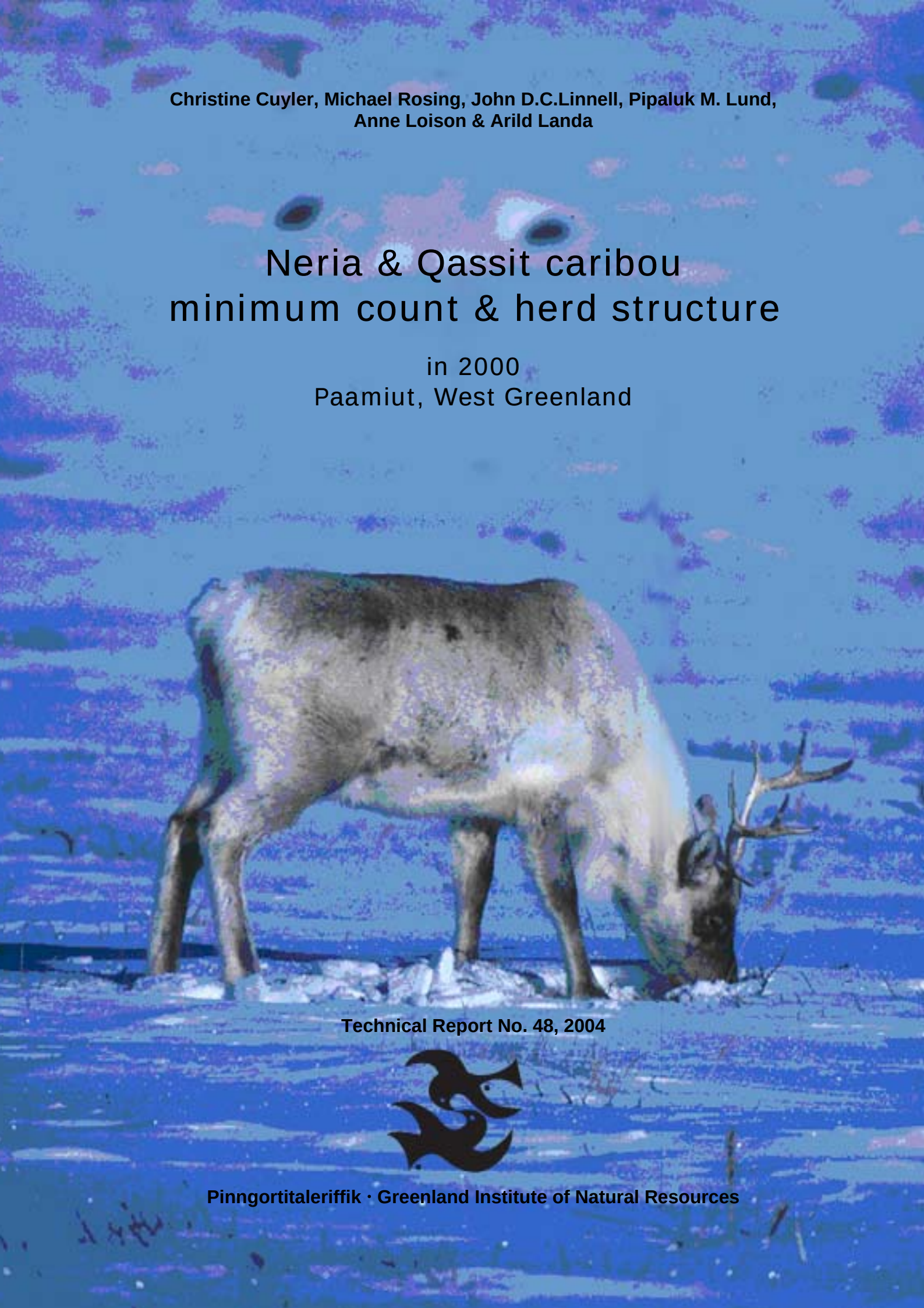
Christine Cuyler, Michael Rosing, John D.C.Linnell, Pipaluk M. Lund,
Anne Loison & Arild Landa

Neria & Qassit caribou minimum count & herd structure

in 2000
Paamiut, West Greenland



Technical Report No. 48, 2004

Pinngortitaleriffik · Greenland Institute of Natural Resources

Title:	Neria & Qassit caribou minimum count and herd structure in 2000, Paamiut, West Greenland.
Authors:	Christine Cuyler[1], Michael Rosing[1], John Linnell[2], Pipaluk M. Lund[3], Anne Loison[4] & Arild Landa[1&2] [1] Greenland Institute of Natural Resources, P.O. Box 570, DK – 3900 Nuuk, Greenland [2] Norwegian Institute of Nature Research, Tungasletta 2, 7485 Trondheim, Norway [3] Technical Division, City Hall, 2080 Eidsvoll Norway [4] UMR – CNRS 5558, Laboratoire de Biometrie et Biologie Evolutive, 69622 Villeurbanne cedex, France
Funding:	DANCEA, Danish Cooperation for Environment in the Arctic – Ministry of Environment and Energy, Strandgade 29, Copenhagen K, Denmark
Series:	Technical Report No. 48, 2004
Publisher:	Pinngortitaleriffik, Greenland Institute of Natural Resources
Cover photo:	Female caribou in winter. Photographer: Christine Cuyler
ISBN:	87-90024-87-7
ISSN:	1397-3657
Editor:	Lene Therkildsen, Milik Publishing
Reference:	Cuyler, C., M. Rosing, J.D.C. Linnell, P.M. Lund, A. Loison, & A. Landa, 2004. Neria & Qassit caribou minimum count and herd structure in 2000, Paamiut, West Greenland. Greenland Institute of Natural Resources. Technical Report No. 48. 46 pp.
Available from:	The report is only available in electronic format. You can download a PDF-file of the report at this homepage http://www.natur.gl/publikationer/tekniske rapporter It is possible to achieve a print of the report here: Pinngortitaleriffik, Greenland Institute of Natural Resources P.O. Box 570 DK-3900 Nuuk Greenland Phone: +299 36 12 00 Fax: +299 36 12 12 E-mail: info@natur.gl www.natur.gl

Contents

Summary

Caribou herd size, structure, recruitment and distribution in the Paamiut region were last investigated in 1995. To obtain information on current conditions, this study first documented local knowledge about the two caribou herds, Neria and Qassit, in the Paamiut region. Hunter interviews and community meetings were held. The knowledge gained structured the subsequent aerial reconnaissance for caribou minimum count, herd structure, autumn recruitment rates (calves/100 cows) and distribution.

The helicopter reconnaissance took place between 28 September and 4 October 2000. As per local hunter instructions a series of spaghetti transects were flown over the ranges of Neria and Qassit herds. A fresh snow layer covered the terrain for all flights and greatly improved caribou sightability, since the presence of fresh tracks allowed rapid localization of actual animals.

Neria herd (south Paamiut)

The minimum count for Neria was 332 caribou. Highest densities were found mid-way between the Davis Strait coast and the Greenland Ice Cap. Average density for the minimum count area surveyed, 180 km^2, was c. 2.2 ± 3.0 SD caribou/km^2. Maximum density was c. 14 caribou/km^2 and occurred on transect 17. Average group size was 4.1 caribou. Calf percentage was 29.8%. The sex ratio was 1.4 cows for every bull. Autumn recruitment was 72.2 calves/100 cows. Annual natural mortality (8-10%) on the minimum count may be between 27-33 animals.

Qassit herd (north Paamiut)

The minimum count for Qassit was 196 caribou. Most caribou were observed north of the large lake *Kangaarsuup tasersua*. Average density for the minimum count area surveyed, 202 km^2, was c. 0.9 ±2.2 SD caribou/km^2. Maximum density was c. 12 caribou/km^2 and occurred on transect 43. Average group size was 4.4 caribou. Calf percentage was 32.2%. The sex ratio was 1.6 cows for every bull. Autumn recruitment was 77 calves/100 cows. Annual natural mortality (8-10%) on the minimum count may be between 16-20 animals.

Conclusions

This reconnaissance data did not allow a calculation of population size for either the Neria or Qassit herds, because areas where maximum caribou were expected were preferentially sampled. Both herds show high autumn calf recruitment, and local opinion believes the caribou are more numerous than ever before. It is possible that both the Neria and Qassit herds are increasing in size, given the

excellent recruitment, bull to cow ratio, good vegetation, lack of predators and the low hunting pressure during the 1990s.

Without the newly fallen snow, sighting caribou would have been almost impossible in the otherwise difficult terrain cover, which included a multitude of glacial erratics (boulders of all sizes), specifically caribou sized. Caribou abundance investigations will always be hampered by these erratics, which reduce caribou sightability. The helicopter flight altitude of 30 metres (100 feet) improved sightability of the caribou and therefore this altitude is recommended for future surveys.

The prospect for future surveys in the traditional sense, i.e., strip or line transect surveys, was judged to be poor due to several features of the caribou and the terrain. Steep-sided valleys dominate the terrain, and the amount of available habitat changes dramatically within short distances. When this is added to the low density and clumped distribution of these caribou the result is two populations for which it is difficult to get an absolute number estimate unless financing is greatly increased. Greater funding would allow more helicopter time, which would increase area coverage and allow a randomization of transects. Alternately, an index of abundance is possible if the reconnaissance described here is repeated, i.e., provided that it is possible to do the same flights in the same season with new snow cover.

The collection of local knowledge provided information about current caribou distribution and relative abundance, and the implementation of local knowledge and instructions from local hunters designed this reconnaissance. Further co-operation between locals and investigators is recommended.

Imaqarniliornera

Paamiut pigisaani tuttoqassuseq, qanoq innerat, piaqqiornerat siammarsimanerallu kingullermik 1995-imi misissorneqarput. Pissutsit maannakkorpiaq qanoq innerat paasiniarlugu misissuinerit aallartivinnginnerini Paamiut pigisaani Neriami Qassimilu tuttut pillugit taqqavanermiut ilisimasaat paasiniaqqaarneqarput. Piniartut apersorneqarput innuttaasunillu ataatsimiititsisoqarluni. Ilisimalikkat pissarsiarineqartut kingusinnerusukkut qulimiguulik atorlugu ikinnerpaassusiliiniarluni kisitsinermi aammalu ataatsimoortukkuutaat kisinneqarnerinut, ukiarnerani amerleriaatinut (kulavaat 100-gaangata norraat qassit) aammalu tuttut siammarsimassussaannut misissuinernut tunngaviupput.

Qulimiguulimmik qulangiuaarineq pivoq 28. septemberimiit 4. oktoberip tungaanut. Taqqavani piniartut ilitsersuinerat aallaavigalugu Neriami Qassinilu tuttunik kisitsisoqarpoq nunap ilusaa naapertorlugu qulangiuaarisoqarluni. Ingerlaarfigisat tamarmik apeqqammisarsimapput taamaalilluni tuttut sumiinnerat paasiniassallugu ajornannginnerulerluni, tussarneqariaannaammatami.

Neriami tuttut (Paamiut kujataa)

Neriami tuttut ikinnerpaamik 332-upput. Amerlanerit Davis Strædep sineriaaniit sermersuup killingata tungaanut qeqqata missaani nassaassaapput. Misissuiffigisami ikinnerpaamik kisitat agguaqatigiissillugu amerlaqatigiikkuutaarnerat tassaavoq 180 km^2, 2,2 ± 3,0 SD tuttut/km^2-imut.. Amerlaqatigiikkuutaani amerlanerpaat tassaapput tuttut 14 /km^2 missaa, tukimoortumi 17-imi nassaarineqartut. Tuttut ataatsimoortukkuutaat amerlassusaasa agguaqatigiissinneri tassaapput tuttut 4,1-it. Norraat 29,8%-iupput. Suiaassutsini agguaqatigiinneri tassaapput pannermut ataatsimut kulavaat 1,4 . Ukiaanerani amerliartuaarneri tassaapput kulavannut 100-nut norraat 72,2-t. Ikinnerpaassusiliiniarluni kisitsinermi ukiumut nappaammit/utoqqalinermit toqussutaasartut (8-10%) nersutit 27-t 33-llu akornanniissasut naatsorsuutigineqarput.

Qassini tuttut (Paamiut avannaa)

Qassini tuttut ikinnerpaamik 196-iupput. *Kangaarsuup tasersuata* avannaani tuttut amerlanerpaat takuneqarput. Misissuiffigisami ikinnerpaamik kisitat agguaqatigiissillugu amerlaqatigiikkuutaarneri tassaavoq 202 km^2, 0,9 ±2,2 SD tuttut/km^2-imi missaat, tukimoortumi 43-mi nassaarineqartut. Tuttut ataatsimoortukkuutaat amerlassusaasa agguaqatigiissinnerat tassaavoq tuttut 4,4-t. Norraat 32,2%-iupput. Suiaassutsini agguaqatigiinnerit tassaapput pannermut ataatsimut kulavaat 1,6-it. Ukiaanerani amerliartuaarneri tassaapput kulavannut 100-nut norraat 77-it. Ikinnerpaassusiliiniarluni kisitsinermi ukiumut nappaammit/utoqqalinermit toqussutaasartut (8-10%) nersutit 16-it 20-llu akornanniissasut naatsorsuutigineqarput.

Naggasiineq

Misissuinernit paasissutissat pissarsiarineqartut Neriami Qassinilu tuttut tamakkiisumik amerlassusaannik naatsorsuinissanut tunngaviliisinnaasimanngillat, tassami misissuinerni sumiiffiit tuttoqarluarnerunissaannik ilimasuffiginerusat ikinnerpaassusiliiniarluni kisitsiffigineqaannarmata. Ukiaanerani norraqarluartarnera tuttut taakku

akornanni takuneqarsinnaavoq, taqqavanermiullu naliliinerat naapertorlugu aatsaat taama tuttoqartigaaq. Neriami Qassinilu tuttut amerliartuaarnissaminnut periarfissagissaarluarput, norraat amerlalluarneri, nerisassaqarluarnera, kiisortoqannginnera aammalu 1990-ikkunni pisaqartoqarpiartannginnera eqqarsaatigalugit.

Apeqqammersimanngikkaluarpat tuttut nassaariuminaalluinnangajassimassagaluarput, nunap qaava arlalippassuartigut sermersimasunik maniikulunnertaqaqimmat (ujararujussuit assigiinngitsunik angissusillit – ingammillu tuttut angeqqatai). Tuttut amerlassusaannik misissuineq tamakkuninnga ajornakusoortinneqartuartartussaavoq, taakkumi tuttut nassaariniarnerinut pisarissersuimmata. Qulimiguulik 30 meterinik qatsissuseqarluni (fodit 100-t) timminerata tuttut nassaariniarnerinut periarfissiilluarpoq, taamaattumillu qatsissutsip taassuma siunissami misissuinissani atorneqarnissaa innersuutigineqarpoq.

Siunissami qulimiguulik atorlugu misissuisarnissani nalinginnaasumik periuseqarluni misissuisarneq, tassa nunap qanoq issusia apeqqutaatinnagu nunap assingani titarnernik malinnillu timmisarnerit atorneqarnissaat innersuussutiginanngilaq, tuttut aammalu nunap qanoq issusaat matumani eqqarsaatigineqarluni. Qooqqut sivingasunik sinaallit tamaani arlaqaqaat nunalu uumaffigineqarsinnaasoq allanngorartupilussuulluni. Tuttoqarfinni taakunani marlunni nunap ilusaa, tuttuisannera aammalu tiggunnikukkuutaartumillusooq tuttut siammarsimanerat eqqarsaatigalugit tuttunik tamakkiisumik kisitsiniarneq ajornakusoorpoq, tamakkiisumik kisitsisoqassappat aningaasaliissutigineqartut amerlineqarujussuaqqaartariaqarput. Aningaasaliissutit amerlineqarpata qulimiguulimmik sivisunerusumik atuisoqarsinnaalissaaq, tamatumalu kingunerisaanik qulangiuaagaq annertusineqassaaq kiisalu sumiiffiit tuttoqarnerunissaanik ilimasuffiunerusut kisiisa pinnagit kisitsinerit ingerlanneqarsinnaalissallutik. Periarfissaq alla tassaavoq amerlassutsit nikerarnerannik malinnaaneq, tassa siuliani misissueriaaseq apeqqammersumi, ukiup taamaalerpiarnerani nunap ilusaa malillugu ikinnerpaassusiliiniarluni kisitsisarnerit imminnut sanilliunneqarsinnaasut ingerlattassallugit.

Sumiiffimmi ilisimasanik katersuineq tuttut maannakkorpiaq siammarsimanerinik aammalu naatsorsuutigisatut amerlassusaannik paasissutissiivoq; aammattaarlu misissuineq manna sumiiffimmi ilisimasat tamaanilu piniartut ilitsersuussutaat tunngavigalugit aaqqissuunneqarpoq. Sumiiffimmi najugaqartut aammalu ilisimatusartartut akornanni suleqatigiinnerup ingerlatiinnarneqarnissaa innersuussutaavoq.

Sammendrag

Rensdyrbestandens størrelse, struktur, tilvækst og udbredelse i Paamiut distriktet blev sidst undersøgt i 1995. For at fremskaffe information om den nuværende situation, var første fase af denne undersøgelse at skaffe dokumentation ud fra lokalt kendskab til de to rensdyrbestande, Neria og Qassit, i Paamiut distriktet. Der blev foretaget interviews med fangere og afholdt møder i lokalsamfundet. Den viden, der blev fremskaffet, dannede grundlag for den efterfølgende rekognoscering fra luften, en minimum- og flokstrukturtælling, efterårstilvækst (kalve pr. 100 køer/simler) og udbredelse af rensdyr.

Rekognoscering med helikopter fandt sted fra 28. september- 4. oktober 2000. På baggrund af instrukser fra de lokale fangere blev der fløjet en serie "spaghetti" tværsnit (dvs. at der bliver fløjet på en sådan måde, at helikopteren følger højden i terrænet) over Neria og Qassit bestandenes områder. Et nyt lag sne dækkede terrænet ved alle overflyvningerne, hvilket i høj grad øgede rensdyrsynligheden, idet tilstedeværelsen af nye spor muliggjorde en hurtig lokalisering af dyrene.

Neriabestanden (syd Paamiut)

Minimum antallet for Neria var 332 rensdyr. De største tætheder blev fundet midtvejs mellem Davis Stræde-kysten og indlandsisen. Den gennemsnitlige tæthed for minimumtællingens rekognosceringsområde, 180 km^2, var c. 2,2 ± 3,0 SD rensdyr/km^2. Maksimum tætheden var c. 14 rensdyr/km^2, der fandtes på tværsnit 17. Den gennemsnitlige gruppestørrelse var 4,1 rensdyr. Andelen af kalve var på 29,8%. Kønsfordelingen var 1,4 køer for hver tyr. Bestandstilvækst i efteråret var 72,2 kalve/100 køer. Den naturlige årlige dødelighed (8-10%) på minimumstællingen anslås at være mellem 27-33 dyr.

Qassitbestanden (nord Paamiut)

Minimum antallet for Qassit var 196 rensdyr. De fleste rener blev set nord for den store sø, *Kangaarsuup tasersua*. Den gennemsnitlige tæthed i minimumtællingens rekognosceringsområde, 202 km^2, var c. 0,9 ±2,2 SD rensdyr/km^2. Maksimum tæthed var c. 12 rensdyr/km^2, der fandtes på tværsnit 43. Den gennemsnitlige gruppestørrelse var 4,4 rensdyr. Kalveandelen var på 32,2%. Kønsfordelingen var 1,6 køer for hver tyr. Bestandstilvækst i efteråret var 77 kalve/100 køer. Den naturlige årlige dødelighed (8-10%) på minimumstællingen anslås at være 16-20 dyr.

Konklusioner

Disse data fra rekognosceringen tillod ikke beregning af bestandens størrelse, hverken for Neria eller Qassit-bestandene, fordi områder hvor der forventedes maksimum antal rensdyr blev prioriteret til undersøgelse. Begge bestande viser høje tal for efterårets kalveandel, og den lokale opfattelse er, at der er flere rensdyr end nogensinde tidligere. Det er muligt, at størrelsen af både Neria og Qassit bestandene vokser i betragtning af den udmærkede kalveandel, kønsfordelingen, god vegetation, ingen tilstedeværelse af rovdyr samt det lave jagtpres i 1990'erne.

Uden den nye sne ville det have været næsten umuligt at se rensdyrene i den ellers vanskelige terrænoverflade med mange tilisede ujævnheder (kampesten i alle størrelser - især af rensdyrstørrelse). Undersøgelse af antallet af rensdyr vil altid blive besværliggjort af sådanne tilfældige objekter, der reducerer muligheden for at observere rensdyrene. Helikopter flyvehøjden på 30 meter (100 fod) forbedrede muligheden for at se rensdyrene, og derfor anbefales denne højde for fremtidige undersøgelser.

Udsigten for fremtidige undersøgelser på den traditionelle måde, dvs. strip- eller line-tværsnit tællinger, blev vurderet til at være dårlig på grund af flere aspekter ved såvel rensdyrene som terrænet. Dale med stejle sider dominerer terrænet, og det tilgængelige livsmiljø varierer dramatisk på korte afstande. Når dette føjes til den lave tæthed og den klumpede udbredelse af disse rener, er resultatet to bestande, for hvilke det er vanskeligt at anslå et absolut antal, medmindre finansieringen forøges væsentligt. Tilførsel af flere penge ville muliggøre mere helikoptertid, hvilket vil forøge det dækkede område og muliggøre randomisering (beregning af bestandsestimatet er afhængig af vilkårligheden) af tværsnittene. Alternativt er et talrighedsindeks en mulighed, hvis rekognosceringen der er beskrevet her gentages, dvs. hvis det er muligt at foretage de samme flyvninger på den samme årstid med nyfalden sne.

Indsamlingen af lokal viden skaffede information om den aktuelle udbredelse af rensdyrene og deres relativt store antal; og det var på basis af den lokale viden og instruktioner fra de lokale fangere, at denne rekognoscering blev tilrettelagt. Fortsat samarbejde mellem de lokale beboere og forskerne anbefales.

Introduction

Region Paamiut contains the most southern distribution of native caribou (*Rangifer tarandus groenlandicus*) in West Greenland. They have no natural predators. These caribou are unique and perhaps in a Greenlandic sense "pure". Genetic testing in 1995 revealed that the Paamiut caribou possessed a lack of genetic diversity and were genetically distanced from other herds in Greenland (Jepsen 1999). Although, historically there has always been talk of 2 sub-populations/herds in region Paamiut, the Neria herd to the south and the Qassit herd to the north (Meldgaard 1986, Kristian Dahl pers. comm.), until 20001 they have been managed and assessed as one population (Meldgaard 1986, Jepsen 1999). Within this report they are treated as two distinct and separate herds.

There are long traditions for caribou hunting in region Paamiut (Grønnow & Meldgaard 1982). Historical records in Meldgaard (1986) indicate that caribou were scarce in region Paamiut from the mid-1700s through to about 1840. After a 10 to 15 year period of relative abundance numbers again fell. It is difficult to evaluate what is meant by scarce or abundant in these contexts. With the beginning of the 20th Century hunting and trading statistics began to be kept for Paamiut. Between 1910-20 about 500 to 600 caribou were harvested annually (number traded was less). Between 1925-45 harvests typically took 100 to 200 caribou annually. From 1945-72 harvesting was usually below 100 caribou annually. In 1972 the harvest took c. 300 caribou, but subsequent years reported only c. 150 caribou per year. In 1980, the Neria herd was thought to be around 400 caribou (Reimers 1980), and in 1982 the Qassit herd was thought to contain c. 200 animals (Aastrup 1983, Strandgaard et al. 1983). All of the above suggest that caribou have seldom been discernibly abundant in region Paamiut. Although the recorded harvests above were not large, Strandgaard et al. (1983) suggested that the low caribou numbers in both herds were due to overly heavy hunting pressure.

Distribution of the Neria caribou has shown little temporal, but some spatial variation, e.g., lower densities near the seacoast and higher concentrations near the inland Ice Cap (Reimers 1980). The Qassit caribou concentrate use to the area immediately south of *Frederikshåb Isblink,* which is a tongue of the Ice Cap (Figure 1), with lower densities closer to the seacoast (Aastrup 1983).

Although hunting had been prohibited for two years, 1993-94, aerial line-transect surveys in 1994 and 1995 indicated caribou were once again low in number for the Paamiut region. The population size estimates were only 181 (62 to 525) and 407

(225 to 738) respectively (Ydemann & Pedersen 1999). Quota regulated harvesting was instituted in 1995. Since then reported harvests have been between 29 and 180 caribou.

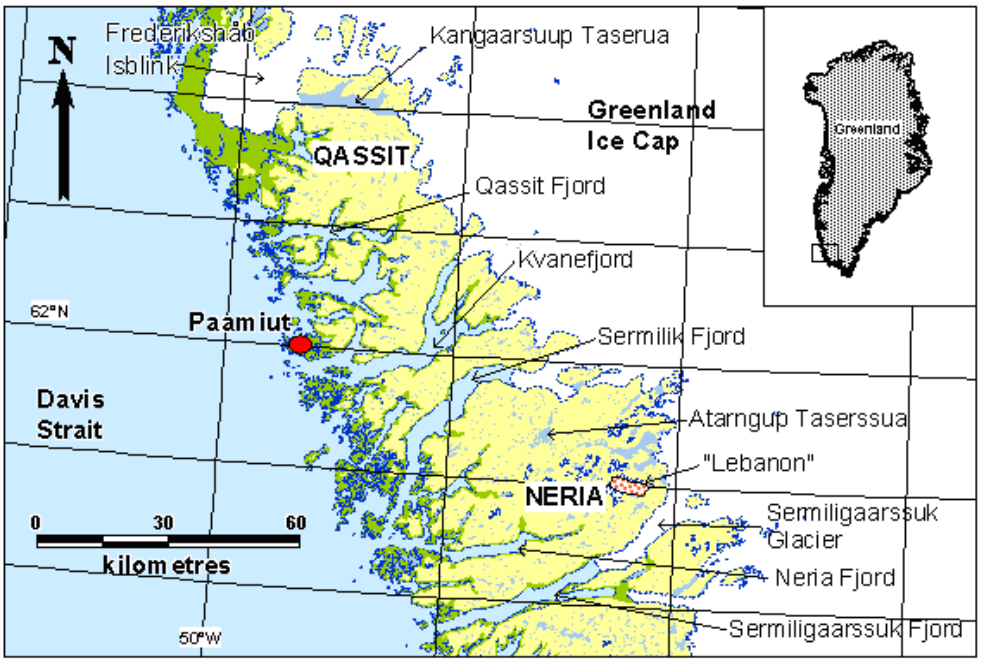


Figure. 1. Place names in the Paamiut region.

Today, the largest human settlement within the region is the town of Paamiut (Frederikshåb), with 2,082 inhabitants, while a further 197 people live in smaller settlements (Grønlands Statistisk Årbog 2000). By the turn of the 21st Century, caribou were plentiful both along the inner fjord coastlines and further inland, with group sizes of up to 30 animals being reported (Nikolaj Knudsen & Karl Berthelsen pers. comm.). A new survey for abundance was requested, which might reflect and support local ideas about caribou herd size in region Paamiut.

Surveying for caribou abundance is at best beset by sundry intrinsic difficulties (Thomas 1998). Although region Paamiut is the smallest of the caribou regions, at c. 5,100 km^2, the terrain is rugged to the extreme, with abrupt fjord to high mountain elevation changes. Glacial erratics of all sizes litter much of the region at all elevations. Both these conditions make observing caribou difficult. Given the earlier low herd size estimates and the fact that it was unknown where caribou would be currently found, or at what densities, stratifying the area and applying strip transects for survey were unreasonable for this region. If caribou numbers were as low as suggested by previous counts than flying a selection of random transects might only use the entire budget and give us little information. Given the Paamiut situation, a better approach was to obtain local knowledge of the present day caribou distribution and relative densities in order to concentrate a reconnaissance effort for minimum count and herd structure.

Based on aerial reconnaissance in September and October 2000, this report provides new information about the two caribou herds of region Paamiut. Although estimates of abundance are not presented, information is given on minimum count, herd structure and recruitment for the Neria and Qassit herds, plus local knowledge concerning these herds.

Methods

Local knowledge & involvement

To obtain a local perspective on caribou distribution, relative abundance and hunting traditions, interviews with local hunters were conducted on 21-22 September 2000 with an interpreter, Aqqaluk Petersen, present (Appendix 1). Maps were provided so that local knowledge could be collected with both spatial and temporal components.

Further local knowledge on caribou distribution and relative abundance was gathered by holding a community meeting on 23 September 2000, with interpreter Aqqaluk Petersen present. Using maps, the hunters instructed on where caribou could be found, and which routes the helicopter reconnaissance should fly. At this meeting several local hunters from the Paamiut (Frederikshåb) community were chosen by the local KNAPK hunters' association (P.A.P.P.) to participate as observers in the helicopter reconnaissance for caribou. Participants included both professional and recreational hunters, Lars Petersen, Nielseeraq Jakobsen, Tittus Lorentzen, Tittus Andersen, Kim Kielsen, Jokum Schmidt and Nikolaj Knudsen.

A second meeting was held 2 October 2000 to discuss the results of the reconnaissance, and 28 locals attended. The investigators and local hunters who participated explained for the community what had been done and the initial results obtained.

Helicopter reconnaissance objectives

The major objectives were to ascertain present day caribou minimum count, herd structure, autumn recruitment (number of calves per 100 cows) and distribution for both the Neria and Qassit herds.

Helicopter reconnaissance for caribou distribution, minimum count and herd structure

An aerial reconnaissance of region Paamiut occurred between the 28th of September and the 4th of October 2000. September was chosen because local knowledge concerning caribou is best for this time period, i.e. the caribou harvest.

October was included due to delays caused by the weather. An AS 350 helicopter was employed, which in addition to slow flight speed, could follow abrupt terrain features while maintaining a constant altitude above ground level. To increase sightability of caribou all spaghetti transects were flown slowly, 50 to 90 km/hr, and at an altitude of c. 30 metres (100 feet) above the ground, following recommendations from an aerial survey completed earlier in 2000 (Cuyler et al. 2002). Wind direction and speed determined and changed necessary flight speeds to remain airborne.

Strip width was based on experience from the present and previous surveys using similar methods. Strip width was initially set to 500 meters on either side of the helicopter, for a total strip width of 1 kilometre. To ascertain the 500 m mark for each observer, Leica laser distance-finder binoculars were used. While hovering at the specified altitude and aided by the binoculars, each observer individually marked both a 500 & 300 metre strip width on the helicopter window. It became apparent however, that the actual strip width for observing caribou was c. 300 metres to each side of the helicopter. A 2x300 metre strip width was therefore used in calculation of transect area. A continuous series of spaghetti transect, of known start and finish Global Positioning System (GPS) locations, were flown. The length of each segment varied. All reconnaissance flights were flown following a fresh snowfall at all elevations.

Usually there were 4 observers, 2 for each side of the helicopter. Alternately there were 3 observers, of whom two counted on the left side of the helicopter and one on the right side. All observers counted caribou independently of each other, e.g., no verbal or other contact, while a transect was being flown. Manual click-counters were used to log the number of caribou seen on a specific spaghetti transect by each observer. The number counted by each observer was recorded immediately following the finish of that segment, after which click-counters were zeroed before the start of the next segment. It was not possible to ascertain when observers on the same side saw the same caribou. The number of caribou on a given spaghetti transect equalled the sum of the maximum observed from each side of the helicopter. The left front-seat observer simultaneously observed caribou, navigated the helicopter and recorded all routes taken.

The spaghetti transects chosen were based on knowledge collected from local hunters through interviews and a community meeting. The object was to observe as many caribou as possible. Thus when making route choices for the spaghetti transects, areas where caribou were expected were preferentially sampled. Transects were consecutive. 27 spaghetti transect segments were flown over the

range of the Neria herd, on 28 September and 1 October 2000 (Figure 2). 34 spaghetti transect segments were flown over the range of the Qassit herd, on 2 and 4 of October 2000 (Figure 3).

The *Kvanefjord* peninsula also received 2 spaghetti transects, since the peninsula had to be crossed to reach the Neria range. These occurred on 28 September and 1 October.

The results are presented as a minimum count. No general methodology is available to estimate population numbers based on spaghetti transects, specifically since transects were not random but selected as the best possible areas for sighting caribou. This report does not present a population size estimate for either Neria or Qassit, because the resulting estimate would be heavily biased due to the biased sampling design.

Herd structure and recruitment counts were obtained by backtracking transects in a zigzag pattern, never flying more than c. 2 kilometres from the segment line. Choice of a segment for backtracking depended on the number of caribou present, since the object was to maximize the number of caribou sexed and aged. There was close communication between all observers and pilot during this exercise. All caribou sighted were sexed and aged (< or > 1 year old) following a brief overpass with the helicopter. On occasion so few caribou were seen on a segment that these could be sexed and aged immediately without the need of backtracking.

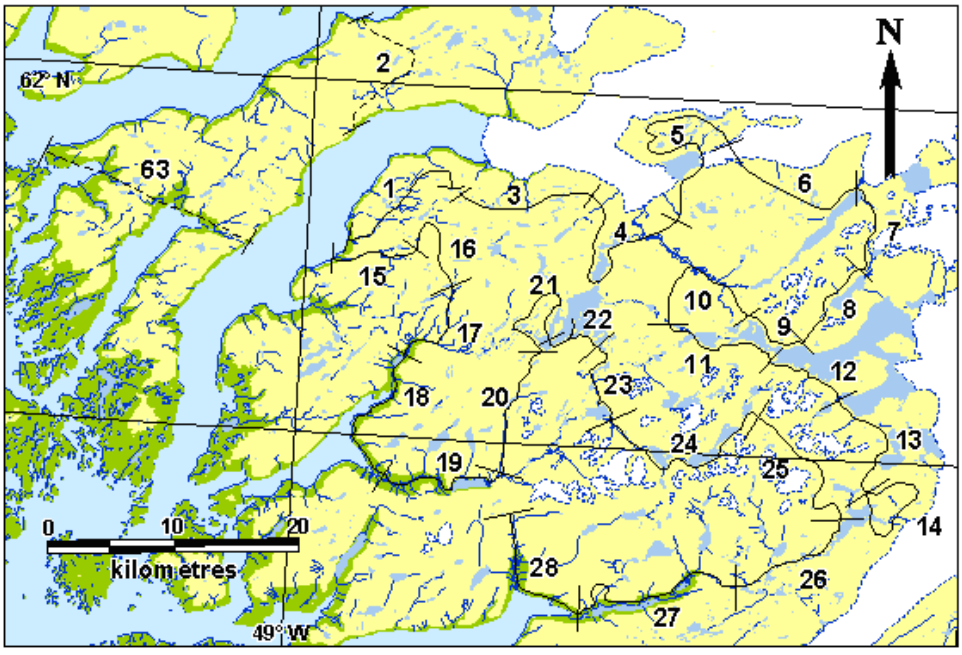


Figure 2. Aerial reconnaissance Neria herd: spaghetti transects.

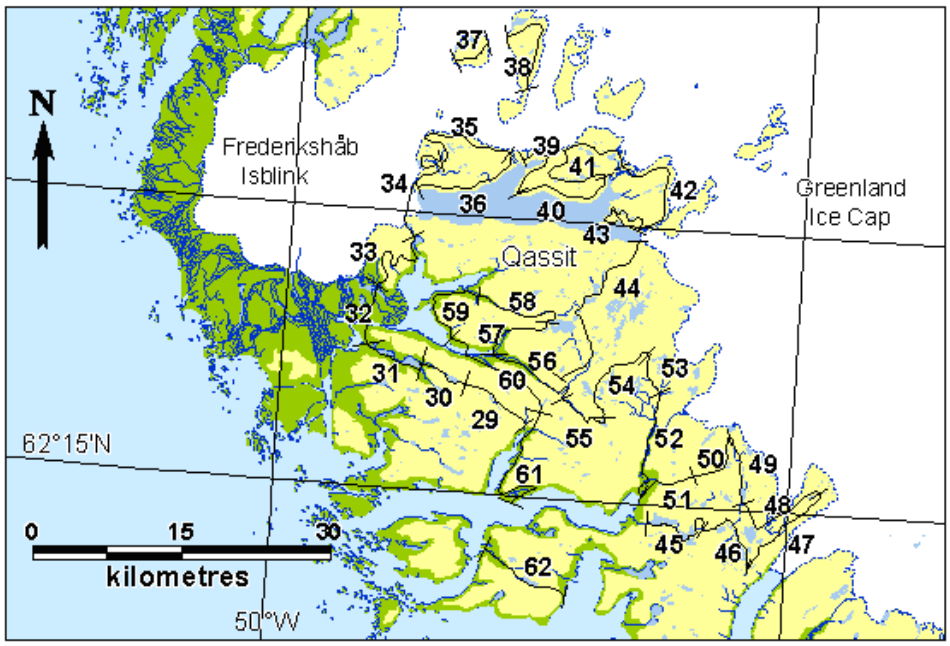


Figure 3. Aerial reconnaissance Qassit herd: spaghetti transects.

Sex & age criteria

Sex was determined by presence or absence of a vulva and/or urine patch on the rump. This reliably indicated a female on both adults and calves. No other method was 100% certain, e.g., antler size, shape, presence/absence were not used. There were two age categories used in subsequent analyses, calf (≤ 9-10 months old) and adult (> 1 year). Age was determined by body size. Calves of both sexes were considerably smaller than all others. Group size was based on proximity and group cohesion during possible flight response, e.g., several small groups separated by several hundred metres, which fled in separate directions, would not be regarded as one group.

Study Areas

Although region Paamiut encompasses an area of about 5,100 km², the ranges used by the two sub-populations/herds are much smaller.

Neria

To the south the Neria herd occupies an area of c. 2,300 km², which includes islands, lakes & rivers, but deletes fjords, ice caps & glaciers, between the *Sermilik* and *Sermiligaarssuk* fjords. Much of Neria, i.e., c. 2,000 km², lies over 200 m above sea level (ASL). Abrupt and large elevation changes are the norm with glacial erratics covering the landscape at all elevations. In addition to the Ice Cap to the east there are numerous alpine glaciers in the south-central portion.

Qassit

To the north, the Qassit herd occupies an area of c. 1,400 km², which includes islands, rivers and lakes (excluding the large *Kangaarsuup tasersua* lake), but does not include fjords, ice caps and glaciers. This encompasses all land immediately

south of the *Frederikshåb Isblink* down to the lands immediately north of Qassit fjord, and east to the Ice Cap. There are few valleys or lowlands in the Qassit area, i.e., c. 1,000 km² lie above 200 m ASL. A large lake, *Kangaarsuup tasersua* stretches across the northern portion. Abrupt elevation changes, and high mountain plateaus characterize the area. Glacial erratics cover the landscape at all elevations. Thing (1982) described the Qassit range as extremely lush, specifically as regards lichens. Precipitation is plentiful year round, and in winter the snow cover is complete and often deep.

Results

Local knowledge

Twelve local hunters gave interviews on caribou distribution and abundance. Seven of these were elders over 60 years of age, which allowed a historical perspective. A further twelve local hunters attended the community meeting, which was for the collection of local knowledge and to give a general orientation of the study. The interviews and community meeting with local hunters provided current local knowledge about the Neria and Qassit caribou populations (Figures 4, 5).

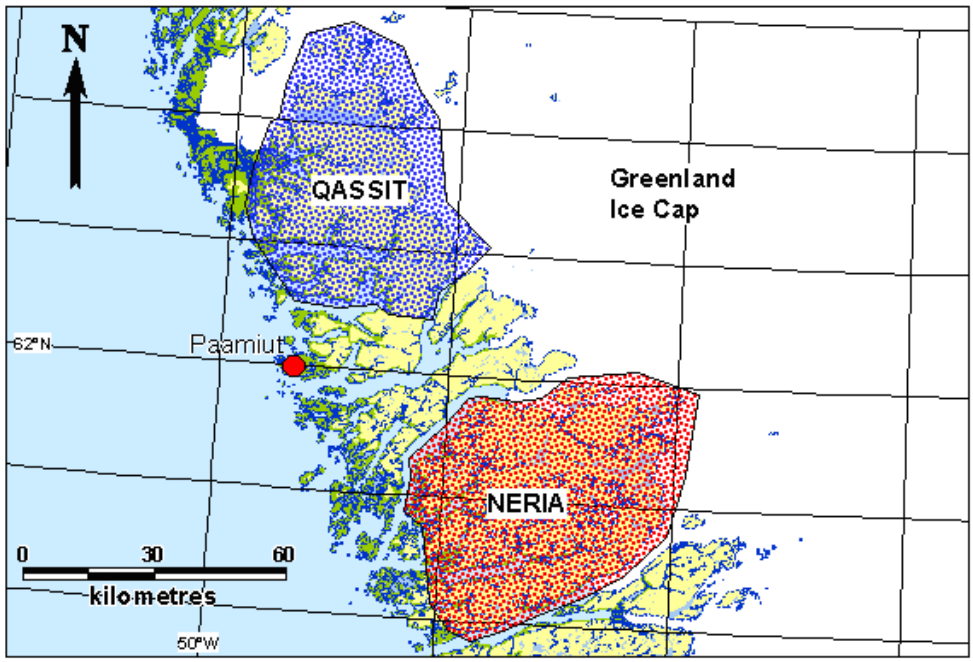


Figure 4. Local knowledge in 2000 on approximate ranges used by the Neria and Qassit caribou herds in the Paamiut region.

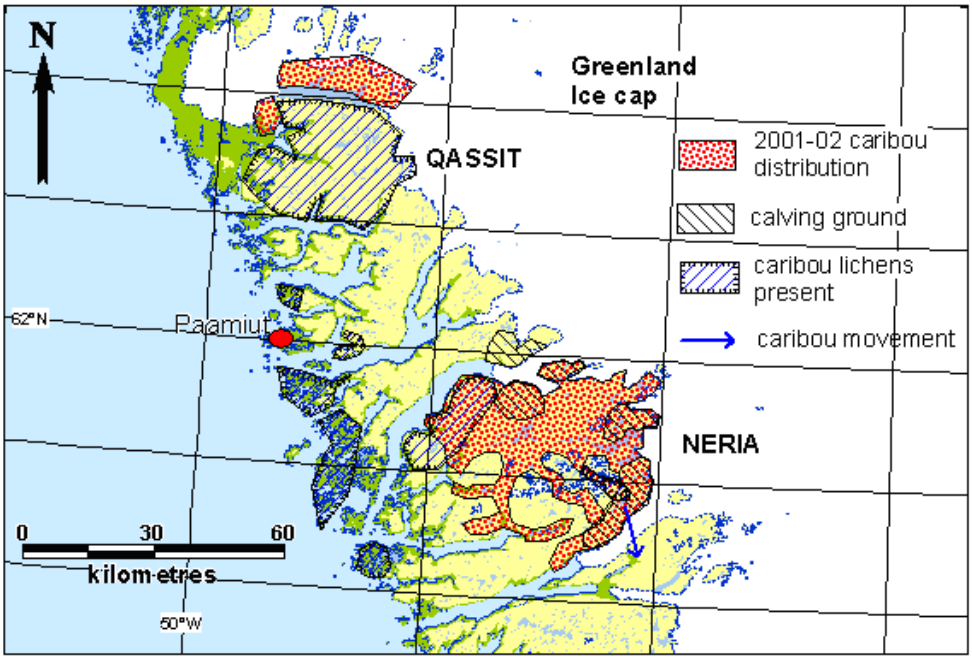


Figure 5. Local knowledge in 2000 on caribou distribution, movement, calving areas and lichen range for the Neria and Qassit caribou herds in the Paamiut region.

Aerial reconnaissance logistics

The manual click-counter animal counts from each observer for each segment provided the basis for the total minimum count of each population. Observers spotted most caribou at distances of ≤ 300 metres. The presence of newly fallen snow was the single most important factor for locating caribou in the boulder-strewn terrain, because fresh tracks permitted quick spotting of actual animals. This survey used about 13 helicopter hours for reconnaissance and 5 helicopter hours for ferrying to and from the study areas. Area coverage was c. 8 % for Neria and c. 15% for Qassit (Appendix 2).

Caribou minimum count

The minimum count was 332 caribou for Neria, and 196 for Qassit (Table 1). Population size estimates were not possible, because transects were not chosen randomly but rather areas where caribou were expected were preferentially sampled. Additionally, strip width was likely variable and a calculation of variance of the strip width was not possible, i.e., since measured distances to animals could not be obtained.

No caribou were observed on the *Kvanefjord* peninsula, although tracks in the fresh snow indicated the presence of perhaps 3 animals for the segments flown.

Herd structure & recruitment

The autumn recruitment suggests an excellent calf production in both the Neria and Qassit herds. The sex ratio is 1.4 cows for every bull in the Neria herd, and 1.6 cows for every bull in the Qassit herd.

Table 1. *Herd Structure for two caribou herds in region Paamiut, 1-4 October 2000*

	Neria herd	**Qassit herd**
Location	Paamiut south	Paamiut north
Date	1 October 2000	2 & 4 October 2000
Method	Helicopter	Helicopter
Total counted	332	196
Total sexed & aged	131	146
Average group size	4.1	4.4
Maximum group size	14	24
Bull (>1 year)	38 (29.0 %)	38 (26.0 %)
Cow (>1 year)	54 (41.2 %)	61 (41.8 %)
Calf	39 (29.8 %)	47 (32.2 %)
Autumn recruitment (calves/100 cows*)	72	77

* All cows >1 year old

Neria caribou distribution and density

A minimum count of 332 caribou were observed along the 28 spaghetti transects. Maximum caribou density, c. 14 caribou/km^2, was observed on transect number 17. Transects having densities > than 4 caribou/km^2 were in descending order, 17, 15, 22, 26 and 19 (Appendix 2; Table 4). Areas of high caribou density were unevenly distributed. There were, however, some common characteristics, e.g., they were 1) situated midway between the Davis Strait seacoast and the Greenland Ice Cap, 2) at elevations between 400 and 700 metres, 3) in close proximity to a fresh water lake or waterway, and 4) perhaps a south-facing aspect. Caribou were conspicuous in their absence close to the Ice Cap in the north-eastern portion of the Neria range. Although no transects were allocated to the Davis Strait coastline, two refuelling flights overflew the coastal areas and islands, which were covered with freshly fallen snow. No caribou or caribou tracks were found on the outer coastal areas or islands bordering Davis Strait. During the time period covered, the caribou distribution of the Neria herd generally agreed with local knowledge obtained prior to the reconnaissance.

Qassit caribou distribution

A minimum count of 196 caribou were observed along the 33 spaghetti transect segments. Maximum caribou density, c. 12 caribou/km^2, was observed on transect

number 43. There were only two transects having densities > than 4 caribou/km^2. These were in descending order, 43 and 34 (Appendix 2; Table 5). It was striking that the majority of caribou, i.e., 123, were seen on the three nunatak-like pieces of land sandwiched between the lake *Kangaarsuup tasersua* and the *Frederikshåb Isblink*. Over 50 caribou were observed foraging on the *Kangaarsuup Nunaa (Karra)* in the west, and most of these were on the exceedingly steep south facing "rock" slopes. Further, about twenty animals were observed moving west across the *Frederikshåb Isblink,* which is riddled with deep crevasses. Just to the east, on the middle nunatak-like area, almost 30 caribou were foraging on similarly steep south facing rocky slopes. Furthest to the east, over 60 caribou had aggregated to forage on the southwestern shore of the third, most easterly and final nunatak-like area north of lake *Kangaarsuup tasersua*. In contrast to the first two areas, here the caribou were grazing on gentle south-facing slopes. No caribou or tracks were seen on the true nunataks embedded within *Frederikshåb Isblink*. Thus the majority of the Qassit herd were observed in the area north of lake *Kangaarsuup tasersua* during the period of the reconnaissance.

Discussion

The minimum count for Neria was 332 caribou, and for Qassit 196 animals. This reconnaissance data did not allow a calculation of population size for either the Neria or Qassit herds, because areas where maximum caribou were expected were preferentially sampled. Application of more sophisticated methods of line-fitting and variance calculation were deemed inappropriate due to the highly biased sampling, and further, any result would be highly dependent on the strip width, which was likely to be variable. An approximate total area perferred by Neria caribou and possible inference to a population estimate are discussed in Appendix 5.

Neria herd – south region Paamiut

Caribou were scarce where alpine glaciers were numerous or near the Ice Cap. Although both locals and previous researchers (Meldgaard 1986, Reimers 1980, Strandgaard et al. 1983) have indicated that high concentrations of caribou would be found close to the inland Ice Cap, there were few or no caribou there during the time period of this reconnaissance. In all else, local knowledge was supported by reconnaissance observations. Some animals were observed below 200 metres elevation in the inner fjords, typically along shorelines. No caribou were found on the outer coastal areas or islands bordering Davis Strait. Instead, concentrations of caribou were found midway between the Davis Strait seacoast and the Greenland

Ice Cap, at elevations between 400 and 700 metres, in close proximity to fresh water lakes or waterways and often on south-facing slopes. Locations included the area around the lake, *Atarngup tasersua* , and the highlands above the south shore of *Sermilik* fjord and along the north side of the *Sermiligaarsuk* glacier tongue. The latter suggests support for the local opinion that animals regularly move south across the *Sermiligaarsuk* glacier.

Previous herd size estimates have been low (Table 2) and calf percentages of only 13 to 15% were observed in 1994 – 1995 (Ydemann & Pedersen 1999), suggesting a herd in difficulty. According to local sources the vegetation is generally thought to be good, and could support a healthy herd. Hunters observed many calves in 1997-98 (Kielsen pers. comm.). The present autumn recruitment observed in Neria, 72 calves/100 cows, was high compared to other studies. Typical autumn calves/100 cows values are lower, e.g., 27 to 36 in central Alberta, Canada (Edmonds 1988), an average of 60 for the period 1970s and 1980s in *Forelhogna*, Norway (Skogland 1988), 61 in *Rondane*, Norway (Andersen & Hageland 1994), and 59 in the Porcupine herd (Fancy et al. 1994). In the absence of predators a high recruitment, as observed in the Neria herd, can promote a rapid increase in animal numbers.

The herd may also be expanding its range. From the local knowledge gathered, there is the suggestion of range expansion westward to the inner fjord coasts and also dispersal south across *Sermiligaarsuk* glacier tongue. Both indicate an increasing herd size, since caribou in Greenland typically disperse and expand range when herd size increases (Meldgaard 1986). Caribou dispersal is also an indication that vegetation may no longer be optimal (Baskin 1990), which suggests that the Neria range may already have reached its carrying capacity for caribou.

Adult natural mortality for caribou in 5 North American herds without natural predators is 4-6% annually (Bergerud 1967, 1971, Skoog 1968, Kelsall 1968), which corresponds to a life expectancy of 17 to 25 years. Adult annual natural mortality has been c. 8% on Southampton Island (NWT, Canada), which is also without predators (Heard & Ouellet 1994). Region Paamiut lacks all natural predators. Actual natural mortality values for Greenland caribou appear around 8-10%, given the general average life expectancy of 10 to 12 years found in Loison et al. (2000) and Cuyler & Østergaard (2002). Using a natural mortality of 8-10% and the minimum count of 332 caribou for the Neria herd, equates to an expected minimum natural mortality of about 27 to 33 caribou each year in the Neria portion of region Paamiut.

Table 2. *Estimated herd sizes and harvest quotas for the Neria & Qassit caribou herds, region Paamiut.*

Year	Herd Size Neria	Herd Size Qassit	Harvest Quota Paamiut	Reported Harvest Paamiut
1980		200[1]	X[4]	c. 150[5]
1982	400[2]		X[4]	c. 150[5]
1993			0	0
1994	181 (62-525)[3]		0	0
1995	407 (225-738)[3]		50	50
1996			Not specified	104
1997			Not specified	130
1998			Not specified	180
1999			80	29
2000			160	86

[1] Aastrup 1983, [2] Reimers 1980, [3] Ydemann & Pedersen 1999, [4] harvest unregulated, [5] Meldgaard 1983

Qassit herd – north region Paamiut

Once again local knowledge agreed well with reconnaissance observations. The caribou were concentrated in the most northern portion of the area. Almost all caribou observed occurred on 3 south-facing slopes in the small area immediately north of the lake *Kangaarsuup tasersua.* Few animals or caribou tracks were observed elsewhere, although transect coverage of the entire area was 15%. From the local knowledge gathered, and observations during the reconnaissance dispersal across the *Frederikshåb Isblink* into the southernmost portions of region "South" would appear possible.

The local knowledge sources indicate the vegetation is good over large areas of the range. The autumn recruitment observed by the present study was 77 calves/100 cows, which is similar to the Neria value and excellent relative to other caribou populations studied in Scandinavia and North America. In the absence of predators this recruitment value can promote rapid increase in the population. Hunters say that big bulls are taken here, which suggests excellent forage is supporting good caribou body condition. Further, during the reconnaissance animals appeared to have good body condition. The population may be relatively small but given the above, herd size could increase.

Using a natural mortality of 8-10% and the minimum count of 196 caribou for the Qassit herd, equates to an expected minimum natural mortality of about 16 to 20 caribou each year in the Qassit portion of region Paamiut.

Implications for caribou harvest

In 1996, 1997 and 1998 there was no harvest quota specific to region Paamiut. The reported harvests for these years were 104, 130 and 180 caribou respectively. However, a low specific quota was designated for Paamiut starting in 1999. The quota was 80 in 1999 and 160 in 2000. Hunters reported taking only 36% and 54% of the allocated harvest quota for the Paamiut region in 1999 and 2000 respectively. This corresponded to 29 and 86 animals taken. The low numbers taken were due to the relatively low quotas given for Paamiut, which made it less cost effective, i.e., cost time and travel versus amount meat in return, for hunters to hunt in Neria (Kim Kielsen pers. comm.). At Neria typically only 1 caribou per hunter was allowed. In contrast, several caribou were allowed further north in region South if one hunted the Qeqertarsuatsiaat or Ameralik caribou populations. Not surprisingly, many hunters went to region South.

Since both Neria and Qassit herds are likely increasing, which could endanger range quality, to encourage hunters to harvest in region Paamiut the 2001 recommended harvest quota for the Neria herd became 500, and for the Qassit herd 100 caribou. The 2001 quotas remained unchanged in 2002. Further, in 2003 an additional winter hunt of 250 was allowed, while the summer hunt in 2003 became unlimited. To maintain a herd structure that is advantageous for population stability, future harvests should be 50:50 bulls to cows.

Acknowledgements

This project was financed by DANCEA (Danish Cooperation for Environment in the Arctic – Ministry of Environment and Energy, Strandgade 29, Copenhagen K, Denmark). Grateful thanks to Kristian Dahl, Mike Petersen at the Paamiut *Erhvervs* Office, for their invaluable help in advertising, arranging, providing venues and obtaining an interpreter for both interviews and meetings. Aqqaluk Petersen was interpreter and translator at meetings and interviews. A warm thank you to the locals who sat as caribou observers in the helicopter, KNAPK hunters, Lars Petersen, Nielseeraq Jakobsen, Tittus Lorentzen, Tittus Andersen, & Nikolaj Knudsen, and sport hunters Kim Kielsen & Jokum Schmidt. Greenland Air helicopter pilots Ulf Østerlund & Bent Rejs provided hours of safe flying. Paamiut heliport made their coffee-break room available for pre-flight discussions. Hotel Paamiut prepared refreshments for the community meetings. Sincere thanks go to Erik W. Born, Mads-Peter Heide-Jørgensen, Michael Kingsley and Frank Riget for reviewing the manuscript.

Thanks are also due the locals who gave local knowledge interviews, Manasse Møller, David Rosing, Thomas Abrahamsen, Peter Eigildsen, Jokum Schmidt, Aqqaluk Petersen, Anders Berthelsen, Ole Petersen, Kim Kielsen, Birger Knudsen, Orla Wallbohm and Kristian Dahl. Locals participating in community meetings included, Karl Berthelsen, Jokum Schmidt, Oleraq Kristoffersen, Enok Broberg, Karl Josefsen, Lars Petersen, Thor Berthelsen, John Heskiassen, Tittus Andreassen, Karl Samuelsen, Kim Kielsen, Henrik Petersen, Abia Thorsteinsen, Ulrik Frederiksen, Sem (Angutinnquaq) Frederiksen, Angutimarik Lorentzen, Esaias Lorentzen, Hermann Hegelund, Bente Kreilgaard, Peter M. Petersen, Karl K. Knudsen, Konrad Kristoffersen, Sigurd Klemmensen, Tobias Klemmensen, Jokum Cortzen, Tittus Lorentzen, Jørgen Jakobsen, Nukaaraq Jakobsen, Nielseran Jakobsen, Adolf Frederiksen, Nikolaj Knudsen, Ole M. Petersen, Mike Gerth Petersen, Ole Petersen, Kristian Dahl, Aqqaluk Petersen.

References

Aastrup, P. 1983. Rensdyrbestanden nord for Kvanefjord. Kapital 9: 57-63 - *In:* Miljø-undersøgelser vandkraftprojekt Iterlaa, Paamiut/Frederikshåb, 1982. Grønlands Fiskeriundersøgelser, Tagensvej 135, 220 København N. 89 pp.

Andersen, R. & Hageland J. 1994. Strukturtelling i Rondane høsten 1994 – resultater og erfaringer. *Villrein*. 1994: 68-70. (in Norwegian)

Baskin, L.M. 1990. Population dynamics of reindeer. Rangifer, Special Issue No. 3: 151-156.

Bergerud, A.T. 1967. Management of Labrador caribou. *J. Wildl. Manage.* 31: 621-642.

Bergerud, A.T. 1971. The population dynamics of Newfoundland caribou. *Wildl. Monogr.* 25: 55 pp.

Cuyler, C. & Østergaard, J. 2002. Fertility in two west Greenland caribou populations on different ranges, 1996/97. Pinngortitaleriffik - Greenland Institute of Natural Resources. Progress Note 1. 11 pp.

Cuyler, C., Rosing, M., Linnell, J.D.C., Loison, A., Ingerslev, T., & Landa, A. 2002. Status of the Kangerlussuaq-Sisimiut caribou population (*Rangifer tarandus groenlandicus*) in 2000, West Greenland. Greenland Institute of Natural Resources. Technical report No. 42. 52 pp.

Edmonds, E.J. 1988. Population status, distribution, and movements of woodland caribou in west central Alberta. *Can. J. Zool*. 66: 817-826.

Fancy, S.G., Whitten, K. R., & Russell, D. E. 1994. Demography of the Porcupine caribou herd, 1983-1992. *Can. J. Zool.* 72: 840-846.

Grønlands Statistisk Årbog 2000. Grønland 2000 Kalaallit Nunaat: statistisk årbog Ukiumoortumik kisitsisitigut paasissutissat. Grønlands Hjemmestyre. Grønlands Statistik 2000. 624 pp. (in Danish)

Grønnow, B. & Meldgaard, M. 1982. Arkæologiske recognosceringer i Paamiut, Nuuk og Sisimiut kommuner, 1982. – Field report on file at Kalaallit Nunaata Katersugaasivia (Grønlands Landsmuseum), Nuuk, Grønland. (in Danish)

Heard, D.C. & Ouellet, J.P. 1994. Dynamics of an introduced caribou population. Arctic. 47(1): 88-95.

Jepsen, B.I. 1999. Populationsgenetiske studier af vildren (*R.t.groenlandicus*) and tamren (*R.t. tarandus*) i Vestgrønland. MSc Thesis, Botany Institute, University of Copenhagen, Denmark. 64+ pp. (in Danish)

Kelsall, J.P. 1968. The migratory barren-ground caribou of Canada. - Can. Wildl. Serv., Queen's Printer, Ottawa, Canada, 340 pp.

Loison. A., Cuyler, C., Linnell, J.D.C. & Landa, A. 2000. The caribou harvest in west Greenland, 1995-98: sex, age and condition of animals based on hunter reports. Pinngortitaleriffik – Greenland Institute of Natural Resources Technical Report No. 36. 33 pp.

Meldgaard, M. 1986. The Greenland caribou – zoogeography, taxonomy, and population dynamics. Meddelelser om Grønland. *Bioscience* no. 20. 88 pp.

Reimers, E. 1980. Rensdyrbestanden på Disko, Nûgssuaq, Frederikshåb- og Angmassalik-områderne. Report on file at Vildtbiologisk Station, Kalø, Denmark: 33pp. (in Danish)

Skogland, T. 1988. Bestands analyse av villreinstammen i Forelhogna. *Villrein* : 14-22. (in Norwegian)

Skoog, R.O. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. - Ph.D. Thesis, University of California, Berkeley, 699 pp.

Strandgaard, H., Hothe, V., Lassen, P. & Thing, H. 1983. Rensdyrsundersøgelser i Vestgrønland 1977-82.- Job completion report. Vildtbiologisk Station, Kalø: 1-29. (in Danish)

Thomas, D. 1998. Needed: Less counting of caribou and more ecology. *Rangifer*, Special Issue No. 10: 15-23.

Ydemann, D. & Pedersen, C.B. 1999. Rensdyr i Vestgrønland 1993-1996. Unpublished report to Greenland Institute for Natural Resources, Nuuk, Greenland. (in Danish)

Appendix 1

Local Knowledge

Interviews

The locals who gave local knowledge interviews (Figure 6) included; Manasse Møller (69 years), David Rosing (67 years), Thomas Abrahamsen (74 years), Peter Eigildsen (66 years), Jokum Schmidt (60 years), Aqqaluk Petersen (63 years), Anders Berthelsen (66 years), Ole Petersen (56 years), Kim Kielsen (34 years), Birger Knudsen (resident for 27 years), Orla Wallbohm (resident for 35 years) and Kristian Dahl.

Community meetings

Locals participating in community meetings (Figure 7) included; Karl Berthelsen, Jokum Schmidt, Oleraq Kristoffersen, Enok Broberg, Karl Josefsen, Lars Petersen, Thor Berthelsen, John Heskiassen, Tittus Andreassen, Karl Samuelsen, Kim Kielsen, Henrik Petersen, Abia Thorsteinsen, Ulrik Frederiksen, Sem (Angutinnquaq) Frederiksen, Angutimarik Lorentzen, Esaias Lorentzen, Hermann Hegelund, Bente Kreilgaard, Peter M. Petersen, Karl K. Knudsen, Konrad Kristoffersen, Sigurd Klemmensen, Tobias Klemmensen, Jokum Cortzen, Tittus Lorentzen, Jørgen Jakobsen, Nukaaraq Jakobsen, Nielseran Jakobsen, Adolf Frederiksen, Nikolaj Knudsen, Ole M. Petersen, Mike Gerth Petersen, Ole Petersen, Kristian Dahl, Aqqaluk Petersen.

Figure 6. Local knowledge interview with hunter in Paamiut.
Photo by: Michael Rosing.

Figure 7. Local knowledge meetings at Paamiut.
Photos by: Christine Cuyler and Michael Rosing.

General

First it was ascertained where caribou were unlikely to be present. It was generally acknowledged that caribou would not be found on outer coastal areas or islands bordering Davis Strait. Similarly, the majority of locals indicated that caribou seldom now occur on the long-armed peninsula between *Kvanefjord* and *Sermilik* fjords, although 3 or so individuals might be shot each autumn at highland locations close to the Ice Cap. Between 1940-80 at least one hunter always hunted the inland highland portion of the long-armed peninsula and he always found caribou then. However, few if any caribou have been sighted there during the 1990s.

Local knowledge from the caribou harvest of August-September 2000 shows most of the quota of 160 animals were taken in areas close to and accessible from inner fjord coastlines. Hunters did not need to penetrate far inland to obtain caribou. Reasons given for hunting at the inner fjord coasts were 1) animals were easy to get, and 2) not far to carry back to the boat. Primarily females and calves use these inner fjord coast areas. Hence, in contrast to other regions, there is a large proportion of females in the caribou harvest from region Paamiut. Female caribou of region Paamiut are typically polled, i.e., are without antlers.

The low number of caribou harvested in region Paamiut in 1999 and 2000 was not due to a lack of accessible caribou in region Paamiut. Rather with only 1 caribou allotted per hunter a Paamiut hunting trip was not worth the time and financial effort, specifically since most hunters made an extended trip to region South where they had been allotted several caribou. Locals said that prior to regulation of the harvest in the 1990s, Paamiut hunters traditionally took about 500 caribou from Neria and 100 from Qassit.

Neria Herd

Caribou distribution

Since 1995 caribou have been seen regularly near the inner fjord coasts, specifically in springtime. Many caribou use the inland north-central portion around the lake, *Atarngup tasersua*. Other favoured areas included, areas adjacent to the Ice Cap, highlands running just north of the *Semiligaarsuk* glacier tongue, the south shore highlands of *Sermilik* fjord, inner fjord coastlines and valleys, and sometimes the highlands between the Neria and *Sermiligaarsuk* fjords. Not all were agreed on the last.

Caribou abundance

During the 1940s caribou were few and hunters had to go right in to the inland Ice Cap to find caribou (this took c. 1 week). Since animals could only be found close to the Ice Cap this area was made a caribou reserve during the 1950-60s. The result was that the caribou number increased. Caribou number increased slowly and steadily since the 1940s & 1950s. By the late 1960's hunters could take caribou in the inner fjord coastal valleys, similar to the situation since 1995. Some locals felt there were more animals now than earlier, however some locals had noticed no discernable change in animal abundance from 1978-1998. However, the proportion of sub-adults in the Neria population during autumn 1997 and 1998 was striking. Another local spoke of fewer animals being present in 1960s versus 1973, when plenty were observed in the inland north-central portion of the area. Another hunter thought caribou were scarce in the 1970s and only became abundant with excellent body condition during the 1980s. This same hunter thought caribou were smaller and skinnier around 1990.

Although many interviewed felt the trend over the last 60 years was one of general increase, one hunter felt that there were noticeably less caribou in the early 1990s, and another who thought a weak decline had occurred. There is a general consensus however, that since 1995 numbers have certainly been steadily increasing.

Caribou body condition

Hunters always found good fat animals every year in the period 1978-1998 (last 2 years missing because unlucky at licence lottery). In 1989 the fattest bull ever was taken. Biggest and tastiest animals come from interior of Neria. Others felt that the best animals came from the highlands just north of the *Sermiligaarsuk* glacier tongue. During the hunting season of August-September, caribou found near inland Ice Cap have the best body condition, while those at inner fjord coasts have

the poorest and are smaller. Many near the inner fjord coasts in 2000 had a poor pelt.

Caribou movement
Animals can be found in coastal valleys in March, in the high mountain elevations in August and in the north-central area during September. Caribou have been known to cross the *Sermiligaarsuk* glacier tongue and spread into southern regions since the 1980s.

Vegetation
Vegetation is good over the entire Neria range, with specifically good vegetation on the northeast portion of the area, which encompasses all the south shore highlands of *Sermilik* fjord. Since in recent years animals are being observed near the inner fjord coasts, some locals questioned whether this was due to overgrazed range conditions further inland near the Ice Cap, forcing the caribou to use new range. In 1961 the vegetation in the north-central area was lush, but by 1973 the range had deteriorated and much of the area close to the Ice Cap was a desert. There is an area, called "Lebanon" by locals, in the far eastern and central portion of Neria. Lebanon is known for its lush vegetation.

Calving regions
Calving took place in several areas. All were in close proximity to the Ice Cap.

Miscellaneous
There was a general feeling and belief that semi-domestic reindeer from the Isortoq reindeer-herding district were moving north towards Neria. Caribou were first seen south of Neria and the *Sermiligaarsuk* fjord in c. 1997-98. It was thought that these were semi-domestic reindeer. It was feared these would mix with the native caribou of region Paamiut, weakening and ruining the native animals. One bull was observed in the north-central interior of Neria in the late 1990s.

Qassit herd
Caribou distribution
Caribou are most likely to be found on the nunatak-like pieces of land between the lake, *Kangaarsuup tasersua*, and *Frederikshåb Isblink*. This is also the most preferred hunting area. Highest densities of caribou can be found here and on the mountain, *Avangnardleq*, which is immediately southwest of the lake. Other secondary areas include the lands and inner fjord coastlines surrounding the Qassit fjord.

Caribou abundance
There are more caribou now than earlier. The herd had a peak in animal numbers around 1918 through the 1920s, when an abundance of animals appeared on the

nunatak-like pieces of land between the lake, *Kangaarsuup tasersua*, and *Frederikshåb Isblink*. Hunters would kayak over, tie their kayaks together, then collect, and ferry back 14 to 15 caribou at a time, again and again. A recent increase in herd size was noticed during the summer of 2000 when c. 300 caribou were counted on the nunatak-like land between the lake, *Kangaarsuup tasersua*, and *Frederikshåb Isblink*.

Caribou body condition
1975 was the first year warble flies were observed; now there are few or none. Many healthy big caribou were observed in summer 2000, on the nunatak-like pieces of land between the lake, *Kangaarsuup tasersua*, and *Frederikshåb Isblink*.

Caribou movement
Throughout the Qassit area, caribou move from the coasts to the inland starting in August and perhaps July as well. Animals from region South, north of *Frederikshåb Isblink* may occasionally join animals of the Qassit herd. They may move between the regions by either skirting around the front of *Frederikshåb Isblink*, or by using the nunataks to cross *Frederikshåb Isblink* itself. Very few caribou live north of *Frederikshåbs Isblink*.

Vegetation
The terrain between the lake *Kangaarsuup tasersua* and Qassit fjord has good lichen forage for caribou.

Calving regions
No local knowledge about calving sites was available.

Miscellaneous
The large lake in the north, *Kangaarsuup tasersua*, broke loose around 1930. The far western outlet of the lake gave way and the level of the lake quickly dropped by several meters. Scars on the landscape at the western outlet are still visible today.

Appendix 2

Aerial reconnaissance 2000 data for Neria & Qassit caribou populations in region Paamiut West Greenland

Table 3. Aerial reconnaissance Neria & Qassit caribou herds, region Paamiut, Sept-Oct 2000.

Region Paamiut – West Greenland		
	Neria caribou herd	**Qassit caribou herd**
Area size[1] (km^2)	2,356	1,384
Number spaghetti transects (*n*)	27	34
Total length spaghetti transects (km)	c. 300	c. 336
Total strip width (metres)	2 x 300	2 x 300
Area covered (km^2)	c. 180	c. 202
Area coverage	c. 8%	c. 15%
Flight altitude (metres)	30 (100 feet)	30 (100 feet)
Flight ground speed (km/hr)	50 to 90	50 to 90
Total caribou seen	332	196

[1] includes islands, lakes & rivers, but deletes ice caps and glaciers

Table 4. Caribou densities per transect sorted from maximum to minimum: Aerial reconnaissance Neria, region Paamiut, Sept-Oct 2000.

Transect number	*Transect length (km)*	*Transect area (km^2)*	*Number caribou seen*	*Density Caribou*	*Rank*
17	8.00	4.80	65	13.54	1
15	7.00	4.20	26	6.19	2
22	6.34	3.80	23	6.05	3
26	10.75	6.45	37	5.74	4
19	11.30	6.78	31	4.57	5
14	13.30	7.98	27	3.38	6
4	17.10	10.26	27	2.63	7
9	5.73	3.44	9	2.62	8
21	12.05	7.23	14	1.94	9
23	7.70	4.62	8	1.73	10
18	12.90	7.74	12	1.55	11
3	10.81	6.49	8	1.23	12
28	11.10	6.66	8	1.20	13
1	11.36	6.82	8	1.17	14
12	6.80	4.08	4	0.98	15
16	8.30	4.98	4	0.80	16
13	10.60	6.36	5	0.79	17
20	10.97	6.58	5	0.76	18
10	11.28	6.77	3	0.44	19
27	16.59	9.95	4	0.40	20
8	7.61	4.57	1	0.22	21
5	20.88	12.53	2	0.16	22
24	16.15	9.69	1	0.10	23
6	12.60	7.56	0	0.00	24
7	7.93	4.76	0	0.00	24
11	9.96	5.98	0	0.00	24
25	13.12	7.87	0	0.00	24
Total	**Total**	**Total**	**Total**	**Mean ±SD**	
27	**298.23**	**178.94**	**332**	**2.16 ± 2.96**	-

Table 5. Caribou densities per transect sorted from maximum to minimum: Aerial reconnaissance Qassit, region Paamiut, Oct 2000.

Transect number	*Transect length (km)*	*Transect area (km²)*	*Number caribou seen*	*Density Caribou*	*Rank*
43	8.80	5.28	63	11.93	1
34	13.90	8.34	43	5.16	2
55	6.47	3.88	7	1.80	3
40	10.68	6.41	10	1.56	4
39	7.79	4.67	7	1.50	5
56	10.04	6.02	8	1.33	6
44	19.61	11.77	14	1.19	7
41	17.15	10.29	12	1.17	8
58	9.79	5.87	6	1.02	9
49	7.16	4.30	4	0.93	19
36	11.35	6.81	6	0.88	11
46	8.67	5.20	4	0.77	12
29	7.57	4.54	3	0.66	13
35	13.54	8.12	4	0.49	14
48	10.49	6.29	2	0.32	15
42	13.41	8.05	2	0.25	16
52	11.32	6.79	1	0.15	17
30	5.17	3.10	0	0.00	18
31	6.73	4.04	0	0.00	18
32	6.21	3.72	0	0.00	18
33	12.21	7.33	0	0.00	18
37	4.00	2.40	0	0.00	18
38	10.64	6.38	0	0.00	18
45	9.48	5.69	0	0.00	18
47	11.10	6.66	0	0.00	18
50	6.52	3.91	0	0.00	18
51	5.84	3.50	0	0.00	18
53	4.58	2.75	0	0.00	18
54	10.13	6.08	0	0.00	18
57	6.86	4.12	0	0.00	18
59	9.78	5.87	0	0.00	18
60	12.95	7.77	0	0.00	18
61	16.33	9.80	0	0.00	18
62	9.70	5.82	0	0.00	18
Total	**Total**	**Total**	**Total**	**Mean ±SD**	
34	**335.97**	**201.57**	**196**	**0.91 ± 2.15**	-

Table 6. Raw data aerial reconnaissance Neria caribou herd, southern region Paamiut, Sept-Oct 2000.

Date ddmmyy	Spaghetti transect[1]	Number Caribou observed on transect				Rear seat observers		
		Left front[2] (CC)	Left rear[2]	Right rear (1)[2]	Right rear (2)[2]	Left[2]	Right (1)[2]	Right (2)[2]
28.09.00	1	0	5	3	0	TL	KK	MR
01.10.00	3	8	7	0	0	TL	KK	MR
01.10.00	4	22	20	4	5	TL	KK	MR
01.10.00	5	2	2	0	0	TL	KK	MR
01.10.00	6	0	0	0	0	TL	KK	MR
01.10.00	7	0	0	0	0	TL	KK	MR
01.10.00	8	1	1	0	0	TL	KK	MR
01.10.00	9	2	2	7	5	TL	KK	MR
01.10.00	10	1	0	2	2	TL	KK	MR
01.10.00	11	0	0	0	0	TL	KK	MR
01.10.00	12	4	2	0	0	TL	KK	MR
01.10.00	13	4	3	0	1	TL	KK	MR
01.10.00	14	10	12	12	15	TL	KK	MR
01.10.00	15	19	7	6	7	JS	LP	MR
01.10.00	16	0	4	0	0	JS	LP	MR
01.10.00	17	33	37	24	28	JS	LP	MR
01.10.00	18	10	5	0	2	JS	LP	MR
01.10.00	19	19	18	11	12	JS	LP	MR
01.10.00	20	1	4	1	1	JS	LP	MR
01.10.00	21	14	10	0	0	JS	LP	MR
01.10.00	22	10	16	7	6	JS	LP	MR
01.10.00	23	6	8	0	0	JS	LP	MR
01.10.00	24	0	0	0	1	JS	LP	MR
01.10.00	25	0	0	0	0	JS	LP	MR
01.10.00	26	8	8	21	29	JS	LP	MR
01.10.00	27	1	0	3	3	JS	LP	MR
01.10.00	28	0	0	2	8	JS	LP	MR
		Left side		**Right side**				
Totals		**201**		**131**				
Total caribou		**332**						

Neria reconnaissance observers: (CC) Christine Cuyler, (TL) Tittus Lorentzen, (KK) Kim Kielsen, (MR) Michael Rosing, (JS) Jokum Schmidt, and (LP) Lars Petersen.

[1] Spaghetti transects are presented in the order flown.

[2] Indicates seat position in helicopter.

Table 7. Raw data aerial reconnaissance Qassit herd, northern region Paamiut, October 2000.

Date ddmmyy	Spaghetti transect[1]	Number Caribou observed on transect				Rear seat observers		
		Left front[2] (CC)	Left rear[2]	Right rear (1)[2]	Right rear (2)[2]	Left[2]	Right (1)[2]	Right (2)[2]
02.10.00	29	0	0	3	0	NJ	NK	MR
02.10.00	30	0	0	0	0	NJ	NK	MR
02.10.00	31	0	0	0	0	NJ	NK	MR
02.10.00	32	0	0	0	0	NJ	NK	MR
02.10.00	33	0	0	0	0	NJ	NK	MR
02.10.00	34	16	14	27	27	NJ	NK	MR
02.10.00	35	0	0	0	4	NJ	NK	MR
02.10.00	36	0	1	5	5	NJ	NK	MR
02.10.00	37	0	0	0	0	NJ	NK	MR
02.10.00	38	0	0	0	0	NJ	NK	MR
02.10.00	39	1	6	1	1	NJ	NK	MR
02.10.00	40	3	6	3	4	NJ	NK	MR
02.10.00	41	5	5	7	7	NJ	NK	MR
02.10.00	42	2	2	0	0	NJ	NK	MR
02.10.00	43	32	28	23	31	NJ	NK	MR
02.10.00	44	1	1	13	13	NJ	NK	MR
04.10.00	45	0	0	0	-	NK	TA	-
04.10.00	46	4	4	0	-	NK	TA	-
04.10.00	47	0	0	0	-	NK	TA	-
04.10.00	48	0	0	2	-	NK	TA	-
04.10.00	49	4	4	0	-	NK	TA	-
04.10.00	50	0	0	0	-	NK	TA	-
04.10.00	51	0	0	0	-	NK	TA	-
04.10.00	52	1	0	0	-	NK	TA	-
04.10.00	53	0	0	0	-	NK	TA	-
04.10.00	54	0	0	0	-	NK	TA	-
04.10.00	55	7	6	0	-	NK	TA	-
04.10.00	56	2	2	6	-	NK	TA	-
04.10.00	57	0	0	0	-	NK	TA	-
04.10.00	58	6	6	0	-	NK	TA	-
04.10.00	59	0	0	0	-	NK	TA	-
04.10.00	60	0	0	0	-	NK	TA	-
04.10.00	61	0	0	0	-	NK	TA	-
04.10.00	62	0	0	0	-	NK	TA	-
		Left side		**Right side**				
Totals		**93**		**103**				
Total caribou		**196**						

Qassit reconnaissance observers: (CC) Christine Cuyler, (NJ) Nielseeraq Jakobsen, (NK) Nikolej Knudsen, (MR) Michael Rosing, and (TA) Tittus Andreassen.

[1] Spaghetti transects are presented in the order flown.

[2] Indicates seat position in helicopter.

Table 8. Raw data aerial reconnaissance Kvanefjord peninsula, mid-region Paamiut, Sept-Oct 2000.

Date ddmmyy	Spaghetti transect[1]	Number Caribou observed on transect				Rear seat observers		
		Left front[2] (CC)	Left rear[2]	Right rear (1)[2]	Right rear (2)[2]	Left[2]	Right (1)[2]	Right (2)[2]
28.09.00	2	0	0	0	0	TL	KK	MR
01.10.00	63*	0	0	0	0	TL	KK	MR
01.10.00	63**	0	0	0	0	JS	LP	MR
		Left side		**Right side**				
Totals		**0**		**0**				
Total caribou		**0**						

Kvanefjord peninsula reconnaissance observers: (CC) Christine Cuyler, (TL) Tittus Larentzen, (KK) Kim Kielsen, (MR) Michael Rosing, (JS) Jokum Schmidt, and (LP) Lars Petersen.

[1] Spaghetti transects are presented in the order flown.

[2] Indicates seat position in helicopter.

* No caribou seen, but tracks of 3 caribou observed in bottom of Kangerluarsuk Fjord at c. 400 m above sea level.

** Spaghetti transect 63 was flown twice, once in the morning and again in the afternoon.

Table 9. Raw data aerial reconnaissance herd structure Neria herd, southern region Paamiut, Sept - Oct 2000.

Date ddmmyy	Spaghetti transect	Group Size	Males (Age > 1 year)	Females (Age > 1 year)	Calves (Age < 1 year)
01.10.00	9	4	2	1	1
01.10.00	9	2		1	1
01.10.00	12	2		1	1
01.10.00	12	2	2		
01.10.00	13	3	1	1	1
01.10.00	13	1	1		
01.10.00	14	5	2	2	1
01.10.00	14	2	2		
01.10.00	14	3	1	1	1
01.10.00	14	2		1	1
01.10.00	14	3	3		
01.10.00	14	8	2	4	2
01.10.00	15	1	1		
01.10.00	15	4	2	1	1
01.10.00	15	2		1	1
01.10.00	15	1	1		
01.10.00	15	3	1	1	1
01.10.00	15	1			1
01.10.00	15	4		3	1
01.10.00	15	3	1	1	1
01.10.00	17	2		1	1
01.10.00	17	5		3	2
01.10.00	17	1		1	
01.10.00	17	14	2	7	5
01.10.00	17	13	1	7	5
01.10.00	17	1	1		
01.10.00	17	13	4	7	2
01.10.00	17	3	1	1	1
01.10.00	17	1	1		
01.10.00	26	10	2	4	4
01.10.00	26	6	2	2	2
01.10.00	26	6	2	2	2
TOTALS		**131**	**38**	**54**	**39**

Table 10. Raw data aerial reconnaissance herd structure Qassit herd, northern region Paamiut, October 2000.

Date ddmmyy	Spaghetti transect	Group Size	Males (Age > 1 year)	Females (Age > 1 year)	Calves (Age < 1 year)
02.10.00	34	3	1	1	1
02.10.00	34	6	2	3	1
02.10.00	34	1	1		
02.10.00	34	24	5	11	8
02.10.00	40	3	1	1	1
02.10.00	41	3		2	1
02.10.00	41	2		1	1
02.10.00	41	5	2	2	1
02.10.00	42	1		1	
02.10.00	42	1	1		
02.10.00	43	1	1		
02.10.00	43	17	4	8	5
02.10.00	43	1	1		
02.10.00	43	1			1
02.10.00	43	1	1		
02.10.00	43	9		5	4
02.10.00	43	8	1	4	3
02.10.00	43	9	3	3	3
02.10.00	43	1	1		
02.10.00	43	2		1	1
02.10.00	43	5		3	2
02.10.00	43	1	1		
02.10.00	43	7	1	3	3
02.10.00	44	1	1		
02.10.00	44	1	1		
04.10.00	46	4		2	2
04.10.00	48	2		1	1
04.10.00	49	4	2	1	1
04.10.00	51	1	1		
04.10.00	55	7	1	3	3
04.10.00	56	6	2	2	2
04.10.00	56	2	1	1	
04.10.00	58	6	2	2	2
TOTALS		**146**	**38**	**61**	**47**

Table 11. Spaghetti transects for aerial reconnaissance Neria herd, southern region Paamiut, Sept – Oct 2000.

Date ddmmyy	Spaghetti transect	Spaghetti transect start		Spaghetti transect end	
		Latitude	Longitude	Latitude	Longitude
28.09.00	1	61° 53.14'	48° 55.80'	61° 56.0'	48° 49.0'
01.10.00	3	61° 54.41'	48° 45.51'	61° 54.76'	48° 36.82'
01.10.00	4	61° 54.76'	48° 36.82'	61° 54.545'	48° 27.994'
01.10.00	5	61° 54.545'	48° 27.994'	61° 58.387'	48° 25.092'
01.10.00	6	61° 58.387'	48° 25.092'	61° 56.537'	48° 12.006'
01.10.00	7	61° 56.537'	48° 12.006'	61° 53.794'	48° 09.993'
01.10.00	8	61° 53.794'	48° 09.993'	61° 49.870'	48° 15.302'
01.10.00	9	61° 49.870'	48° 15.302'	61° 51.019'	48° 20.507'
01.10.00	10	61° 51.019'	48° 20.507'	61° 50.655'	48° 28.189'
01.10.00	11	61° 50.655'	48° 28.189'	61° 49.847'	48° 19.678'
01.10.00	12	61° 49.847'	48° 19.678'	61° 47.858'	48° 11.538'
01.10.00	13	61° 47.858'	48° 11.538'	61° 42.539'	48° 06.589'
01.10.00	14	61° 42.539'	48° 06.589'	61° 41.843'	48° 06.671'
01.10.00	15	61° 52.341'	48° 57.480'	61° 52.562'	48° 50.558'
01.10.00	16	61° 53.344'	48° 50.388'	61° 51.673'	48° 46.389'
01.10.00	17	61° 51.673'	48° 46.389'	61° 48.448'	48° 50.663'
01.10.00	18	61° 48.448'	48° 50.663'	61° 43.228'	48° 51.833'
01.10.00	19	61° 43.228'	48° 51.833'	61° 44.129'	48° 41.366'
01.10.00	20	61° 44.129'	48° 41.366'	61° 49.088'	48° 38.233'
01.10.00	21	61° 49.088'	48° 38.233'	61° 49.523'	48° 37.519'
01.10.00	22	61° 49.523'	48° 37.519'	61° 49.555'	48° 33.720'
01.10.00	23	61° 49.555'	48° 33.720'	61° 45.867'	48° 30.991'
01.10.00	24	61° 45.867'	48° 30.991'	61° 46.339'	48° 19.211'
01.10.00	25	61° 46.339'	48° 19.211'	61° 43.138'	48° 11.263'
01.10.00	26	61° 43.138'	48° 11.263'	61° 39.474'	48° 19.965'
01.10.00	27	61° 39.474'	48° 19.965'	61° 41.646'	48° 40.322'
01.10.00	28	61° 41.646'	48° 40.322'	61° 42.0'	48° 40.5'
Total number of spaghetti transects flown = 27					

Table 12. Spaghetti transects for aerial reconnaissance Qassit herd, northern region Paamiut, October 2000.

Date ddmmyy	Spaghetti transect	Spaghetti transect start		Spaghetti transect end	
		Latitude	Longitude	Latitude	Longitude
02.10.00	29	62° 19.115	49° 31.610'	62° 20.435'	49° 37.558'
02.10.00	30	62° 20.435'	49° 37.558'	62° 21.826'	49° 43.704'
02.10.00	31	62° 21.826'	49° 43.704'	62° 22.655'	49° 49.674'
02.10.00	32	62° 22.655'	49° 49.674'	62° 25.952'	49° 49.593'
02.10.00	33	62° 25.952'	49° 49.593'	62° 28.616'	49° 45.205'
02.10.00	34	62° 28.616'	49° 45.205'	62° 32.867'	49° 43.304'
02.10.00	35	62° 32.867'	49° 43.304'	62° 33.109'	49° 36.948'
02.10.00	36	62° 33.109'	49° 36.948'	62° 31.278'	49° 46.118'
02.10.00	37	62° 38.045'	49° 41.971'	62° 39.012'	49° 38.856'
02.10.00	38	62° 40.317'	49° 36.300'	62° 38.072'	49° 33.203'
02.10.00	39	62° 33.477'	49° 33.468'	62° 31.357'	49° 35.034'
02.10.00	40	62° 31.357'	49° 35.034'	62° 32.005'	49° 23.739'
02.10.00	41	62° 32.005'	49° 23.739'	62° 33.392'	49° 21.143'
02.10.00	42	62° 33.392'	49° 21.143'	62° 29.733'	49° 19.404'
02.10.00	43	62° 29.733'	49° 19.404'	62° 30.298'	49° 22.636'
02.10.00	44	62° 29.351'	49° 19.087'	62° 20.729'	49° 27.926'
04.10.00	45	62° 13.825'	49° 16.663'	62° 14.253'	49° 08.728'
04.10.00	46	62° 14.253'	49° 08.728'	62° 12.251'	49° 04.600'
04.10.00	47	62° 12.251'	49° 04.600'	62° 16.031'	48° 56.039'
04.10.00	48	62° 16.031'	48° 56.039'	62° 15.367'	49° 04.949'
04.10.00	49	62° 15.367'	49° 04.949'	62° 18.613'	49° 06.488'
04.10.00	50	62° 18.613'	49° 06.488'	62° 16.318'	49° 12.065'
04.10.00	51	62° 16.318'	49° 12.065'	62° 15.576'	49° 17.027'
04.10.00	52	62° 15.576'	49° 17.027'	62° 20.256'	49° 16.289'
04.10.00	53	62° 20.256'	49° 16.289'	62° 22.871'	49° 18.483'
04.10.00	54	62° 22.871'	49° 18.483'	62° 19.801'	49° 21.747'
04.10.00	55	62° 19.801'	49° 21.747'	62° 20.424'	49° 26.985'
04.10.00	56	62° 20.424'	49° 26.985'	62° 22.507'	49° 34.482'
04.10.00	57	62° 22.507'	49° 34.482'	62° 24.252'	49° 29.231'
04.10.00	58	62° 24.252'	49° 29.231'	62° 25.85'	49° 37.5'
04.10.00	59	62° 25.85'	49° 37.5'	62° 23.040'	49° 40.006'
04.10.00	60	62° 23.040'	49° 40.006'	62° 20.801'	49° 31.209'
04.10.00	61	62° 20.801'	49° 31.209'	62° 14.671'	49° 32.516'
04.10.00	62	62° 11.875'	49° 34.878'	62° 09.179'	49° 26.762'
Total number of spaghetti transects flown = 34					

Table 13. Spaghetti transects for aerial reconnaissance Kvanefjord peninsula, mid region Paamiut, Sept–Oct 2000.

Date ddmmyy	Spaghetti transect	Spaghetti transect start		Spaghetti transect end	
		Latitude	Longitude	Latitude	Longitude
28.09.00		61° 57.99'	48° 57.12'	62° 02.978'	48° 58.605'
01.10.00		61° 41.20'	49° 25.00'	61° 52.800'	49° 05.500'
Total number of spaghetti transects flown = 2					

Appendix 3

List of terms

Annual – occurring, or done every year.

Body Condition – pertaining to amount of fat present, i.e., plenty of fat equals excellent body condition.

Confidence Interval – statistical term for when the SE is combined with a probability (*P*) level to yield confidence limits (CL) and their interval, the confidence interval (CI). For example: at a $P = 0.90$ (alpha = 0.1) then assuming no bias a 90% CI is likely to contain the true population size in 90% of surveys of the same type and intensity. NOTE: it is incorrect to state that there is a 90% chance that the actual number of caribou in a survey area is within the CI.

Criteria – standards set on which judgement can be made, i.e. the sex or age of a caribou.

Density – the number of caribou per square kilometre of land area.

Erratics – large stones and boulders left behind erratically on the landscape by former glaciations.

Estimate – a calculation as to the likely or approximate size of the caribou population.

Fecundity – related to fertility and is the potential level of reproductive performance of a population, which is usually much greater than the realised reproduction (fertility). However, fecundity and fertility are often used inconsistently and even interchangeably in the literature.

Fertility – of a population is the number of live births over a time period, usually a year, e.g., the number of live births per female, or the number of female young born per female. To calculate fertility we need to know the average litter size, average number of litters produced per time interval (year) and the sex ratio at birth (Caughley 1977).

Fertility Index – see also under *recruitment*. Is the ratio of calves to females, or calves to adults.

Front-seat observer – only observer present during all survey flights, and sat in the front left seat of helicopter. In addition to counting caribou, this observer kept data record of caribou count/observer for each segment, recorded segment characteristics, determined herd structure, recorded miscellaneous data, and navigated for the pilot.

Herd – see also under *population*. Greenlandic caribou seldom or never aggregate into large coherent groups. Group size typically stays under 4 animals, with groups scattered throughout a large area.

Herd Structure – this is the sex and age distribution of the animals within a given population/herd.

Logistics – the obtaining, distribution, maintenance and replacement of field equipment and personnel.
Management – e.g., wildlife management, which is the act of manipulating, directing, controlling, regulating and/or administrating the utilization of a wildlife resource and any number of the factors affecting that wildlife resource.
Natural Mortality – all mortality due to factors other than hunting (disease, accident, starvation, predation, parasites, etc.).
Net recruitment – or rate of increase of the herd is determined by subtracting the adult mortality rate from the gross recruitment.
Nunatak – an isolated mountaintop sticking out of the inland Ice Cap.
Population – see also under *herd*. All the animals of the same species living in a specific region, which do not mix with animals from other regions, i.e., they are reproductively isolated. A population is a demographic unit distinct by virtue of its unique density, distribution, birth & death rate, sex & age structure, immigration and emigration rates, and other demographic parameters.
Population status – states a wildlife species' occurrence and abundance, i.e., where and how many.
Population analysis – attempts to determine herd structure (sex & age) and the forces controlling the composition of the population/herd.
Population dynamics – in any analysis of herd structure and status the parameters are seldom if ever static, therefore the term population *dynamics*.
Range – the extent of the land area on which the caribou wander and graze. The land area used during foraging/calving/rutting by the caribou, e.g., summer and winter ranges. The word is often synonymous with pasture or habitat; however, the term range brings vegetation to mind rather than for example topography.
Reconnaissance – an inspection or exploration of an area to obtain information.
Recruitment – see also under *fertility index*. Typically it is the late winter (March) value for calves/100 cows, which indicates the increment in caribou number for a specific population/herd from one year to the next. When specified, recruitment can also refer to number of calves/100 cows at other times of year.
Sightability – degree of difficulty of actually seeing a caribou present within the strip flown, due to factors such as flight speed, flight altitude, patchy snow cover, etc.
Terrain – refers to the land or ground, usually in conjunction with a description of topography, e.g., rough terrain, mountainous terrain, etc.

Appendix 4

Recommendations for the future

Local knowledge

Local knowledge was both helpful in designing the reconnaissance and as a source of data. There was generally good agreement between local knowledge obtained about caribou distribution and relative abundance and the later reconnaissance observations. Continued local knowledge / data collection about the two herds and their future development could provide useful information for management.

Aerial reconnaissance method & design

Field methods

Due to the extreme physical topography of the region and its multitude of caribou sized glacial erratics, it is strongly recommended that all future aerial studies be conducted by helicopter at low flight altitude and slow speeds. Since most caribou were seen within 300 metres of the helicopter flight path, a strip width of 300 m is recommended. Further, fresh snow cover was the single most important factor during this reconnaissance, since the presence of fresh tracks allowed rapid localization of actual animals. Caribou sightability in region Paamiut would have been seriously handicapped without newly fallen snow. Newly fallen snow is therefore deemed a necessity for future aerial surveys.

Given the rugged terrain, although difficult, a constant flight altitude is necessary, or there is the risk of missing observations of caribou, e.g., if one flies at too high an altitude across a narrow deep valley.

At best it is difficult to define or maintain a constant strip width/area. Without the aid of markings (tape or lines) on the helicopter window, it would be impossible. Improvements in defining strip area for future surveys should be investigated.

Aerial photography as alternate survey tool could also be investigated for use in future surveys. A photographic record may help overcome differences in observer ability.

Observers

Local involvement was an advantage and should continue. The use of several different rear seat observers and changing their position from left to right rear seat made possible a subjective judgement of observer ability and variable strip width.

Index or line transect surveys?

Surveying for caribou abundance in region Paamiut with any chance of the final estimate reflecting reality will always be a range from difficult to impossible. Line or strip transect aerial survey methods for caribou abundance are not recommended in the Paamiut region at present, because they will lack precision in their final estimates and be expensive due to the Paamiut region's topography, uneven caribou densities and distribution, and the difficulty in establishing a constant strip width, for which a calculation of variance may not be possible.

In the Paamiut region deep steep valleys and high mountaintops dominate the terrain. This ruggedness makes it practically impossible to carry out a line transect survey unless helicopters are used. The amount of available habitat can change dramatically within relatively short distances. The result is large changes in caribou densities over extremely short distances, due to abrupt changes in elevation. Both make a population difficult to count if an absolute number is required, unless more funding is provided than was available for the present study. Line transect surveys usually stratify a region into strata of high and low animal density, but this is difficult in the Paamiut region, where areas of high and low animal density often are not separate or easy to define. However, this reconnaissance observed a generally higher animal density mid-way between coast and Ice Cap, with low animal density at coast and Ice Cap. This knowledge may be useful for stratification of future surveys done during September-October.

Alternately, an index of animal abundance is possible. An index survey is possible in the future if the present reconnaissance is repeated in the same season with a fresh snow cover. Annual or semi-annual fecal pellet density counts are another alternate method, which could also provide an index of animal density on the range. Annual pellet counts would cost less and could encompass a higher degree of local involvement and responsibility than a helicopter reconnaissance.

Semi-domestic reindeer south of Sermiligaarsuk Fjord?

Since 1997-98, feral semi-domestic reindeer (*Rangifer tarandus tarandus*) or native caribou have been observed in the area just south of Sermiligaarsuk Fjord, which is the southern border of region Paamiut. There is widespread local concern and negativity that these animals are semi-domestic reindeer coming north from the Isortoq reindeer-husbandry district. In the Ivittuut municipality, which lies to the south of region Paamiut, however, reindeer were only first observed in 2002 (Per Hansen pers. comm.). Since caribou from Neria have been observed dispersing over the *Sermiligaarsuk* glacier since the 1980s, it is possible that the observed animals are native Neria caribou, which have dispersed southwards. Genetic

testing could identify whether native caribou or semi-domestic reindeer inhabit the area.

Possible Future Management Solution for Paamiut

The Paamiut region could be used as a local caribou management pilot project. Locals would annually monitor the populations, by collecting further minimum counts (caribou number actually seen) and herd structures (number of calves amongst these). Further, annual fecal pellet counts or hunter effort could provide an index of relative caribou density in the region. A local "board" could discuss their annual findings and make management decisions, possibly with suggestions and guidance from the Directorate of Environment and Nature, Directorate for Fisheries and Hunting and the Greenland Institute of Natural Resources.

Appendix 5

"Guesstimate" for Neria caribou population 2000

Possible area preferred by Neria caribou?

A rough estimate of the area possibly preferred by caribou may be made. This reconnaissance surveyed c. 180 km^2 out of the total 2,356 km^2 of Neria, which equates to only an 8% coverage. Within the surveyed area was a smaller area of c. 26 km^2 (corresponding to the top 5 transects), which possessed a caribou density between c. 5 and 14 animals per km^2. Within this area the mean density was 7.2 ±3.6 SD animals per km^2. The common characteristics, which may determine this high concentration of caribou were: a midway location between the seacoast and Ice Cap, an elevation of 400 to 700 metres, close proximity to fresh water, and perhaps a south-facing aspect.

Using MapInfo software a conservative total of unsurveyed areas having similar characteristics was estimated as 151 km^2 (Fig. 8). Additional unsurveyed areas, which may be considered for inclusion, are the first 300 metres beyond the original strip width for the 5 transects having the greatest densities. This gives a further 26 km^2, for a total unsurveyed area of 177 km^2, that had characteristics similar to surveyed areas of high mean caribou density.

Possible number of Neria caribou?

If one assumed this specific unsurveyed area possessed a mean density similar to the surveyed area of the top 5 transects, then a rough population guesstimate may be attempted. To obtain a guesstimate for the Neria caribou population in autumn 2000, the mean density of 7.2 animals per km^2 may be applied to the conservative unsurveyed area calculated, 177 km^2. Finally, with the addition of the minimum count actually observed, a guesstimate is possible. Caution is recommended if such a guesstimate is to be applied to management decisions.

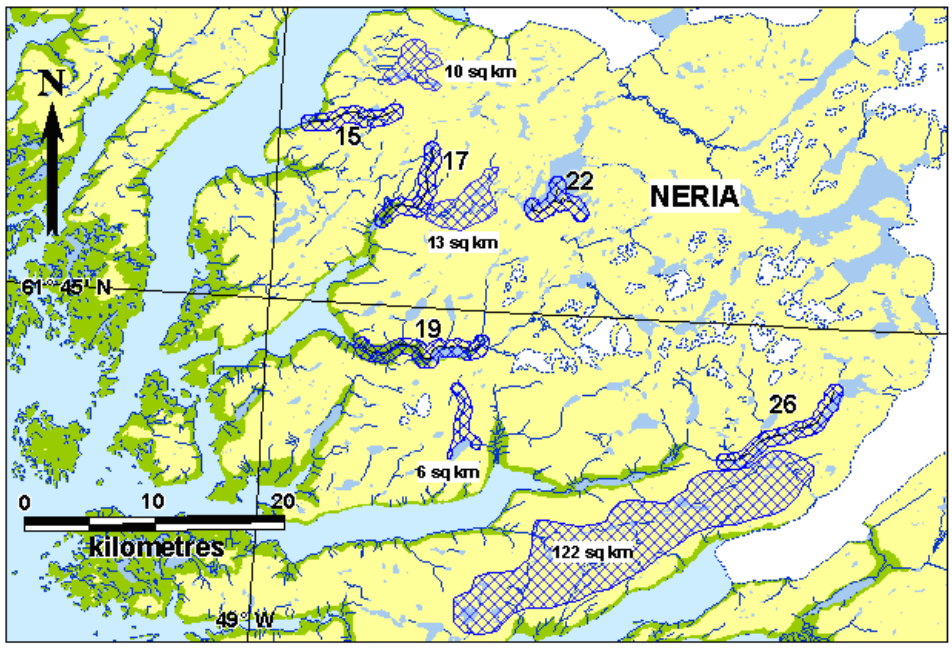


Figure 8. Four Neria areas not surveyed yet possibly preferred by caribou in the Paamiut region plus a further 600 metres width (2x 300m) added to the 5 transects (17, 15, 22, 26 & 19) having highest densities.