitor the likely biotic and abiotic drivers of change (Christenson et al. 2013). To follow up on the Arctic Biodiversity Assessment and for future science-based CAFF assessments, CBMP is developing State of the Arctic Biodiversity Reports (StArT Report) for which progress is to be reported at the CBMP workshop in Iceland, March 2017. The writing workshop is to compile data and summarize status and trends from monitoring terrestrial Focal Ecosystem Components which includes caribou/reindeer. The following text for caribou/reindeer is to provide following information:

(1) We summarize the evidence for the rapid changes that caribou/reindeer are facing as an important but vulnerable indicator in the Arctic and summarize the regionally important stresses facing them.

(2) We describe the existing and historic datasets (methods, data availability and quality) identifying monitoring areas with more detailed datasets.

(3) We suggest caribou indicators that could be developed or refined to test impact hypotheses related to the stressors and rapid changes.

1. Why important, including to communities

Arctic people: Caribou/reindeer are an essential features of the lives and culture of many northern people over 1000s of years to present times. Typically, the importance of caribou/reindeer to northern people is indexed by harvest statisitcs but increasingly, compilations of traditional knowledge reveals the strength and diversity of the cultural importance. What is uncertain is how people will deal with the current extent of declines especially in the Canadian herds – not just food security but social stresses from the loss of cultural values.

Ecological: Caribou/reindeer and muskoxen and caribou are the only large-bodied herbivores in the Arctic and their role is characterised by periodic high numbers and migrations in response to the short but productive plant growth season. The ecological role is summarized in CAFF (2013).

2. Pressures (abiotic & biotic) and Monitoring indicators

Determining the effect of biotic and abiotic pressures on herds is difficult. Although the demographic mechanisms for trends in herd abundance (productivity and survival) are monitored, the underlying mechanisms such as weather or predation interact with each other and their monitoring is fragmentary or incomplete.

Climate and weather: Almost every ecological aspect of caribou/reindeer ecology is influenced by weather and climate and annual variation is high (e.g.: Caughley and Gunn 1993) but patterned at the decadal scale by large-scale regional patterns such as the Arctic Oscillation. Superimposed on these annual and decadal patterns are overall trends resulting from the accelerated warming now being measured for the Arctic. Measuring these trends at the spatial scale of caribou/reindeer ranges has been

made possible through CARMA's conversion of spatial climate data available through MERRA (Russell *et al.*2013). Currently CARMA is updating the herd seasonal ranges based on satellite collars and has climate data downloaded to 2016.

As an example, the climate indices for drought and warble fly harassment when combined with an index for mushroom growth (mushroom fruiting bodies help caribou/reindeer fatten up in the fall) suggest severe summers for the Bathurst herd in the mid-1990s and 2012 -2014 – trends are difficult to detect given the high annual variability (Figure 1). Correlating the climate indices with trends in abundance and vital rates such as adult and calf survival is underway for the Bathurst herd and similar analyses would be a valuable contribution for understanding trends in abundance for other herds. In the Bathurst herd, the peak values for the indice of adverse summers were in the 1990s when the decline began and then again in 2014 when the rate of decline acclerated.

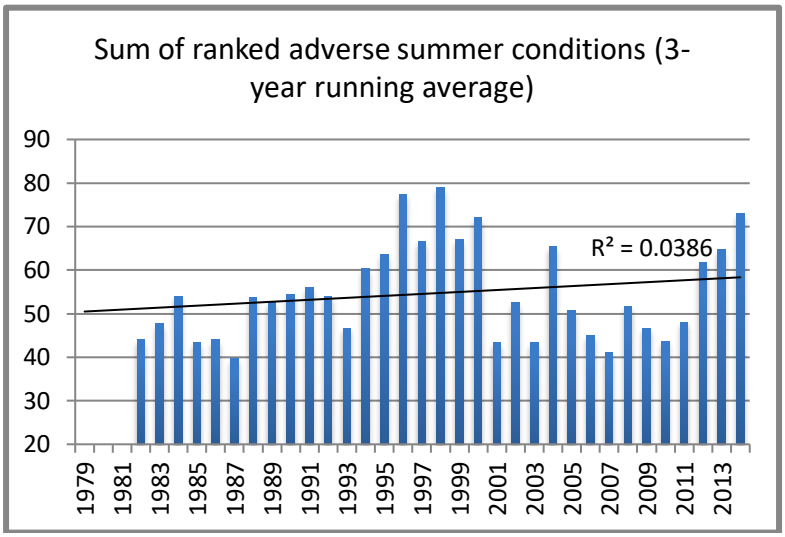

Figure 1. Sum of ranked adverse climate conditions on the summer range of the Bathurst herd (CARMA unpubl. data).

Predation. Across the North American tundra, Krebs *et al.* (2002), based on biomass transfer between trophic levels, suggested that top-down ecological processes dominate and that climate variation and predation are limiting factors. At the herd scale although overall adult cow survival is monitored and currently reported for eight herds in North America (CARMA unpubl. dataset), predation levels are not directly monitored. In Alaska, a short-term study of calf survival in the Teshepuk herd suggested that winter-wolf predation was significant (Parrett 2013). Other monitoring indicators have included predator sighting rates which are indexed as predators recorded/survey flying hour to index but this is only consistently recorded for a few herds in NWT and NU.

Landscape changes: Industrial development (oil and gas and mining) is increasing on herd seasonal ranges and is described for individual herds typically through environmental assessment reviews. At least six herds in North America have winter or all-season roads which are used to support industrial development and also are used by hunters to access the herds. However, overviews and catalogues of the trends in spatial footprints are currently unreported. In Russia, at the landscape scale, the effect of domesticated Reindeer includes increased predator control as well as poaching and loss of the domesticated Reindeer to the wild Reindeer herds (Baskin 2005).

Monitoring indicators that are used in environmental assessment depend on satellite or GPS collared caribou to index encounter rates with and passage time through sites of industrial activity.

Harvest: Harvest levels are unevenly monitored as some harvests are regulated and reported (commercial, guided hunting) while subsistence harvests are less frequently monitored. Datasets on harvest levels are included in herd-specific reports (Alaska). In Canada, harvest information becomes

available for herds when harvest restrictions are under consideration, and co-management boards hold public hearings with public registries for all evidence considered (references available). By 2016, harvest restrictions are underway for nine herds in Alaska and Canada (CARMA unpubl. information).

3. Historical datasets/baseline

Datasets to assess conservation status (status and trends in abundance) are the national level except that CARMA network maintains a dataset on status and trends for 22 migratory tundra caribou/reindeer herds in Alaska, Canada, Greenland and Russia. CARMA obtained and scanned paper records for historic body condition data (1960s to 1990s) to build a dataset for 18 herds and 8,288 individual caribou (1965-2006) which is available as metadata through ArcticNet.

CARMA has also cooperated with agency biologists to update datasets on seasonal range use (based on satellite collar for 11 herds in Alaska and Canada). This is underway in 2017 and will be used to update the dataset on climate variables for seasonal ranges. CARMA initially created the dataset in 2009 (Russell *et al.* 2013) and since then information on the size and location of seasonal ranges has changed.

Alaska Department of Fish and Game provide levels and trends in herd size, vital rates and regulated harvests in management inventory reports published at roughly 2-3 year intervals. In Canada, the territorial governments publish survey reports for estimates of abundance at intervals which include historic information on vital rates. In the NWT, datasets are available on request on sex and age composition surveys as well as other datasets.

We suggest that while the frequency of information collection and reporting is highest in Alaska and for a few herds in Canada, this may reflect further efforts to determine the availability of datasets for Greenland and Russia. For this reason, it is premature to identify monitoring areas with more detailed datasets.

4. Status and trends – if known (Western Science, CBM & TK)

Abundance and Distribution

In Canada, the current status (2016) is a minimum of 726,000 migratory tundra caribou (for some areas on the northeast mainland, current estimate are lacking). In Alaska, the current status for the four migratory tundra caribou herds is 495,000 caribou. The trend is declines across Alaska and Canada except the Porcupine herd. The mean % decline from peak abundance to the most recent estimate 71% ± 5.9SE for 11 herds with sufficient data (Figure 2).

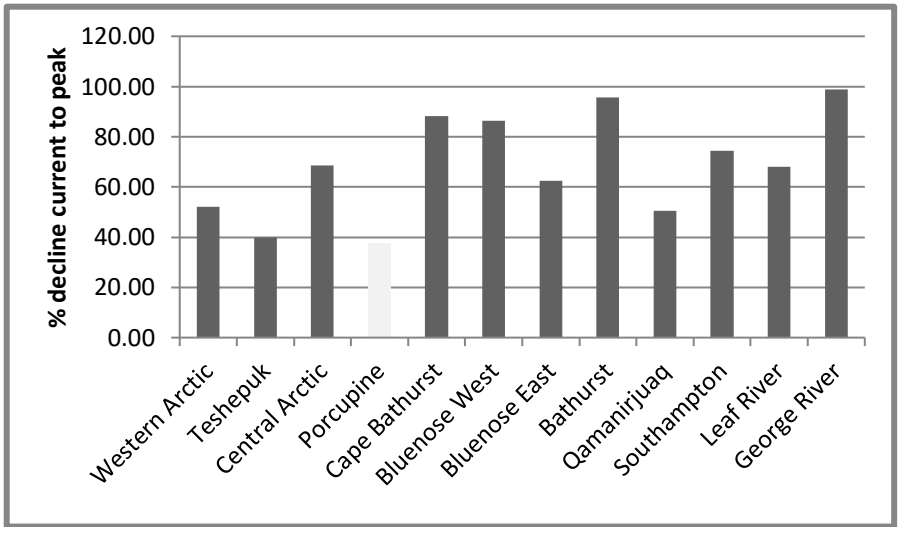

Figure 2. The percentage decline from peak to current abundance for North American migratory tundra caribou herds (the Porcupine herd is an increase).

The overall trend for caribou on Greenland's west coast during the period 2004-2015 is an approximate 30% decline and the current status in 2015 is about 73,430 excluding three populations with feral Reindeer mixed with the Caribou (Cuyler 2015). The most recent peak may have occurred in the late 1990s but changes in census techniques obscure trends (Cuyler *et al.* 2011).

The status of migratory tundra Reindeer (R. t. *sibiricus) in Russia is* 626,000 individuals (North Yukutia, Yamal, and Taimyr) which have declined. On the Yamal Peninsual, abundance has declined from 3000 to 2000 between 1991 and 2015 on ranges impacted by industrial development (I. Mitzin and T. Sipko pers. comm. 2015). Uboni *et al.* (2015) report that Taimyr and North Yakutia (Yana-Indirka, and Sundrun) tundra Reindeer had peaked in the 1990s and then subsequently had declined 25% to 624,000 individuals, while the Lena-Olenek herd increased from 55,000 in 1985 to 90,000 in 2001. With the collapse of the domesticated reindeer industry in Chukotka in the 1980s and 1990s, the wild Reindeer in Chukotka increased rapidly from 33,000 in 1991 to 93,700 by 2015 (I. Mitzin and T. Sipko pers. comm. 2015).

We estimated the exponential rate of change to describe the trends in abundance for the Alaskan and Canadian herds (Figure 3) as the frequency of estimates varies between years . We did not include the Leaf and George River herds (Canada) as the confidence limits were high when the herd sizes exceeded 500,000 caribou. These two herds are woodland caribou although they are strongly migratory with aggregated calving. The George River declined from a peak abundance of 776,000 in 1993 to 9,000 by 2014 while the Leaf River peaked at 638,000 in 2001 and had declined to 200,000 by 2016 (V. Brodeur pers. comm. 2014). We have not yet estimated trends for the Greenland and Russian herds until we have further discussions about methods

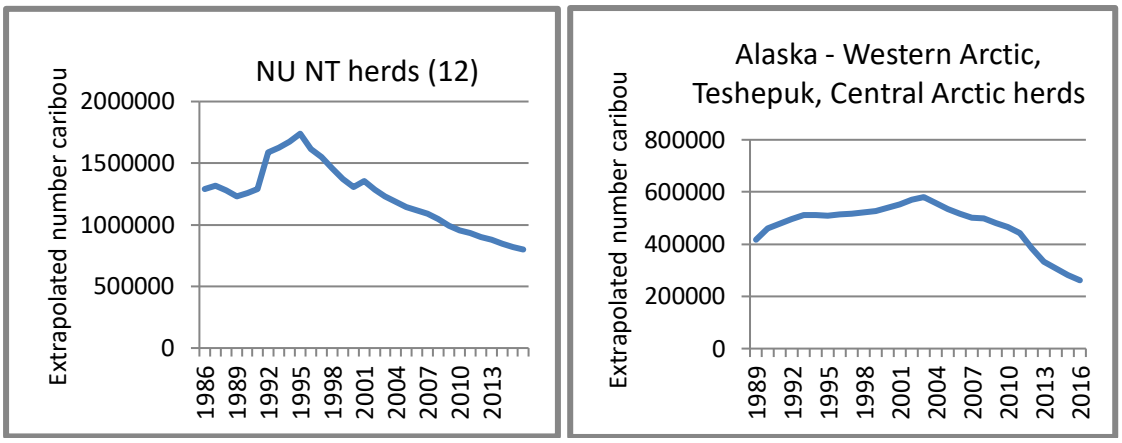

Figure 3. Trend in three Alaskan herds and 12 Canadian herds of barren-ground caribou using exponential rate of change as in-filling method.

The sub-species *R. tarandus pearsoni* is restricted to Novaya Zemlya Island and has declined 30% to 5000 individuals but reindeer on Russia's other Arctic islands have declined at a higher rate (73%) from 41,000 to 11,000 individuals between 1991 and 2015 (I. Mitzin and T. Sipko pers. comm. 2015). On Canada's arctic islands, the overall trend for Peary Caribou, *R. t. pearyi*, is a decline to about 14,000 individuals by 2014 from 22,000 estimated in 1987 and an estimated 25 845 for the High Arctic Islands in 1961 and about 18,000 for the mid-arctic islands in 1973-1980 but infrequent monitoring impedes assessing total numbers (COSEWIC 2015). Peary Caribou occur as 4 island groupings one of which has essentially disappeared since the 1980s; one has declined and stabilized at low numbers while the north-western island grouping has been through two sharp declines followed by recovery. Dolphin and Union (*R.t. groenlandicus x pearyi*) on the large mid-arctic island of Victoria has not recovered to the abundance

recorded in the early 1900s and currently the population is stable or declining at 27,000 between 1997 and 2007 (SARC 2013).

5. Certainty in findings

Caribou/reindeer abundance is typically estimated by one of three main methods. Sample counts using photography and strip transects on the calving grounds are extrapolated to herd size using sex and age composition surveys. For some herds, post-calving aggregations are tracked through radio and satellite locations and the aggregations photographed for a minimum count of herd size. Thirdly areas such as islands are surveyed using strip or line transects as a sample count. Coverage is variable and stratification is used to adjust sampling effort relative to caribou density. Accuracy (bias) is reduced by doubling counting caribou on the photographs or use a double observer count. To estimate the significance of the measured trends various statistical analyses are applied.

Within and between herds, the survey frequency varies widely but for most herds, abundance has been estimated over at least 20 years using relatively standardized sampling methods in Alaska and Canada (Figure 4). The average frequency of estimated abundance is 4.6 ± 0.47 SE (range 2-10 years).

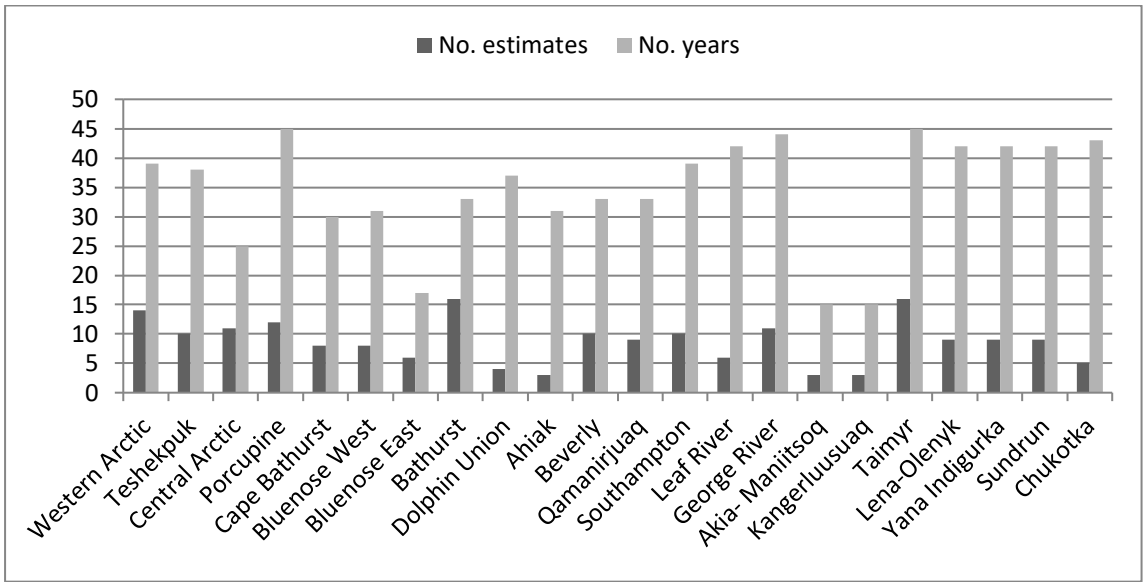

Figure 4. Duration (years) of sampling period and number of abundance estimates for 22 herds (Beverly and Ahiak are now estimated as a single herd since 2011)

Christianson et al. (2013) describe Focal Ecosystem Components (FECs) as those species and ecological processes that determine arctic biodiversity. The FECs have attributes such as abundance and various parameters (Tables 1 and 2) which CARMA has compiled the data or metadata for most caribou/ reindeer herds. CARMA has provided a separate report on monitoring to CBMP (2015).

6. Thresholds

- In other species, the shape of decline curves especially if they are quadratic convex curves identify the likelihood of renewed or new stresses on trends in abundance (DiFonzo et al. 2013). However, this approach to determine the timing of management actions has not yet been applied to caribou/reindeer.
- Spatial thresholds such as used for boreal caribou recovery planning in Canada are not yet being developed for migratory tundra caribou.

- CARMA is starting an examination of distribution to look at the relationship between abundance and spatial distribution to come up with spatial thresholds
- Range shifts, range size and abundance to get spatial threshold for landscape planning

7. Gaps & directions – why important (for policy and management) to fill gaps

- A major gap is quantifying the vulnerability of caribou/reindeer to climate and other changes regionally and overall. Parry *et al.* (2007) defines vulnerability as a function of the *sensitivity of* a particular species to climate changes, its *exposure to those* changes, and its *capacity to adapt to those* changes. Using IPCC approach helps to organize and structure information to assess the vulnerability.
- Analyses of spatial data including distribution, climate and the human footprint (cumulative effects) especially the interaction between road-based harvesting, industrial development which would support both management and landscape scale planning (thresholds and trade-offs) and conservation.
- Understanding the implications of regionally synchronized and steep rates of decline for herds and their conservation is a gap. Changes in range use and subsequent exposure to stresses (harvesting, industrial development and diseases) are likely but we lack experience of such rapid and extensive reductions in caribou abundance and thus unexpected changes are a possibility.

8. Describe cross-cutting issues (e.g. Herbivory, invasive species). Issues related to integrated ecosystem assessment.

- Monitoring and mitigating the cumulative landscape effects of industrial disturbances including roads, atmospheric transport of contaminants and climate changes is both a cross-cutting issue and a need for an intergated ecosystem assessment for caribou and muskoxen as well as their predators (wolves and grizzly bears).
- The relationship between the rapid climate changes to plant growth, nutrient dynamics and plant communities is a cross-cutting issue for muskoxen and caribou and their inter-specific relationships.
- A cross-cutting issue for caribou and muskoxen is understanding the implications of genetic variation and epigenetic variation relative to parasite and disease sensitivity and exposure when effective population size is low and climate is changing.
- Invasive species as hosts or carriers for diseases and parasites novel to the Arctic as the climate warms are a cross-cutting issue for both caribou and muskoxen.

9. How this work feeds into the Aichi Targets, relevant Arctic Council processes, national and subnational conservation planning, global assessments and other processes

- CBMP (Barry *et al.* 2013) has listed meeting the Aichi Targets for the Terrestrial Plan but it is uncertain who or how to evaluate progress for caribou/reindeer relative to the Targets.
- At the international (global scale) level, the most recent IUCN assessment was in 2016 and Rangifer tarandus was rated Vulnerable, A2(a) compared to Least Concern in 2008.
- The ratings for conservation status (nationally rated as endangered, threatened or special concern) based on designated units (Canada) or oblasts (regions in Russia) and which emphasize the vulnerability of the sub-arctic woodland and mountain *Rangifer*. In Russia, wild Reindeer are assessed and listed by conservation status in regional Red Books which recognize *R. t. pearsoni* as Rare/Restored.
- In Canada, the national Committee On the Endangered Wildlife In Canada (COSEWIC) has assessed barren-ground caribou as Threatened (2016); Peary caribou as Threatened (2015).
- *Rangifer* is not a recognized species within the Convention of Migratory Species as few migrations cross international boundaries. One barren-ground caribou herd annually ranges over international

boundaries between Canada and the US (the Porcupine herd) and international cooperation is through agreements.

Literature Cited

Barry, T., T. Christensen, J. Payne, M.Gill. 2013. Circumpolar Biodiversity Monitoring Program Strategic Plan, 2013-2017: Phase II Implmentation of the CBMP. CAFF Monitoring Series Report Nr. 8. CAFF International Secretariat. Akureyri, Iceland. ISBN 978-9935-431-27-1

Baskin LM. 2005. Number of wild and domestic Reindeer in Russia in the late 20th century. Rangifer 25: 51-57.

Caughley, G. and A. Gunn. 1993. Dynamics of large herbivores in deserts: kangaroos and caribou. Oikos 67: 47-55.

Christensen, T., J. Payne, M. Doyle, G. Ibarguchi, J. Taylor, N.M. Schmidt, M. Gill, M. Svoboda, M. Aronsson, C. Behe, C. Buddle, C. Cuyler, A.M. Fosaa, A.D Fox, S. Heiðmarsson, P. Henning Krogh, J. Madsen, D. McLennan, J. Nymand, C. Rosa, J. Salmela, R. Shuchman, M. Soloviev, and M. Wedege. 2013. The Arctic Terrestrial Biodiversity Monitoring Plan. CAFF Monitoring Series Report Nr. 7. CAFF International Secretariat. Akureyri, Iceland. ISBN 978-9935-431-26-4

COSEWIC. 2015. COSEWIC assessment and status report on the Peary Caribou Rangifer tarandus pearyi in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 92 pp. (http://www.registrelep-sararegistry.gc.ca/default_e.cfm).

Cuyler, C. 2015. http://www.natur.gl/en/birds-and-mammals/terrestrial-mammals/caribou-Reindeer/

Cuyler, C., Rosing, M., Mølgaard, H., Heinrich, R. & Raundrup, K. 2011. Status of two West Greenland caribou populations 2010; 1) Kangerlussuaq-Sisimiut, 2) Akia-Maniitsoq. Pinngortitaleriffik – Greenland Institute of Natural Resources. Technical Report No. 78. 162 pp. (Part I: 1-90; Part II: 91-162).

Di Fonzo, M.D., B. Cullen, and G.M. Mace. 2013. A new method for identifying rapid decline dynamics in wild vertebrate populations. Ecology and Evolution 3:2378–2391.

Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P.J. & Hanson, C. E. 2007. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Eds. Cambridge University Press, Cambridge, UK, 976 pp

Parrett, L.S. 2013. Unit 26A, Teshekpuk caribou herd. P. Harper, editor. Caribou management report of survey and inventory activities 1 July 2012–30 June 2014. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2013-3, Juneau.

Russell, D.E., P.H. Whitfield, J. Cai, A. Gunn, R.G. White and K. Poole. 2013. CARMA's MERRA-based caribou climate database. Rangifer, 33, Special Issue No. 21:145-152.

Species at Risk Committee. 2013. Species status report for Dolphin and Union caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories. Northwest Territories, Yellowknife, NT. Available at http://nwtspeciesatrisk.ca/sites/default/files/dolphin_and_union_caribou_nwt_status_report_dec_2013_final_1.pdf. 106 pp.

Uboni, A., T. Horstkotte, E. Kaarlejärvi, A. Sévêque, F. Stammler, J. Olofsson, B. C. Forbes, and J. Moen. 2015. Long-term population dynamics of Eurasian Reindeer: trends, synchrony and role of large-scale climate. Downloaded 15 November 2015: www.arcticbiodiversity.is/program/posters/uboni/8-auboni-Reindeer.../file

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