Recent trends in abundance of Peary Caribou (*Rangifer tarandus pearyi*) and Muskoxen (*Ovibos moschatus*) in the Canadian Arctic Archipelago, Nunavut

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RECOMMENDATIONS TO GOVERNMENT

ABSTRACT

Updated information on the distribution and abundance for Peary caribou on Nunavut's High Arctic Islands estimates an across-island total of about 4,000 (aged 10 months or older) with variable trends in abundance between islands. The total abundance of muskoxen is estimated at 17,500 (aged one year or older). The estimates are from a multi-year survey program designed to address information gaps as previous information was up to 50 years old. Information from this study supports the development of Inuit Qaujimajatuqangit (IQ)- and scientifically-based management and monitoring plans. It also contributes to recovery planning as required under the 2011 addition of Peary caribou to Schedule 1 of the federal Species At Risk Act based on the 2004 national assessment as Endangered.

The population estimates are mostly based on line transect distance sampling methods designed to increase survey accuracy. The survey estimates were for caribou (10 months or older) as the surveys were almost all pre-calving (April-May). We surveyed the islands as island groups between 2001 and 2008. We estimated 187 caribou (95% CI 104–330 caribou) on Bathurst Island Complex in May, 2001 which is an increase since a die-off in the mid-1990s. Sightings during 2010 suggest the increase of Peary caribou on Bathurst Island has continued. We observed only a single, adult female caribou during the aerial survey of Cornwallis Island and Little Cornwallis Island in May, 2002 and on Devon Island in April/May 2008, we counted 17 caribou after flying 7985 km.

In May 2004, we did not see Peary caribou on Prince of Wales and Somerset islands which indicates no recovery from the severe decline between 1980 and 1995. The observation of possibly only one Peary caribou on Boothia Peninsula during a muskoxen survey in 2006 (M. Dumond, personal communication) gives emphasis to a caribou study on the Peninsula.

The total estimated abundance of caribou on Ellesmere Island (including Graham Island) is 1,021 caribou based on surveys of southern Ellesmere (219 caribou 95% CI 109-442) in May, 2005, and northern Ellesmere (802 caribou 95% CI 531 -1207) in May 2006. On Axel Heiberg Island in April 2007, we estimated 2,291 (95% CI 1,636 – 3,208). Due to the low occurrence of caribou on Amund Ringnes, Ellef Ringnes, King Christen, Cornwall, and Meighen Islands, we estimated the total abundance of Peary caribou as 282 (95% CI 157 – 505) for these islands. For Lougheed Island, 32 clusters of caribou were observed providing a density estimate of 262 caribou/1000 km^2.

For muskoxen, survey estimates were for animals one year or older, as the surveys coincided with calving (April-May). A total of 12,683 muskoxen were counted across the study area, including 1,492 new born calves. In May, 2001 we observed 7 clusters of muskoxen on Bathurst Island Complex for a minimum count of 82 muskoxen. We report a minimum count of 18 muskoxen during the aerial survey of Cornwallis and Little Cornwallis Island in May, 2002 and estimate 513 (95% CI 302 – 864) on Devon Island in April/May 2008.

For May 2004, we estimated 2,086 muskoxen (95% CI 1,582 – 2,746) on Prince of Wales Island and another 1,910 (95% CI 962 – 3,792) on Somerset Island. We estimated 456 (95% CI 312 – 670) on Southern Ellesmere in 2005, and observed 40

emaciated muskox carcasses during the survey. The estimated abundance of muskoxen on Northern Ellesmere was 8,115 (95% CI 6,632 – 9,930) for May 2006, and we noted high concentration of muskoxen with newborn calves on the Fosheim Peninsula. On Axel Heiberg Island in April 2007, we estimated 4,237 (95% CI 3,371 – 5,325) muskoxen and noted high concentrations east of the Princess Margaret Range. In contrast, due to the low occurrence of muskoxen on Amund Ringnes, Ellef Ringnes, King Christen, Cornwall, Meighen, and Lougheed islands we report a combined minimum count of 21 muskoxen for those islands.

***Key Words*:** Peary caribou, Muskoxen, Aerial Survey, Ground Survey, Nunavut, Distance Sampling, *Rangifer tarandus pearyi, Ovibos moschatus*

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ᓄᑖᙳᖅᑎᓯᒪᑦᔪᑦ ᑐᑭᓯᒋᐊᕈᑎᒃᓴᑦ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᑦ ᓇᓃᓐᓂᖏᑦ ᐅᓄᕐᓂᖏᓪᓗ ᓄᓇᕗᒻᒥᑦ ᖁᑦᓯᒃᑐᕐᒥᑦ ᕿᑭᖅᑕᖏᓐᓂᑦ ᓇᓚᐅᑦᓵᖅᓯᒪᔪᑦ ᕿᑭᖅᑕᐅᔪᓂᑦ ᑲᑎᓪᓗᒋᑦ ᐃᒻᒪᖔ 4,000 (10-ᓂᒃ ᑕᕐᕿᖃᖅᑐᑦ ᐅᖓᑖᓂᓘᓐᓃᑦ) ᐊᔾᔨᒌᙱᓂᖃᖅᖢᑎᒃ ᐅᓄᕐᓂᖏᑦ ᕿᑭᑦᑕᓂᒃ ᐊᔾᔨᒌᙱᑦᑐᓂᒃ. ᑲᑎᓪᓗᒋᑦ ᐅᓄᕐᓂᖏᑦ ᐅᒥᖕᒪᐃᑦ ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᖅ 17,500 (ᐅᑭᐅᖃᖅᑐᑦ 1 ᐅᖓᑖᓂᓘᓐᓃᑦ). ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᑦ ᐊᑐᖅᑐᑦ ᐊᑕᐅᓯᐅᙱᑦᑐᒥᒃ ᐅᑭᐅᓂᒃ ᖃᐅᔨᓴᕐᓂᐅᓯᒪᔪᓂᒃ ᐋᕐᕿᒃᓱᖅᑕᐅᓯᒪᔪᑦ ᑲᒪᒋᔭᖃᕐᓂᐊᕐᓗᑎᒃ ᑐᑭᓯᒋᐊᕈᑎᒃᓴᖃᖅᑲᙱᓂᐅᔪᓂᒃ ᑕᐃᒃᑯᐊ ᑭᖑᓪᓖᑦ ᑐᑭᓯᒋᐊᕈᑎᒃᓴᐅᓚᐅᖅᑐᑦ ᓄᑕᐅᙱᑎᒋᓚᐅᕐᒪᑖ 50 ᐅᑭᐅᓄᑦ ᑎᑭᓪᓗᒍ. ᑐᑭᓯᒋᐊᕈᑎᒃᓴᑦ ᑕᑉᐸᙵᑦ ᖃᐅᔨᓴᕐᓂᐅᔪᒥᒃ ᐃᑲᔪᖅᑐᐃᔪᖅ ᐱᕙᓪᓕᐊᓂᖓᓂᒃ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᒃ – ᐊᒻᒪ ᖃᐅᔨᓴᕐᓂᓕᕆᓂᕐᒨᓕᖓᔪᓂᒃ ᐊᐅᓚᑦᓯᓂᕐᒧᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᓪᓗ ᐸᕐᓇᐅᑎᓂᒃ. ᐃᑲᔪᖅᑐᐃᙱᔪᖅ ᐅᑎᖅᐸᓪᓕᐊᓂᕐᒧᑦ ᐸᕐᓇᖕᓂᕐᒧᑦ ᐱᔭᓇᐊᖃᖅᑑᒐᒥ ᑕᕝᕙᓂ 2011-ᒥᑦ ᐃᓚᒋᐊᕐᓂᐅᔪᒥᒃ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᓂᒃ ᐃᓛᒃᑯᑦ 1-ᒧᑦ ᒐᕙᒪᑐᖅᑯᑦ ᐆᒪᔪᐃᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑦᑐᑦ ᒪᓕᒐᕐᔪᐊᕐᒥᑦ ᒪᓕᒃᖢᑎᒃ 2004-ᒥᑦ ᑲᓇᑕᓕᒫᒧᑦ ᖃᐅᔨᓴᕈᑕᐅᓚᐅᖅᑐᕐᒥᒃ ᐅᓗᕆᐊᓇᖅᑐᒦᓯᑎᔭᐅᓪᓗᑎᒃ.

ᐅᓄᕐᓂᖏᓐᓂᒃ ᓇᓚᐅᑦᓵᕐᓂᐅᔪᑦ ᒪᓕᓗᐊᖅᑐᑦ ᐊᕕᒃᑐᖅᑕᐅᓯᒪᓪᓗᑎᒃ ᓄᓇᑦ ᐅᖓᓯᖕᓂᖏᑎᒍᑦ ᖃᐅᔨᓴᕈᑎᖃᖅᑐᑎᒃ ᐋᕐᕿᒃᑕᐅᓯᒪᔪᑦ ᑕᒻᒪᙱᓐᓂᖅᓴᐅᓂᕐᒥᒃ ᓈᓴᕐᓂᐅᔪᕐᒥᒃ. ᓈᓴᕐᓂᐅᔪᒃᑯᑦ ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᑦ ᐃᓚᖅᑲᓚᐅᖅᑐᑦ ᑐᒃᑐᓂᒃ (10-ᓂᒃ ᑕᕐᕿᖃᖅᑐᑦ ᐅᖓᑖᓚᓘᓐᓃᑦ) ᓈᓴᕐᓂᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑲᓴᒃ ᑲᔪᓯᓚᐅᕐᒪᑕ ᓄᕐᓇᐊᓚᐅᖅᑎᓐᓇᕆᑦ (ᐄᐳᕆ-ᒪᐃ). ᓇᓴᓚᐅᖅᑐᒍᑦ ᕿᑭᖅᑕᕐᓂᑦ ᑲᑎᓯᒪᓂᐅᓪᓗᑎᒃ ᕿᑭᖅᑕᐅᔪᑦ ᐊᑯᓐᓂᖓᓐᓂᑦ 2001 ᐊᒻᒪ 2008. ᓇᓚᐅᑦᓵᖅᑐᒍᑦ 187 ᑐᒃᑐᑦ (95% *CI* 104-300 ᑐᒃᑐᑦ) ᑐᒃᑐᓯᐅᕐᕕᖕᒥᑦ ᒪᐃ, 2001-ᒥᑦ ᐊᒥᓱᙳᕐᓂᐅᓪᓗᓂ ᑕᒪᙵᑦ ᑐᖁᒐᕐᓂᐅᓚᐅᖅᓯᒪᔪᒥᒃ 1990-ᖏᓐᓂᑦ. ᑕᑯᔭᐅᑦᑕᕐᓂᐅᔪᑦ 2010-ᒥᑦ ᐃᓱᒪᒋᔭᐅᓕᖅᑐᖅ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᑦ ᑐᒃᑐᓯᐅᕐᕕᖕᒥᑦ ᑲᔪᓯᖕᒪᑦ. ᑕᑯᓚᐅᖅᑐᒍᑦ ᐊᑕᐅᓯᑐᐊᕐᒥᒃ ᐊᕐᓇᓪᓗᕐᒥᒃ ᑐᒃᑐᒥᒃ ᖃᖓᑕᓲᒃᑯᑦ ᓈᓴᕐᓂᖃᖅᑎᓪᓗᒋᑦ ᒪᕐᕈᓕᕐᕿᒥᑦ (*Cornwallis Island* ᐊᒻᒪ *Little Cornwallis Island*) ᒪᐃ, 2002-ᒥᑦ ᐊᒻᒪᓗ ᑕᓪᓗᕈᑎᒥᑦ ᐄᐳᕆ/ᒪᐃ 2008-ᒥᑦ, ᓈᓴᓚᐅᖅᑐᒍᑦ 17-ᓂᒃ ᑐᒃᑐᓂᒃ ᖃᖓᑕᓚᐅᖅᖢᑕ 7,985 ᑭᓛᒥᑕᓂᒃ.

ᒪᐃ 2004-ᒥᑦ, ᑕᑯᖖᒋᓚᐅᖅᑐᒍᑦ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᓂᒃ ᑭᖖᖑᐃᓚᕐᒥᑦ ᐊᒻᒪ ᑰᖕᖓᓇᔩᑉ ᓅᓇᖕᖓᓂᑦ ᑐᑭᓯᔾᔭᑕᐅᓪᓗᓂ ᑕᒪᓐᓇ ᐅᑎᖅᐸᓪᓕᐊᖖᒋᓂᖕᒋᓐᓂᒃ ᑕᐃᒪᖖᖑᑦ ᐅᓄᕈᖕᓇᐃᒻᒪᕆᖕᓂᐅᓚᐅᖅᑐᕐᒥᒃ ᐊᑯᓐᓂᖕᖑᓐᓂᑦ 1980 ᐊᒻᒪ 1995. ᑕᑯᓂᐅᓚᐅᖅᑐᖅ ᐃᒻᒪᕐᑳ ᐊᑕᐅᓯᑐᐊᕐᒥᒃ ᖃᑯᖅᑕᑯᓗᒃ ᑐᒃᑐᒥᒃ ᐆᑎᐊᒥᑦ (*Boothia Peninsula*) ᐅᒥᖕᒪᖕᓂᒃ ᓈᓴᕐᓂᕐᑲᖅᑎᓪᓗᓂ 2006-ᒥᑦ (*M. Dumond*, ᓇᖕᒥᖕᓂᖅ ᑐᓴᖅᑎᓐᓂᓇᓚᐅᖅᑕᖕᖓ) ᐱᒻᒪᕆᐅᓕᖅᑎᑦᓯᔭᖅ ᑐᒃᑐᓂᒃ ᖃᐅᔨᓴᕆᐊᖃᕐᓂᐅᔪᖖᖑᒃ ᑕᐃᑲᓂ.

ᑲᑎᑦᑐᒥᑦ ᓇᓚᐅᑦᓵᕐᓂᐅᔪᑦ ᑐᒃᑐᑦ ᐅᓄᕐᓂᖕᒋᓐᓂᒃ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖕᖓᓂᒃ (ᐃᓚᒋᑦᑐᒍ ᒍᕌᒻ ᕿᑭᖅᑕᖅ *Graham Island*) 1,021 ᑐᒃᑐᑦ ᒪᓕᒃᖁᒋᑦ ᓈᓴᕐᓂᐅᓯᒪᔪᑦ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖕᖓᓂ ᓂᒋᖕᖓᓂᒃ (219 ᑐᒃᑐᑦ 95% *CI* 109-442 ᑐᒃᑐᕐ) ᒪᐃ, 2005-ᒥᑦ, ᐊᒻᒪ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖕᖓᓂ ᐅᐊᖕᓇᖕᖓᓂ (802 ᑐᒃᑐᑦ 95% *CI* 531 -1207 ᑐᒃᑐᕐ) ᒪᐃ, 2006-ᒥᑦ. ᐅᒥᖕᒪᑦ ᓄᓈᓂᑦ (*Axel Heiberg Island*) ᐄᐳᕈ 2007-ᒥᑦ, ᓇᓚᐅᑦᓵᓚᐅᖅᑐᒍᑦ 2,291 (95% *CI* 1,636 – 3,208). ᑐᒃᑐᕐᑲᕋᔪᖖᒋᓗᐊᕐᓂᖕᒋᓐᓂᒃ ᑖᒃᑯᐊ ᕿᑭᖅᑕᐅᔪᓂᒃ *Amund Ringnes, Ellef Ringnes, King Christen, Cornwall,* ᐊᒻᒪ *Meighen*, ᓇᓚᐅᑦᓵᖅᓯᒪᔪᒍᑦ ᑲᑎᑦᑐᒥᑦ ᐅᓄᕐᓂᖕᒋᑦ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᑦ 282-ᖑᔪᑦ (95% *CI* 157 – 505) ᑖᒃᑯᓇᓂ ᕿᑭᖅᑕᓂᑦ. ᓛᕼᐄᑦ ᕿᑭᖅᑕᕐᒥᑦ (*Lougheed Island*) 32 ᑲᑎᓯᒪᓂᐅᔪᑦ ᑐᒃᑐᑦ ᑕᑯᔭᐅᓚᐅᖅᑐᑦ ᓇᓚᐅᑦᓵᕈᑕᐅᓕᖅᖁᑎᒃ ᐃᒻᒪᕐᑳ 262 ᑐᒃᑐᑦ/1,000 ᑭᓛᒥᑕᑦ ᐃᖅᑐᐊᖅᑐᑦ.

ᐅᒥᖕᒪᐃᓪᓕ, ᓈᓴᕐᓂᐅᓯᒪᔫᒃᑯᑦ ᓇᓚᐅᑦᓵᕐᓂᐅᓚᐅᖅᑐᑦ ᐅᑭᐅᖅᑲᖅᑐᓂᒃ 1 ᐅᖓᑖᓂᔫᓐᓃᑦ, ᓈᓴᕐᓂᕐᑲᓚᐅᕐᒪᑦ ᐊᑕᐅᑦᓯᒃᑯᑦ ᓄᕐᓇᐊᕐᓂᕐᑲᖅᑎᓪᓗᒋᑦ (ᐄᐳᕈ-ᒪᐃ). ᑲᑎᑦᑐᒥᑦ 12,683 ᐅᒥᖕᒪᐃᑦ ᓈᓴᖅᑕᐅᓚᐅᖅᑐᑦ ᓈᓴᕐᕕᓕᒫᒥᑦ, ᐃᓚᒋᑦᑐᒋᑦ 1,492 ᐃᓅᓕᓵᑦ ᓄᕐᕋᐃᑦ. ᒪᐃ, 2001-ᒥᑦ ᑕᑯᓚᐅᖅᑐᒍᑦ 7-ᓂᒃ ᑲᑎᓯᒪᓂᐅᔪᓂᒃ ᐅᒥᖕᒪᖕᓂᒃ ᑐᒃᑐᓯᐅᕐᕕᖕᒥᑦ ᐊᑦᓕᖅᐹᒥᒃ ᓈᓴᕐᓂᕐᑲᖅᖁᓂ 82 ᐅᒥᖕᒪᐃᑦ. ᐅᓂᒃᑳᖅᓯᒪᔪᒍᑦ ᐊᑦᓕᖅᐹᒥᒃ 18 ᐅᒥᖕᒪᐃᑦ ᖃᖕᖓᑕᓲᒃᑯᑦ ᓈᓴᕐᓂᕐᑲᖅᑎᓪᓗᑕ *Cornwallis* ᐊᒻᒪ *Little Cornwallis Island*-ᒥᑦ ᒪᐃ, 2002-ᒥᑦ ᐊᒻᒪ ᓇᓚᐅᑦᓵᖅᖁᑕ 513-ᓂᒃ (95% *CI* 302 – 864) ᑕᑦᑐᕈᑎᒥᑦ ᐄᐳᕈ/ᒪᐃ 2008-ᒥᑦ.

ᒪᐃ 2004-ᒧᑦ, ᓇᓚᐅᑦᓵᓚᐅᖅᑐᒍᑦ 2,086 ᐅᒥᖕᒪᕐᑲᖅᖁᓂ (95% *CI* 1,582 – 2,746) ᑭᖖᖑᐃᓚᕐᒥᑦ ᐊᒻᒪᓗᒃᑲᓐᓂᖅ 1,910 (95% *CI* 962 – 3,792) ᑰᖕᖓᓇᔩᑉ ᓅᓇᖕᖓᓂ. ᓇᓚᐅᑦᓵᓚᐅᖅᑐᒍᑦ 456-ᓂᒃ (95% *CI* 312 – 670) ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖕᖓᓂ ᓂᒋᖕᖓᓂ 2005-ᒥᑦ, ᐊᒻᒪ ᑕᑯᑦᑐᑕ 40-ᓂᒃ ᑐᕐᑲᖕᖓᔪᓂᒃ ᐅᒥᖕᒪᕐᓂᒃ

ᓈᓴᕐᓂᖃᖅᑎᑦᑐᑕ. ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᑦ ᐅᒥᖕᒪᐃᑦ ᐅᓄᕐᓂᖏᑦ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖓᓂ ᐅᐊᖕᓇᖓᓂ 8,115-ᖑᓚᐅᖅᑐᑦ (95% *CI* 6,632 – 9,930) ᒪᐃ 2006-ᒧᑦ, ᐅᔾᔨᕆᔭᖃᖅᓱᑕᓗ ᐅᓄᕐᓂᖏᑦᑕ ᑲᑎᓯᒪᔪᑦ ᐅᒥᖕᒪᐃᑦ ᓄᕐᕋᖃᖅᑐᑦ ᕘᓴᐃᒻᒥᑦ (*Fosheim Peninsula*). ᐅᒥᖕᒪᑦ ᓄᓈᑦᓂ ᐄᐳᕈ 2007-ᒥᑦ, ᓇᓚᐅᑦᓴᓚᐅᖅᑐᒧᑦ 4,237-ᓂᒃ (95% *CI* 3,371 – 5,325) ᐅᒥᖕᒪᖕᓂᒃ ᐅᔾᔨᕆᔭᖃᖅᓱᑕᓗ ᐅᓄᖅᑐᓂᒃ ᑲᑎᓯᒪᔪᓂᒃ ᐳᕆᓐᓯᐊᓯ ᒫᑯᐃ ᐃᓂᖃᕐᕕᖕᒥᑦ (*Princess Margaret*). ᐅᒥᖕᒪᒃᑕᖃᓗᐊᙱᓂᖏᓐᓂᒃ ᕿᑭᖅᑕᓂᒃ *Amund Ringnes, Ellef Ringnes, King Christen, Cornwall, Meighen,* ᐊᒻᒪ *Lougheed* ᐅᓂᒃᑳᓚᐅᖅᑐᒧᑦ ᑲᑎᑦᑐᒋᑦ ᐊᑦᓚᖅᐹᒥᒃ ᓈᓴᖅᑕᐅᓂᖏᓐᓂᒃ 21 ᐅᒥᖕᒪᐃᑦ ᑕᐃᒃᑯᓄᖓ ᕿᑭᖅᑕᓄᑦ.

ᓇᓗᓇᐃᕈᑎᑦ ᑕᐃᒎᓯᑦ: ᖃᖁᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᑦ, ᐅᒥᖕᒪᑦ, ᖃᖓᑕᓲᒃᑯᑦ ᓈᓴᕐᓂᖅ, ᓄᓇᒃᑯᑦ ᓈᓴᕐᓂᖅ, ᓄᓇᕗᑦ, ᐅᖓᓯᖕᓂᒃᑯᑦ ᐆᒃᑐᕋᕈᑎᖃᕐᓂᖅ, *Rangifer tarandus pearyi, Ovibos moschatus*

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PREFACE:

Section 5 and 6 of this report do not necessary represent the views of co-author G. Hope.

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1.0 INTRODUCTION

Peary caribou (*Rangifer tarandus pearyi*) are a distinct caribou subspecies that occurs almost entirely on islands within the Canadian Arctic Archipelago. These ungulates live the farthest north of all *Rangifer* in North America, and are the smallest in stature and in population size (Banfield, 1961). In February 2011, Peary caribou were listed as Endangered under the federal Species at Risk Act, due to declines in abundance and expected changes in long-term weather patterns (Canada Gazette Part II, Vol 145, No4, 2011-02-16). This action has trigged recovery planning and current information on population abundance and trends is required. However, because of their remote location, widespread distribution, and the general inaccessibility of their range, research has been limited and foundation information on the distribution and abundance of Peary caribou is lacking for some portions of their range. Through this report we hope to address some information deficiencies and assist in the planning effort.

Endemic to Canada, the terrestrial range of Peary caribou is roughly 540,000 km^2 and extends across the Queen Elizabeth Islands in the north, and east from Banks Island to Somerset and the Boothia Peninsula in the south (Figure 1). Ice surrounds the islands for most of the year and caribou on some islands use the sea ice during seasonal migrations (Miller 1990b; Miller *et al*., 2005a). Although the range is vast, the area is characterized by extreme weather (Maxwell, 1981), long periods of darkness and large expanses of bare ground, ice and rock (Gould *et. al.,* 2002). The landscape is treeless and environmental conditions, which include a short growing season, approach the physiological tolerance limits of plants (Edlund and Alt, 1989; Edlund *et al*., 1990; Gould *et al.,* 2002). Except for a few northerly islands, muskoxen (O*vibos moschatus*) occur in sympatry with Peary caribou (Figure 2) and in the last 50 years have expanded their range and recolonized areas previously unoccupied (Gunn and Dragon, 1998; Taylor 2005).

In contrast, muskoxen were extirpated from much of their southern range by the early 1900s causing the Canadian Government to implement controls on muskox hunting and trading in 1917 (Urquhart, 1982). In remote areas, muskoxen continued to be used for subsistence (Urquhart, 1982) and since 1969 Inuit of northern Canada have been permitted to hunt muskoxen under a quota system. In general, this species has been recovering and in the Northwest Territories muskoxen have been listed as Secure (Working Group of General Status of NWT Species, 2006). Internationally, muskoxen have been assessed as Low Risk Least Concern by the IUCN (IUCN 2010). On some Arctic islands however, muskoxen, like Peary caribou, have experienced significant declines due to severe weather events (Miller *et al.*, 1977a; Miller 1998; Gunn and Dragon 2002).

In 1961, Tener (1963) completed the first and only comprehensive survey of both Peary caribou and muskoxen across the Queen Elizabeth Islands in a single season and estimated approximately 25,845 Peary caribou and 7421 muskoxen. The majority of caribou (approximately 94%) were located in the western Queen Elizabeth Islands (i.e. Bathurst Island Complex, Cornwallis, Melville, Prince Patrick, Eglinton, Emerald, Borden, Mackenzie King, Brock). A consequence of this finding was that subsequent surveys were focused in that area. The first population estimates for the southern Arctic islands included a 1972 estimate of 11,000 caribou on Banks Island (Urquhart, 1973); 4512 caribou in 1980 on northwestern Victoria Island (Jakimchuk and Carruthers,

Figure 1: Peary caribou range across the Canadian Arctic. Modified from COSEWIC (2004).

1980), 5515 caribou on Prince of Wales and Somerset Islands (Fisher and Duncan, 1976, values converted to all caribou in COSEWIC, 2004) and 561 caribou on the Boothia Peninsula in 1974 (Fisher and Duncan, 1976). Thus, when the first estimates of abundance on the southern Arctic Islands are combined with estimates from the QEI, it's possible that as many as 48,000 Peary caribou occupied the entire range historically (COSEWIC 2004).

For muskoxen, Tener (1963) estimated 7421 muskoxen on the Queen Elizabeth Islands in 1961, while an additional 3800 were estimated on Banks Island during the first systematic survey in 1971-72 (Urquhart, 1973). For Victoria Island, the population was estimated at 908 animals in 1958-59 (Macpherson, 1961) while systematic surveys in 1974-75 resulted in a total population estimate of 600 for Prince of Wales and located no muskoxen on Somerset Island or the Boothia Peninsula (Fisher and Duncan, 1976). These surveys suggest that approximately 12,700 muskoxen occurred in sympatry with Peary caribou in the early 1960-70s.

Between 1961 and 1974, subsequent aerial surveys for the western Queen Elizabeth Islands measured severe declines in both species (Miller et al., 1977) and in 1979, Peary caribou were assigned the status of Threatened by the Committee on the Status of Endangered Wildlife in Canada (Gunn *et al.,* 1981; COSEWIC, 2004). Peary caribou on Banks Island and the High Arctic islands (i.e. the Queen Elizabeth Islands) were re-assessed as Endangered in 1991 and Peary caribou in the lower Arctic stayed as Threatened (Miller, 1990a). In May 2004, the entire subspecies *pearyi* was reassessed as Endangered (COSEWIC) due to continued declines and expected changes in long-term weather patterns. The Endangered status triggered extensive

Figure 2: Muskox range across the Canadian Arctic Archipelago. Modified from Urquhart (1982).

consultations after which the Governor General in Council, in February 2011, amended Schedule 1 of the Species at Risk Act, to include Peary caribou as Endangered (Canada Gazette Part II, Vol 145, No4, 2011-02-16).

The decline of Peary caribou is characterized by four major die-offs which were observed primarily in the western Queen Elizabeth Islands between 1970 and 1998, and involved the synchronous crash of muskoxen (Miller *et al*., 1977a; Miller, 1998; Miller and Gunn, 2001; Gunn and Dragon, 2002; Miller and Gunn, 2003b). Die-off events have been associated with deep snow and icing, which can limit access to forage, increase energy requirements and lead to extreme under-nutrition and death (Parker *et al*., 1975; Miller *et al.,* 1977a; Gunn *et al*., 1981; Parker *et al*., 1984; Miller, 1990a; Miller, 1998; Miller and Gunn, 2003b; COSEWIC, 2004; Miller and Barry, 2009). Observations by local Inuit are in agreement, reporting up to 2 inches of ice in some years (Taylor, 2005; Jenkins *et al.,* 2010a. 2010b).

Fragmented data shows that periods of decline and recovery vary among island populations, and that factors such as anthropogenic activities and landscape changes, predation, hunting and competition may also contribute to the fluctuation of caribou and muskox populations (Riewe, 1973; Miller, Gunn and Dragon 1998, Gunn *et al*., 2000; Miller and Gunn, 2001, Gunn and Dragon, 2002, Jenkins *et* al., 2010a). Inuit in Resolute Bay (Cornwallis Island) and Grise Fiord (Ellesmere Island) have identified exploration activities (i.e., oil and gas, coal and base minerals) as an additional stressor for caribou during some winters (Jenkins *et al.,* 2010a, Jenkins *et al.,* 2010b). They suggest that, during years of high snow accumulation, industrial activities can and have inhibited caribou from moving into areas that were vital for their survival (Jenkins *et al.,* 2010a, Jenkins et al., 2010b). Tews *et al*. (2007a) argued that density-dependent mechanisms may also be important but agreed with other authors that major fluctuations in Peary caribou abundance are likely driven mainly by unpredictable environmental perturbations. Finally, it is recognized that hunting and predation could dampen recovery and exacerbate Peary caribou declines, particularly when populations are small and vulnerable to extinction (Gunn and Decker, 1984; Miller, 1990a; Gunn and Ashevak, 1990; Gunn and Dragon, 2002). The effect of predation on population size is currently unknown (Miller, 1990a; Gunn and Dragon, 2002) and detailed records of caribou harvest (i.e., number harvested, location, date) are not available for most areas. Uncertainties for the future include the potential negative impacts of climate change, (Post and Stenseth, 1999; Miller *et al*., 2005; Tews *et al.,.* 2007a; Tews *et al.,* 2007b; Miller and Barry, 2009), industrial exploration, development, and shipping (Vors and Boyce, 2009; Poole *et al.,* 2010).

Climate induced changes are expected to be the most severe in the Arctic (Maxwell 1997; Anisimov *et al*. 2007, Prowse *et al.* 2009). For example, it is predicted that surface air temperatures will increase in the Arctic at twice the global rate (McBean *et al*. 2005, Anisimov *et al* 2007) and average seasonal precipitation will increase significantly across all seasons (Rinke and Dethloff 2008). Some associated changes include reduced sea ice cover, shifts in the temporal and spatial distribution and composition of vegetation, increased snow cover, and the increased frequency of icing events (Post and Stenseth 1999, Anisimov *et al*. 2007, Post et al. 2008, Rinke and Dethloff 2008, Vors and Boyce 2009). Notably, both the severity and frequency of extreme winter events is expected (ACIA 2005, Tews *et al*. 2007b).

Nunavummiut are concerned about the conservation of Peary caribou and their habitat (Jenkins *et al*., 2010a; Jenkins *et al*., 2010b). Caribou are of major cultural, traditional and economic importance to Inuit, they are a vital part of the Arctic ecosystem and a valued food source (Ferguson and Messier*,* 1997; Miller and Gunn, 2001; Taylor, 2005). In Nunavut, Peary caribou harvest has not been restricted through legislation. Instead, from 1975 to ca. 1989, the Resolute Bay Hunters and Trappers Association (HTA) imposed voluntary harvest restrictions for caribou on the Bathurst Island Complex (Miller, 1990; DoE 2005). This action was triggered by a decline in caribou during the winter of 1973-1974 (Miller, 1990; DoE, 2005a; Nancy Amarualik, personal communication, Sept 2010). The Iviq HTA of Grise Fiord also imposed a 10-year prohibition on Peary caribou harvest (1986-1996) on southern Ellesmere Island due to scarcity of animals in the 1980s (DoE 2005b). However, Inuit knowledge is that conflicting land-use activities (such as mineral exploration) pose a greater potential threat to Peary caribou and their habitat than hunting (Jenkins *et al.,* 2010b).

Ultimately, the Department of Environment (DoE) of the Government of Nunavut (GN) is responsible for the management and conservation of caribou and muskoxen within its jurisdiction. This responsibility is outlined in the Nunavut Land Claim Agreement 1993, Article 5 (Indian and Northern Affairs Canada, 1993). However, for many populations of Peary caribou and muskoxen in Nunavut, estimates of abundance have not been recorded since 1961. Other populations have been surveyed infrequently and information about them is highly fragmented (Miller, 1990a; Miller and Gunn, 2003b). This has created significant knowledge gaps, which poses challenges for wildlife management decision-making.

Due to the fact that populations can change drastically and quickly, lengthy delays between surveys are risky. For example, the Peary caribou on Prince of Wales and Somerset Islands were not surveyed during a 15-year period. It was found that the numbers had declined from about 6000 in 1980 to just a few caribou by 1995 (Gunn and Dragon, 1998). To assess whether the caribou had recovered from such low numbers, these islands were part of our survey program in 2004.

The north central and eastern Queen Elizabeth Islands have not been surveyed since 1961 (i.e., Ellef Ringnes, Amund Ringnes, Axel Heiberg) and only a small number of partial aerial surveys of Ellesmere Island have been completed (Riewe, 1973; Case and Ellsworth, 1991; Gauthier, 1996). Part of the delay was uncertainty about the most efficient and effective approach for an aerial survey in this mountainous and glaciate region. This challenge was discussed at a workshop held in Grise Fiord in 1997, when Inuit hunters and biologists examined survey techniques and explored the idea of combined ground and aerial surveys (DoE, GN unpublished).

Bathurst Island Complex has been re-surveyed relatively frequently and by the early 1990s, the surveys revealed that Peary caribou and muskoxen on Bathurst and its neighbouring islands had returned to levels that Tener (1963) reported for 1961 (Miller, 1997a). However, during three consecutive severe winters marked by icing and deeper snow (1994-95; 1995-96; 1996-97), Peary caribou and muskox abundance dropped and Peary caribou numbered less than 100 by 1997 (Miller, 1997a; Gunn and Dragon, 2002). Subsequent to 1997, there was a need to determine if Peary caribou numbers were recovering on Bathurst and its neighboring islands as the population is particularly important for Inuit from Resolute Bay.

The gaps in information and the need for Nunavummiut to have updated information on the status and recovery of Peary caribou and muskoxen led to a large scale survey program during April and May, 2001 through 2008. In this report, we present the results from the multi-year systematic line transect aerial survey and non-systematic ground survey of Peary caribou and muskoxen across the Canadian Arctic Archipelago in Nunavut. Specifically, we describe population abundance, distribution and productivity estimates for both ungulates across their range in Nunavut (except Melville Island and Boothia Peninsula). This report updates and replaces the previous work of McLoughlin *et al*., (2006).

2.0 METHODS

2.1 POPULATIONS

2.1.1 <u>Peary Caribou</u>

At the subspecies level, Peary caribou vary in relative skeletal size through north-south and east-west gradients (Manning 1960; Thomas *et al*., 1976, 1977; Thomas and Everson, 1982). This diversity has been attributed to the geographic and environmental variation (i.e. climate) that characterizes the Canadian Arctic Archipelago. Peary caribou are smaller and have a lighter-coloured pelage than other caribou subspecies, and they tend to occur in small herds of three to five animals although group size varies seasonally and tends to be greater later in summer (Miller *et al*., 1977). Owing to their low density, small group size, and extensive spatial distribution across islands, these caribou are generally referred to at the scale of 'populations' and not herds (Zittlau 2004).

Peary caribou are usually described as geographic (island) populations, defined by island or island complex boundaries (Gunn *et al*., 1997; Zittlau 2004). Grouping islands is necessary as some Peary caribou are known to make seasonal movements between islands (Miller *et al*., 1977b; Miller 1990b; Miller, 1995a; Miller, 2002; Miller and Barry, 2003; Miller et al. 2005a; Taylor 2005; Jenkins in prep.). We grouped the islands based on the literature (Tener, 1963; Gauthier, 1996; Gunn and Fournier, 2000; Gunn and Dragon, 2002; Miller and Gunn, 2003a; Zittlau, 2004; Miller *et al,*. 2005b; Taylor 2005; Gunn *et al,*. 2006, Miller and Barry 2009; Jenkins in prep) and refer to each population by the ‘Island Group’ name (Table 1, Figure 3). Each Island Group is comprised of multiple islands, which are detailed in Table A, Appendix 1. The level of information used to define each ‘Island Group’ varied, and in Table 1, we identify the ‘Island Groups’ within corresponding larger scale eco-units, metapopulations and conservation units (Miller, 1990a; Gunn *et al.,* 1997; Zittlau, 2004; Miller *et al.,* 2005b; Miller and Barry, 2009).

Melville Island and Boothia Peninsula were excluded from this study.

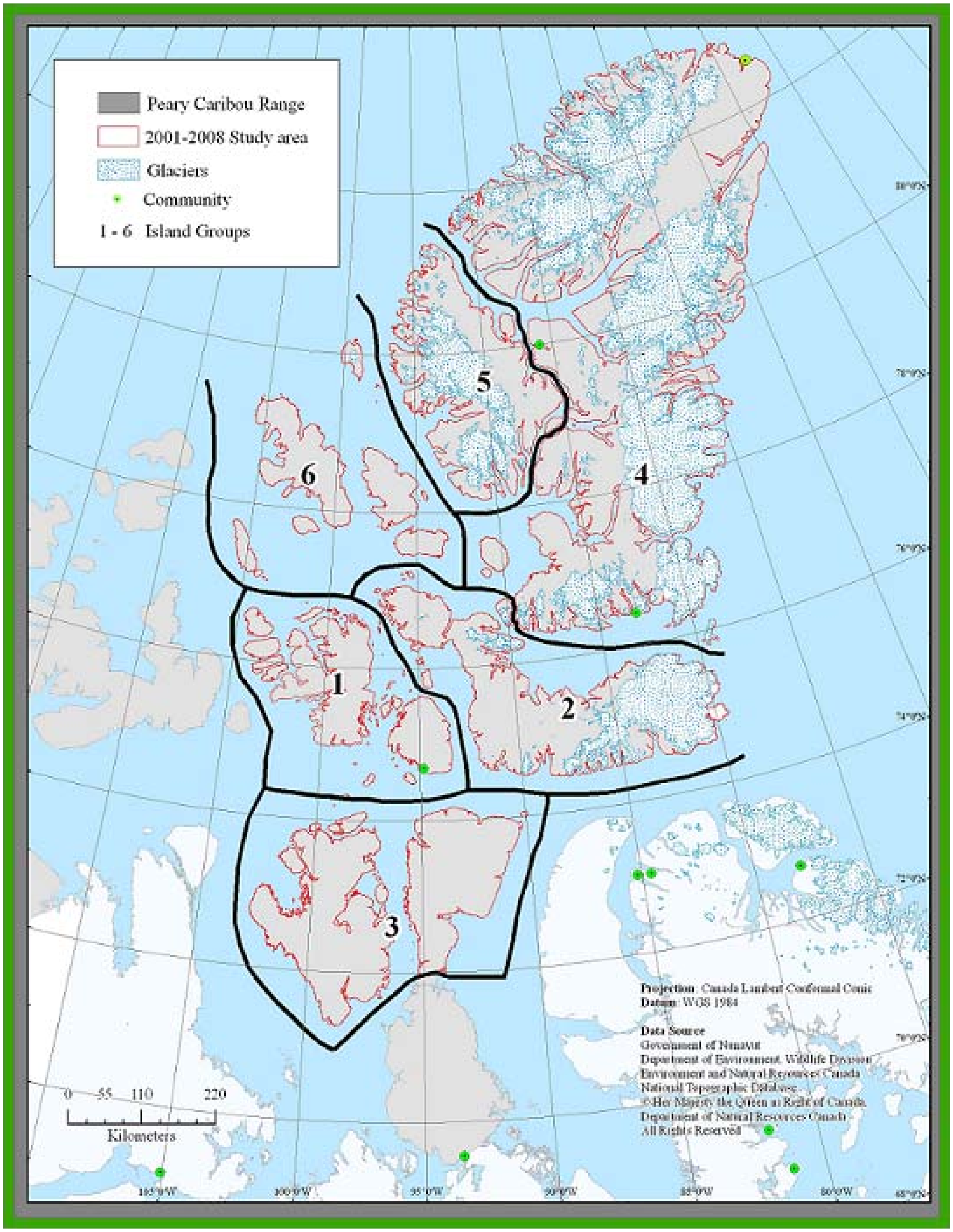


Figure 3: Organization of survey area into Island Groups; 1) Bathurst Island Group, 2) Devon Island Group, 3) Prince of Wales/Somerset Island Group, 4) Ellesmere Island Group, 5) Axel Heiberg Island Group, 6) Ringnes Island Group

Table 1: Peary caribou Island Groups in the Arctic Archipelago, Canada. Island Groups highlighted in blue, occur in Nunavut and were included in this study. Areas that occur (primarily) in the Northwest Territories are highlighted in gray.

		Organization as Applied to this Study		
Metapopulation (Conservation Unit)	**Ecounits**	**Island Group**	**Survey Area (SA)**	**Survey Year**
Western Queen Elizabeth Islands	South-central	The Bathurst Island Group	Bathurst Island Complex	2001
			Cornwallis/Little Cornwallis	2002
	Southwestern	Melville Island Group	n/a	n/a
	Northwestern	Prime Minister Island Group	n/a	n/a
Eastern Queen Elizabeth Islands	Eastern	Ellesmere Island Group	S. Ellesmere	2005
			N. Ellesmere	2006
		Axel Heiberg Island Group	Axel Heiberg	2007
		Devon Island Group	Devon	2008
			North Kent	2008
			Baillie Hamilton	2008
			Dundas/Margaret	2008
	North-central	Ringnes Island Group	Ellef Ringnes	2007
			Amund Ringnes	2007
			Cornwall	2007
			King Christian	2007
			Meighen	2007
			Lougheed	2007
Prince of Wales and Somerset Island Complex (includes Boothia)	n/a	Prince of Wales/Somerset Island Group	Prince of Wales (incl. Russell)	2004
			Somerset	2004
Boothia Peninsula	n/a	n/a	n/a	n/a
Banks Island - Northwestern Victoria Island	n/a	n/a	n/a	n/a
References		**References**		
Gunn *et al.* , 1997; Zittlau, 2004; COSEWIC, 2004	Miller, 1990a; Miller *et al.*, 2005b; Miller and Barry, 2009	Miller et al., 1977b; Miller 1990b; Gauthier, 1996; Gunn and Fournier, 2000; Miller 2002, Gunn and Dragon, 2002; Miller and Gunn, 2003b; Zittlau, 2004; Taylor, 2005; Miller et al. 2005a; Miller and Barry, 2009; Jenkins in prep.		

2.1.2 Muskoxen

We used the same Island Groups for muskoxen as we used for Peary caribou.

2.2 STUDY AREA

The Arctic Islands of Nunavut and the Northwest Territories, and the Boothia Peninsula (Nunavut), are the principle range of Peary caribou. The area lies within the Arctic Cordillera and Northern Arctic Ecozones of Canada, which are characterized by a severe climate, shallow soils, sparse dwarfed plant growth, and large areas of permanent ice or exposed bedrock (i.e., Edlund and Alt, 1989; Edlund, 1990; Natural Resources Canada, 2007). Our study area encompassed 25 major islands (area $\geq$ 200 km^2), 40 minor islands (area <200 km^2), and numerous smaller unnamed islands with a collective island landmass of approximately 407,599 km^2 (Figure 3; Table A, Appendix 1). The majority of these islands are uninhabited by humans. There are only two residential communities within the study area: Resolute Bay (74°41’51’’N, 094°49’56’’W) on Cornwallis Island and Grise Fiord (76°25’03’’N, 082°53’38’’W) on the southern coast of Ellesmere Island. The settlement of Alert is situated on the north coast of Ellesmere Island (82°30’05’’N, 062°20’20’’W) and functions as both a base for the Canadian Forces and an Environment Canada weather station (National Defence 2010). Eureka, located on the west central coast of Ellesmere Island (79°58’59’’N 85°56’59’’W), serves as a permanent research center and the site of an Environment Canada Weather Station (Environment Canada 2011).

The Bathurst Island Group --. This group of islands includes the Bathurst Island Complex (BIC), surveyed in 2001 and Cornwallis/Little Cornwallis Islands surveyed in 2002. The BIC (19,644 km^2) includes Bathurst Island and four major satellite islands (> 200 km^2; Cameron, Vanier, Alexander, Massey, and Helena), and three minor satellite islands (Table A, Appendix 1). The islands are low-lying with few areas exceeding 300 m elevation. The terrain is sparsely vegetated (Edlund, 1981; Edlund, 1983; Edlund and Alt 1989; Walker *et al*., 2005). Low-lying wetlands such as the Goodsir-Bracebridge Inlet have a higher cover of sedges and low-growing willows (Edlund and Alt 1989).

Cornwallis and Little Cornwallis islands (7,474 km^2 including small proximal islands), surveyed in 2002, are low-lying with uplands and hills below 300 m and mostly polar desert with sparse vegetation (Babb and Bliss, 1974). Portions of the western coastline and Eleanor Lake watershed (Cornwallis Island) support more diverse vegetation, including prostrate shrubs in moderately moist habitats, and sedges in the wet areas (Edlund and Alt, 1989)

Devon Island Group --. Devon Island (55,534 km^{2,};including small proximal islands) is characterized by several mountain ranges (e.g., Cunningham Mountains, Treuter Mountains, and the Douro Range), coastal lowlands, and extensive glaciers. The Devon Ice Cap covers a large portion of eastern Devon Island and reaches 1920 m in elevation (Statistics Canada 2010). Extensive uplands stretch west of the Ice Cap across central Devon Island. Low-lying areas occur in coastal areas, primarily along the north and western coast (the Truelove lowlands), but also Philpots Island (a peninsula), portions of the Grinnell Peninsula, Croker Bay, and Cape Sherard (Figure 4).

The landscape of this island is predominantly polar desert with sparse cover of vascular plants (Babb and Bliss, 1974; Edlund and Alt, 1989); however, coastal regions, such as the Truelove Lowlands and portions of the Grinnell Peninsula, support a greater diversity of vegetation dominated by prostrate shrubs (i.e. *Salix arctica* and/or *Dryas integrifolia*) and sedges (Edlund and Alt, 1989). North Kent, Dundas/Margaret, and Baille Hamilton Islands are part of the Island Group.

Figure 4: Devon Island Group.

***Ellesmere Island Group** --.* Ellesmere Island is the largest of the Queen Elizabeth Islands (197,577 km^2). It is approximately 500 km wide and 800 km long (Figure 3). The island is largely covered by mountain ranges and glaciers that are separated by a series of east-west passes. Several glaciers flow into adjoining bays and fiords. These features fragment the island, particularly where the north end of Vendom Fiord approaches the Prince of Wales Ice Cap, and divides the southern portion of the island from the north. Graham (1,387 km^2) and Buckingham (137 km^2) islands were included in the survey (Figure 5) along with a number of small islands proximal to Ellesmere.

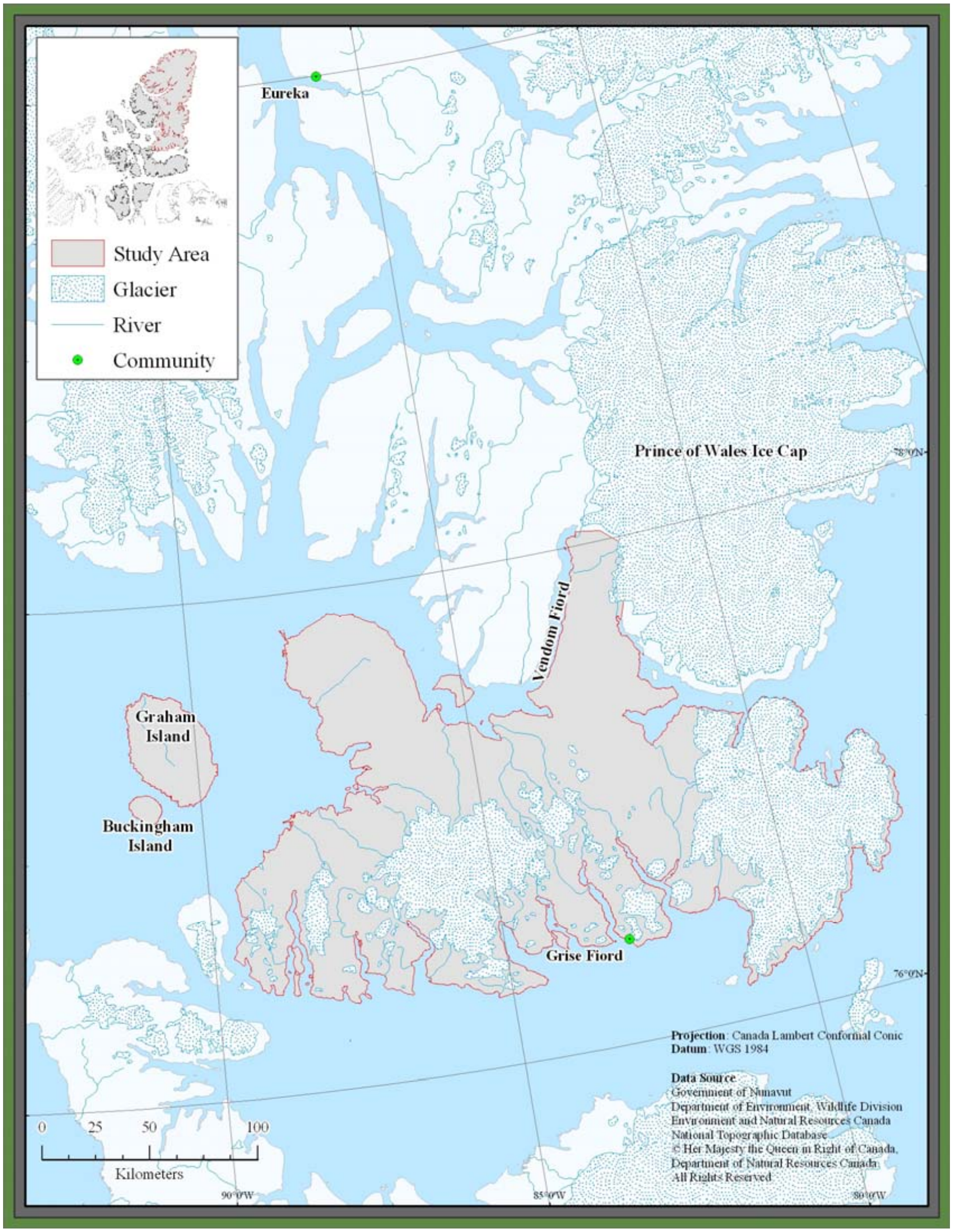


Figure 5: Southern Ellesmere survey area.

Axel Heiberg Group --. Axel Heiberg Island (42,319 km^2) is separated from Ellesmere Island by Nansen and Eureka Sound (Figure 3). This island is mountainous and includes the Princess Margaret Range, which runs north to south through its center. Large ice caps cover much of the landmass (e.g., Muller Ice Cap, Steacie Ice Cap) and spawn many glaciers that flow primarily to the west. Elevations on the island vary, with many mountains topping 1200 m. The highest point occurs centrally at Outlook Peak (2210 m; Statistics Canada 2010). East of the Princess Margaret Range, vegetation progresses from an herb-shrub transition zone at higher elevations to an enriched prostrate shrub zone along the low-lying coast. The plant flora can be diverse and dense, dominated by shrubs (i.e., *Salix arctica* and/or *Dryas integrifolia*) and sedge meadows (Edlund and Alt, 1989). West of the Princess Margaret Range, vegetation is less diverse with large areas of sparse herbaceous communities (Edlund and Alt, 1989).

Ringnes Island Group --. Ellef Ringnes, Amund Ringnes, Lougheed, King Christian, Cornwall, and Meighen Islands are all situated to the west of Axel Heiberg Island and north of the Bathurst Island Complex. Lougheed Island (1,321 km^2), is the most westerly island in the study area and lacks significant topography (maximum elevation 124 m). The vegetation on Lougheed Island is described as entirely herbaceous (Edlund and Alt, 1989) with rich vegetation patches (Tener, 1963). Lougheed is the largest of five small islands that form the Findlay Group. Ellef Ringnes Island, approximate area 11,428 km^2, is sparsely vegetated with low plant diversity. The vegetation is almost entirely herbaceous, with few decumbent shrubs and sedges (Edlund and Alt, 1989). Portions of the island are hilly (i.e., Isachsen Dome, Dumbbells Dome, Baker Hill) with elevations reaching 263 m (Department of Natural Resources, 2006). King Christian Island is located southwest of Ellef Ringnes, has an area of 647 km^2, and is characterized by a dry central plateau and low coastline (Tener, 1963). Its vegetation is described as entirely herbaceous with low diversity (Edlund and Alt, 1989). Amund Ringnes Island, approximate area 5,299 km^2, is relatively low lying but features greater relief in the north. Elevations reach a maximum of 316 m and regional vegetation is entirely herbaceous. The southern half of the island supports more diverse vegetation, primarily herbaceous plants with some shrubs and sedges (Edlund and Alt, 1989). To the south of Amund Ringnes is Cornwall Island, a small hilly landmass with elevations rising to 350 m at Mt. Nicoley on the north-central coast (Tener 1963, Department of Natural Resources). Cornwall is also dominated by herbaceous vegetation (Edlund and Alt, 1989). Meighen Island (approximately 933 km^2), to the northeast of Amund Ringnes, is low-lying with sparse herbaceous vegetation and a large centrally located glacier (the Meighen Ice Cap) that reaches a maximum elevation of 265 m (Department of Natural Resources, 2006)

Prince of Wales/Somerset Island Group --. Prince of Wales (33,274 km^2) is a tundra-covered island that features many small inland lakes. Although the island is generally below 300 m in elevation, some uplands occur along the eastern coast and across the north. Russell Island and Prescott Island (included in the study area) are small proximal islands north and east of Prince of Wales, respectively. Somerset Island (24,548 km^2), separated from the Prince of Wales Island by Peel Sound, is hilly with extensive uplands (higher than 300 m elevation) throughout (Department of Natural Resources, 2000).

In addition to supporting caribou and muskoxen, many of the islands surveyed in this study are known habitat for polar bear (*Ursus maritimus*), arctic wolf (Canis lupus), arctic fox (*Alopex lagopus*), arctic hare (*Lepus arcticus*), snowy owls (*Bubo scandiacus*) and rock ptarmigan (*Lagopus muta*). Arctic wolves are known to prey on both caribou and muskoxen (Miller, 1993b; Mech, 2005).

2.3 SURVEY METHODS

Representatives from nearby communities were consulted to determine the most appropriate survey design. Given the extensive landmasses within the survey area, uncertain weather conditions, and rugged terrain, a combination of both ground and aerial survey methods were selected. The aerial survey design needed to balance between increasing estimate accuracy and precision with safety and logistical practicality. The design had to be standardized to be repeatable and to deal with low densities over large areas for two species with different sightability, which led us to select Distance Sampling methodology (Buckland et al., 2001; Thomas *et al.,* 2002)

2.3.1 Ground Survey

Ground surveys were conducted by hunters on snowmobiles from 2001-2006. The purpose of the ground surveys was to delineate specific areas occupied and unoccupied by caribou and muskoxen based on observations of recent tracks, foraging sites and animals. This information was provided to an aerial survey crew for the purpose of stratifying aerial survey effort. Specifically, ‘areas occupied’ by caribou and muskoxen were included in the aerial survey program, while areas ‘not occupied’ were excluded from the aerial survey and assigned an abundance of zero. When the terrain was too rugged for ground crews to be certain of wildlife occupancy, the area was surveyed using aerial methods.

Ground teams recorded all observations and their geographical locations in field books, including information on wildlife sightings, group size and location. Observations of animal sign were also recorded (e.g., tracks in snow, feeding sites) and samples were collected (e.g., fecal pellets or shed antlers). Hand-held GPS units (Garmin© GPSmap 76S) were used to record locations and to log the survey routes of each snowmobile (called track logs). GPS data were downloaded into a Geographical Information System (GIS). Field observations were entered into Microsoft Excel© spreadsheets and integrated with the survey track data. After 2004, the ground survey program continued but information was not used to direct the aerial survey program. In 2007 and 2008, ground surveys were discontinued due primarily to logistical constraints, including safety (rugged terrain, harsh weather) and remoteness.

2.3.2 Aerial Survey

Peary caribou and muskoxen are dispersed over large geographic areas. A complete census is not possible and abundance estimates are based on sampling methods. We used a distance sampling line transect aerial survey method (Buckland *et al*., 2001; Thomas *et al*., 2002) to estimate densities of Peary caribou and muskoxen for each of the island groups identified above. This was done using a systematic line-transect design with a random start location (Figure 6). Lines were spaced 5 km apart and ran east–west across the study site, except for Prince of Wales and Somerset

Islands, where transect spacing was 10 km (Figure 6). Transect spacing was selected to maximize aerial coverage with the limited available resources for the study. Transect orientation was parallel to lines of latitude with the first transect placed randomly.

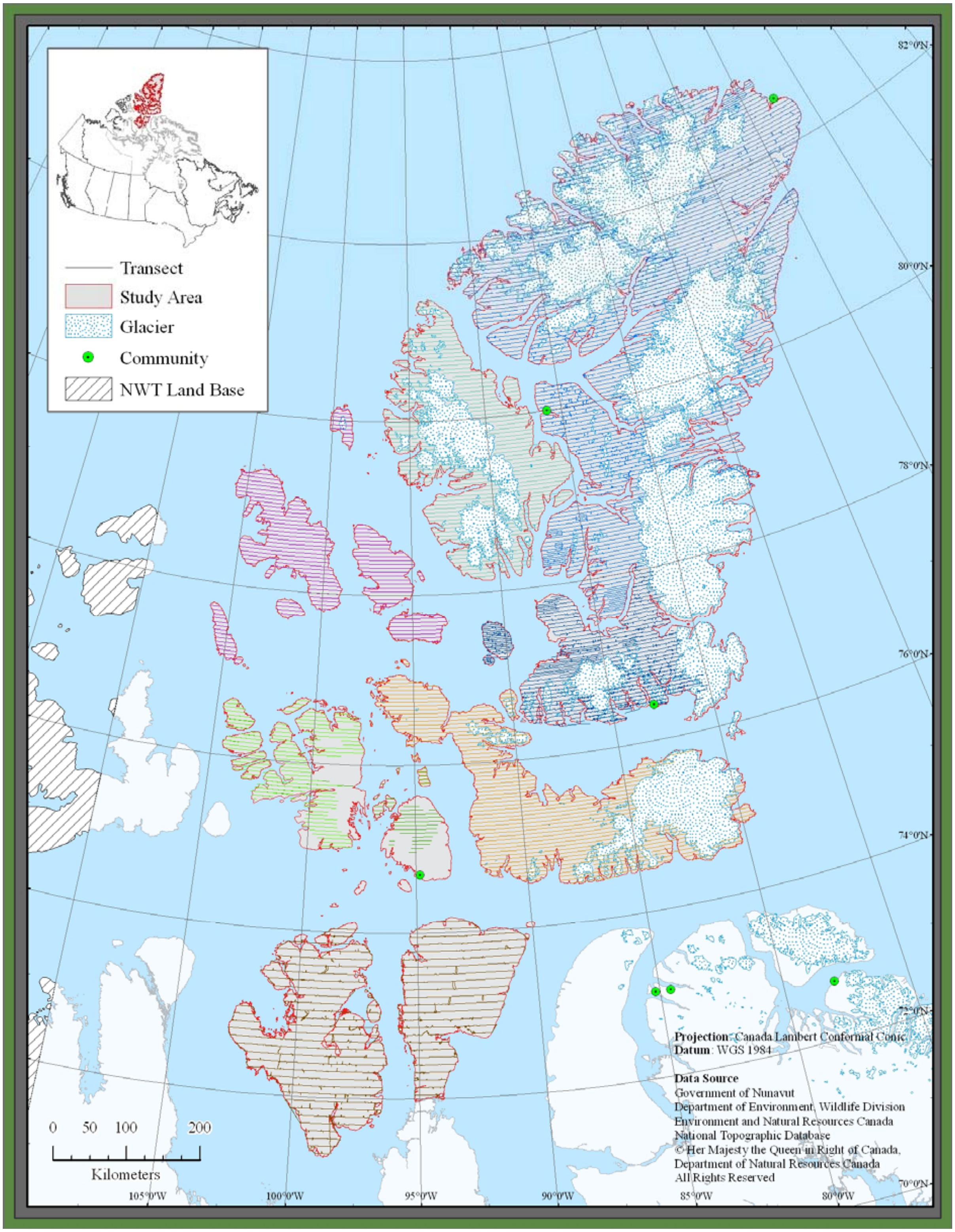


Figure 6: Systematic aerial line-transects for the aerial survey program 2001-2008.

From 2001 through 2008, the line-transect coordinates were imported into ArcView© (www.ESRI.com) and uploaded onto hand-held GPS units (Garmin© 76 and 269 from 2001-2004, Garmin© GPSmap 176 and 276C from 2005-2008) to assist the aircraft along the specified transects. Additionally, from 2005 to 2008, survey routes were plotted in Map Source© and uploaded to duplicate Garmin© GPSmap 176 and 276C units to aid the pilot in navigating each transect. In general, primary transects, identified as "A" transects, covered the entire land base with the exception of extensive ice fields or glaciers. For the initial aerial surveys (2001-2004), a concurrent ground surveys were used to inform aerial crews of areas "not occupied" by Peary caribou and muskoxen. These areas were eliminated from the aerial survey. As well, upon observing caribou along systematically random A transects, aerial crews also sampled additional lines along secondary transects ("B" transects) positioned midway between the primary transects. These additional transects were flown as a form of adaptive sampling, to intensify effort when caribou were seen. Because B transects were not systematically random in their occurrence and they were not part of the survey design across years, observations and flight effort from B transects were excluded from our analysis.

We flew line transects using a Bell 206L or Bell206L4 helicopter at about 120 m above ground level and at an average estimated speed of 130 km/hr. The survey team consisted of four observers, including the pilot. The pilot and forward observer focused on the transect line in front of the helicopter including a search area approximately 45 degrees to the right and left of the helicopter. The two rear observers focused to each side of the helicopter with forward overlap with the front observers' search area. We collected wildlife observations with no fixed transect width (unbounded line transect; Buckland *et al.,* 2001).

Upon detection of target animals (individuals or social groups), the helicopter diverted to fly perpendicular to the transect line to the animals to record location, species, group size, and the sex and age of individuals. The helicopter then circled back to the transect line so that no portions of the line would be missed. From 2007 on, no sex and age classifications were attempted if newborns were present. Hereafter, we refer to each wildlife observation as a cluster, defined for our purposes as an individual animal or group of animals of the same species observed within roughly 100 m of each other. Animal care and safety were priorities, and observation time was kept to a minimum to reduce disturbance. In particular, for muskoxen clusters that included newborns, a first count and location were recorded, a photo was taken (to confirm information), and the aircraft then left the site. Clusters observed while not flying along transects (i.e., while ferrying) were recorded and identified as off-transect observations. We recorded all data in field books and locations as waypoints on hand-held GPS units (Garmin© 76, 269, 176 and/or 276C). The GPS units also recorded automatically the helicopter location every 20-30 seconds, which were downloaded as track logs for each flight. When animal care and environmental conditions permitted, fecal pellets from caribou and muskoxen were collected for genetic analysis (Jenkins in prep).

All survey work was initiated and completed between the months of March and May, when snow cover enhanced visibility of both animals and their sign (i.e. tracks, foraging sites, bedding sites, craters). Survey data were integrated into ArcMap 9.1© (a

Geographical Information System) and used to map the distribution of caribou and muskoxen clusters. The perpendicular distance of wildlife clusters from each transect and the actual transect lengths flown were measured in ArcMap 9.1© following Marques *et al*. (2006). To reduce measurement error, we used a North Pole Azimuthal Equidistant Coordinate System that was centered on each of the survey areas and a map scale of 1:180,000 for transect length measurements. For measurements involving wildlife clusters, the scale was always less than 1:5000.

During our field program we took care to meet the three key assumptions of distance sampling (below) in order to produce an unbiased estimate of density (Anderson *et al*., 2001; Buckland *et al*., 2001):

1) All animals of interest that were directly on the transect line were detected.

2) Animals of interest were detected at their initial location before they moved in response to the observer (i.e., away from the aircraft).

3) Perpendicular distance (x) from the transect line to each detected cluster was measured accurately.

To address assumption # 1, our survey platform (the helicopter) was designed with two forward-sitting observers who had a clear view and direct focus on the transect line ahead of the helicopter. Thus, it can be assumed that no caribou and muskoxen on the ground directly beneath our flight path were missed. This was reasonable given the platform design, but also the relatively large mobile animals of interest, the general occurrence of these animals in groups, the snowy-white backdrop we had for observing due to time of year, and the treeless environment.

Assumption #2 relates to the concern for the sampling of animals that move to hiding places when startled by observers or for animals that are attracted to the observer and move prior to being sited (Buckland *et al*., 2001). However, both the field protocols and study area were conducive to spotting wildlife prior to movement. That is, the open barren landscape allowed for early detection of animals, and a lack of features such as vegetation meant that animals did not have access to shelter for hiding. As well, forward observers on the survey tried to minimize location error by looking ahead of the helicopter as the area was searched. If movement occurred subsequent to initial sighting, the original location of detection was recorded. Animal movement was generally random and slow relative to the speed and direction of the helicopter, and this eliminated the likelihood of serious sampling issues. Finally, we found that wildlife generally did not run from the helicopter except when they were very close to the transect line; thus, animals were generally detected in advance of movement and their original locations were easily recorded. For muskoxen, animals generally did not run from the helicopter but instead formed defense circles. To minimize disturbance, particularly as newborns might have been present in muskox clusters, the helicopter climbed to a higher altitude as soon as the animals were observed. This reduced noise and made the group less apt to move.

Finally, to address the third assumption, we followed Marques *et al*. (2006) and relied on post-sampling analyses using a Geographical Information System (GIS) to determine the perpendicular distance of clusters (given by the overhead GPS position of the animal cluster at the point where first observed) to the plotted transect flown by the pilot. Measurement error was minimized by using a North Pole Azimuthal Equidistant Projection centered on the island group of interest.

2.3.3 Age and Sex Composition

To evaluate herd structure and recruitment, the helicopter, after waypointing the location of the initial cluster observation, reduced altitude and briefly over flew the cluster. All caribou sighted were sexed (male or female) and aged (newborn calves- less than 1 month of age; calves or 'short yearlings' - 10-12 months; yearling - 22-24 months; adult: older than 2 years). Sex was determined based on the presence or absence of a vulva patch and/or urine staining on the rump (Miller, 1991). Supplemental information on the presence/absence of antlers and their size and shape was relatively diagnostic. Non-pregnant barren-ground females typically shed their antlers in April but less is known about the timing of shedding antlers in Peary caribou (Miller, 1991)

For muskoxen, during most survey years, detailed sex and age information was not collected. This was a response to calving and the presence of newborn calves within muskoxen groups. Thus, most muskoxen were categorized in two age classes: newborn calves (less than 2 months) and adult (one year or older). In some surveys, calves or ‘short yearlings’ (the previous year’s calves, approximately 11-12 months) were recorded separately.

For both caribou and muskoxen, newborn calves were excluded from the analysis of density and abundance due to expected low survival rates.

2.4 ANALYSIS

2.4.1 Density and Abundance

To estimate population density, we followed Buckland *et al*. (2001) and used the software Program Distance, Version 5.0, Beta 3 (Thomas *et al*., 2005) to model the line-transect data for each species. We derived density estimates using Conventional Distance Sampling for line-transect data and detection function models (key function/series expansions) recommended by Buckland *et al*. (2001). Each density estimate was multiplied by the survey area to derive an abundance estimate. We defined the survey area as the area within which systematic line (A) transects were surveyed (Aars *et al.,* 2008).

Distance sampling method assumes that some animals will be missed and that the number of observations will diminish with perpendicular distance away from the transect line. In many field surveys, only a small percentage of the animals of interest are detected (Anderson *et al*., 2001; Buckland *et al*., 2001); however, unbiased estimates of density can still be made for these populations using distance sampling methods. Thus, although we knew that not all groups of caribou and muskoxen would be detected during a given survey, this method allowed the average proportion detected P_a to be estimated based on the perpendicular distance of animal clusters from the transect line. This was accomplished by computing a detection function g(x), where:

g(x) = the probability of detecting the animal (or, in this case, cluster of animals) given that it is at perpendicular distance x from the centerline of the transect being flown

and, P_a (the probability that a cluster in the survey area is detected):

$$\hat{P}_a = \frac{\int_0^w \hat{g}(x)dx}{w}$$

where $\hat{g}(x)$ is the estimated detection function and w is the strip width, or in this case the truncation distance. We used Program Distance v. 5.0 (Thomas *et al*., 2005) to calculate $\hat{g}(x)$, $\hat{P}_a$, and the estimated standard error (SE) of $\hat{P}_a$, the effective strip width (ESW, as defined below), as well as estimates of density (D, estimated as $\hat{D}$) and precision for the objects of interest. Here, $\hat{D}$ is estimated from standard line-transect theory:

$$\hat{D} = \frac{n}{2wL\hat{P}_a} \qquad \text{or} \qquad = n\,/\,(2 \times L \times ESW)$$

where n is the number of sightings, $\hat{P}_a$ is the estimated (average) proportion of objects detected within the covered region, L is the total length of the transect line, and ESW is the effective strip half-width (and can be substituted into the equation). This refers to distance on either side of the transect line where by as many objects are detected beyond the distance as are missed within it (Buckland *et al*. 2001, p424). $\hat{D}$ is, in effect, an estimate of the average density during the time of the survey and it is based on the total sampling effort.

As noted, observations in this study are clusters of animals. Therefore, the density of animals D is expressed as a product of the density of clusters $\hat{D}$ (above) multiplied by the average cluster size $\mathrm{E(s)}$:

$$D = \hat{D} \ x \ E(s)$$

The probability of detection may be a function of cluster size such that the sample of cluster size exhibits size bias. In the absence of size bias, we used $\mathrm{E(s)}$ = the mean size of the detected clusters. When size bias was present, we used the regression method to estimate cluster size and correct for size bias (Buckland *et al*., 2001: 73-75). Buckland *et al*. (2001) presents details on the estimated sampling variance of D which is calculated using program Distance 5.0© (Thomas *et al*., 2005).

In order to model the detection function, we pooled data by species across all transect lines by survey area within island groups. Newborn calves were excluded from the analysis due to low expected survival rates. We considered several recommended models for the estimated detection function: half-normal (adjusted with cosine or Hermite polynomials), uniform (adjusted with cosine series or simple polynomial series), and hazard rates (adjusted with cosine series or simple polynomial series; Buckland *et al.,* 2001). Preliminary analysis allowed us to evaluate the distance data and the identification of an appropriate truncation distance which is recommended to delete outliers, to address size bias in detected clusters, and to facilitate modeling of the data (Buckland *et al*. 2001). In our final analysis, several robust models were tested and we used Akaike's Information Criterion (AIC) to select the model with best fit. We accepted the best-fit model if it had a non-significant goodness-of-fit value (χ^2) and a non-significant Kolmogorov-Smirnov Test. For a full description of modeling rationale and options available in program Distance 5.0©, consult Buckland *et al*. (2001) and Thomas *et al*., (2005).

2.4.2 Age and Sex Composition

When our data allowed, we estimated the proportion of calves in the population. For caribou, this was defined as the number of calves (or short yearlings) divided by the total number of caribou seen on transect. For muskoxen, this was defined as the number of newborn calves divided by the total number of muskoxen seen on transect.

The difference in approach between species was necessary as most surveys occurred during muskoxen calving and 1-2 months prior to caribou calving.

For caribou, we also determined adult sex ratios. This was defined as the number of adult males per 100 adult females.

3.0 RESULTS

3.1 STUDY AREA FINDINGS

3.1.1 Ground Surveys

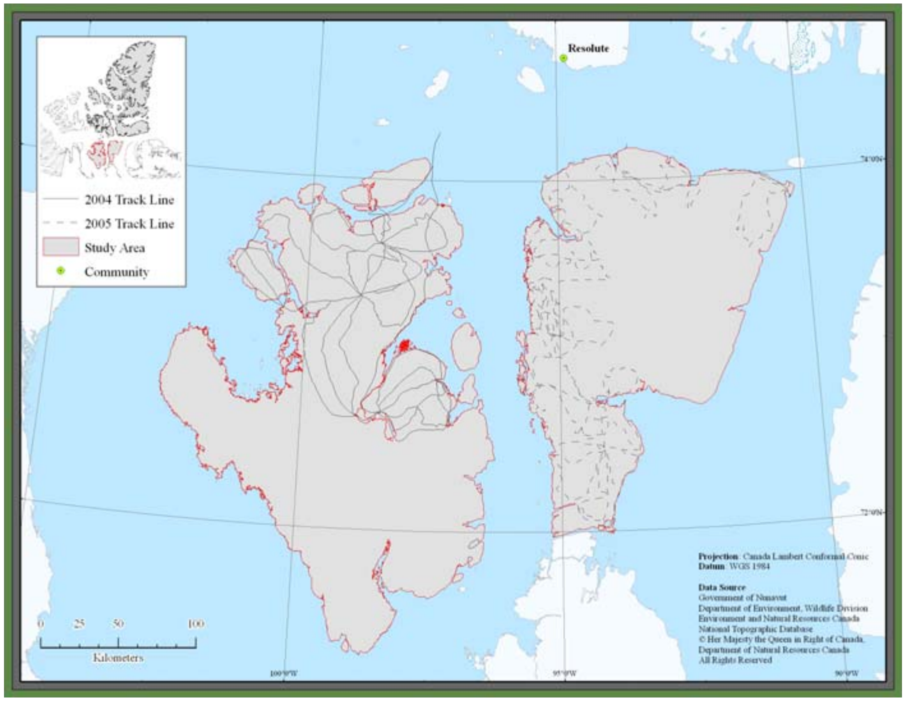
Ground surveys were completed in April-May of 2001, 2002, 2004, 2005 and 2006 on islands or portions of islands that originally corresponded with the aerial survey program. As noted, the original design was that information from ground teams would help direct the aerial survey effort; however, rugged terrain, harsh weather conditions, and areas of deep or no snow precluded some areas from being investigated on the ground. On occasion, whiteout conditions and severe winds made it impossible for ground crews to operate for days (Seeglook Akeeagok and Jeffrey Qaunaq, personal communication, September 2010). Thus, integration of the two methods was difficult and by 2004 the ground and aerial teams were working independently from a survey perspective. For example, Somerset Island was surveyed by aerial methods in 2004 and by ground methods in 2005. Ground surveys were not included in the 2007 and 2008 study program due to logistical constraints, including safety (rugged terrain, harsh weather) and remoteness.

Overall, from 2001 through 2006, snowmobile teams logged a total of 18,513 km of survey track on Bathurst, Cornwallis, western Devon, Prince of Wales and Somerset Islands, and portions of Ellesmere Island (Figures 7-8). The teams observed 44 Peary caribou clusters (137 individual caribou; Table 2) and 110 clusters of muskoxen (605 individuals; Table 3).

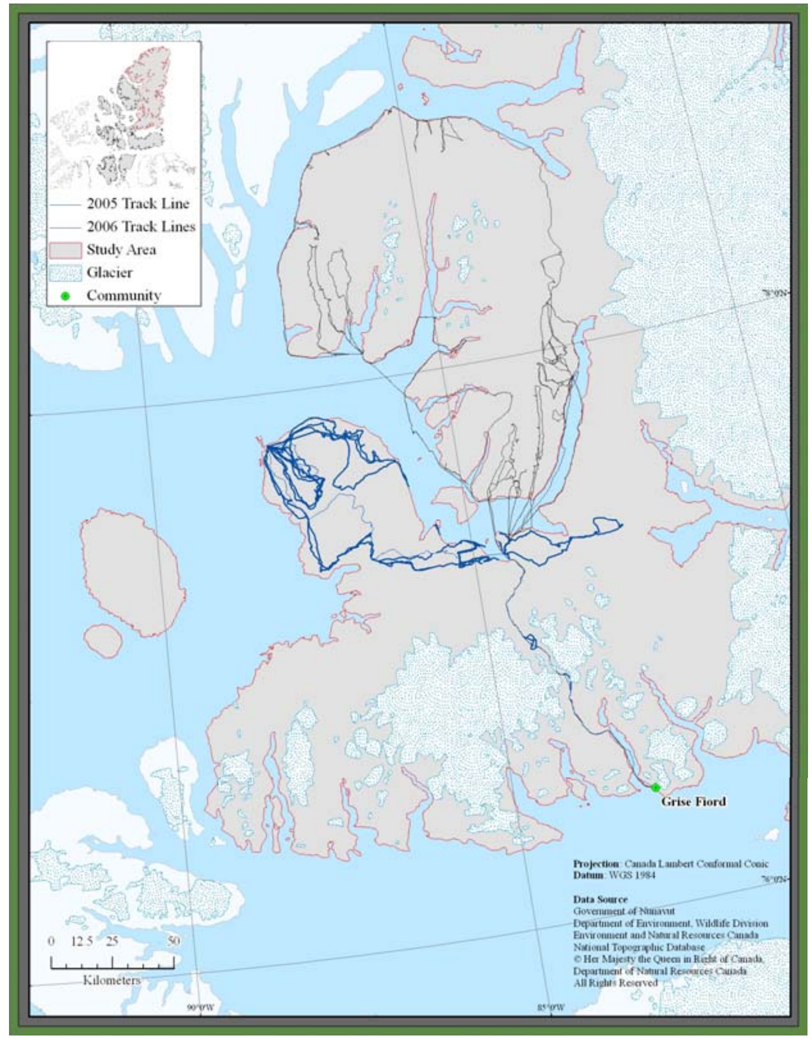
A)

(B)

Figure 7: Survey routes recorded by ground crews within 3 survey areas: (A) Bathurst Island Complex (2001) and (B) Cornwallis Group and Devon Island (2002).



A)



(B)

Figure 8: Survey routes recorded by ground crews within 4 survey areas: (A) Prince of Wales Island (2004), Somerset Island (2005), and (B) Southern Ellesmere Island (2005), and Northern Ellesmere Island (2006).

Table 2: Peary caribou ground survey results, 2001-2006.

Geographical Area	Year Surveyed	Distance (km)	Total # Clusters Observed	# of Caribou Observed	# Newborn Calves	COMPOSITION			Clusters per 1000 km travelled	Tracks Observed	Carcasses Observed	Feeding Areas Observed
						Male	Female	Unknown				
Bathurst Island	2001	3887	18(1)	46	4	13	12	25	4.6	20	0	7
Cornwallis Island	2002	1566	0	0	0	0	0	0	0	2	0	2
Devon Island	2002	3642	7(1)	18	4	6	4	12	1.9	5	2**	1
Prince of Wales Island	2004	1968	0	0	0	0	0	0	0	0	0	0
Somerset Island	2005	2864***	2	3	1	1	1	2	0.7	1	0	1
Ellesmere Island S.	2005	1662	6	17	^^	^^	^^	17	3.6	1	0	^
Ellesmere Island N.	2006	2924	11	44	0	8	19	17	3.8	13	3	^

Notes: ** These specimens were recorded as ' found a bone' so not neccessarily a carcass. *** Distance travelled as per snowmobile odometers was 2936 km. () Figures in brackets represent duplicate cluster observations. ^ Not recorded in the only area where caribou were present. ^^ Not recorded. # of Caribou Observed = number of caribou 10 months or older.

Table 3: Muskoxen ground survey results, 2001-2006.

Georaphical Area	Year Surveyed	Distance (km)	Total # Clusters Observed	# of Muskox Observed	# Newborn Calves	COMPOSITION			Clusters per 1000 km travelled	Tracks Observed	Carcasses Observed	Feeding Areas Observed	Feces Observed
						Male	Female	Unknown					
Bathurst Island	2001	3887	3	28	2	3	8	19	0.77	9	1	6	3
Cornwallis Island	2002	1566	8	22	0	4	3	15	5.11	6	0	9	1
Devon Island	2002	3642	11**	45**	9	3	3	48	3.02	3	0	2	1
Prince of Wales Island	2004	1968	14~	160	^	^	^	^	7.11	^	0	^	
Somerset Island	2005	2864***	24	134	****	^	^	^	6.98	3	17	2	9
Ellesmere Island S.	2005	1662	23	56	0	3	1	52	13.84	3	6	^	
Ellesmere Island N.	2006	2924	27	187	16	21	32	150	9.23	6	3	^	2

Notes: ** Includes one group of three, however no location was provided. *** Distance travelled as per snowmobile odometers was 2936km. **** 5 calves were recorded however it is unclear whether they were calves of the year or just turned 1 year old. ~ Includes one group of 6 muskoxen observed on the sea ice. () Figures in brackets represent duplicate cluster observations. ^ Not recorded. # of Muskox Observed = number of muskoxen one year or older.

3.1.2 Aerial Surveys

We flew 51,832 km on transect from April to May, 2001 to 2008. The survey area included the non-glaciated portion of 65 islands (plus small proximal unnamed islands: Appendix 1. Table A), in the six Island Groups (Figure 3).

Across the entire study area we tallied 398 observations of caribou that included 1,605 individual caribou (10 months or older) and 10 newborns. Although the timing of the survey work was designed as pre-calving, newborns were observed on Bathurst Island Complex as the survey was flown in late May 2001. The majority of Peary caribou clusters were in the eastern Queen Elizabeth Islands, primarily within the Axel Heiberg (31%) and Ellesmere (32%) Island Groups (Table 4, Figure 9). Abundance estimates were generated based on 305 observations of 1,336 caribou (10 months or older) that were seen on transect. Details are presented by survey area and Island Group in Table 4, Figure 9.

We tallied a total of 1,371 clusters of 11,191 muskoxen (1 year or older) and 1,492 newborn calves across the study area (Table 5, Figure 10). No muskoxen were observed on Ellef Ringnes, Meighen, and Lougheed Island in the Ringnes Island Group The number of clusters and the total number of individuals (both on- and off transect) are presented by survey area and Island Group in Table 5.

The majority of muskox clusters were observed in the eastern Queen Elizabeth Islands, primarily within the Ellesmere (57%) and Axel Heiberg (22%) Island Groups. Abundance estimates (Table 5) were generated based on 1,305 observations of 10,856 muskoxen (1 year of age or older).

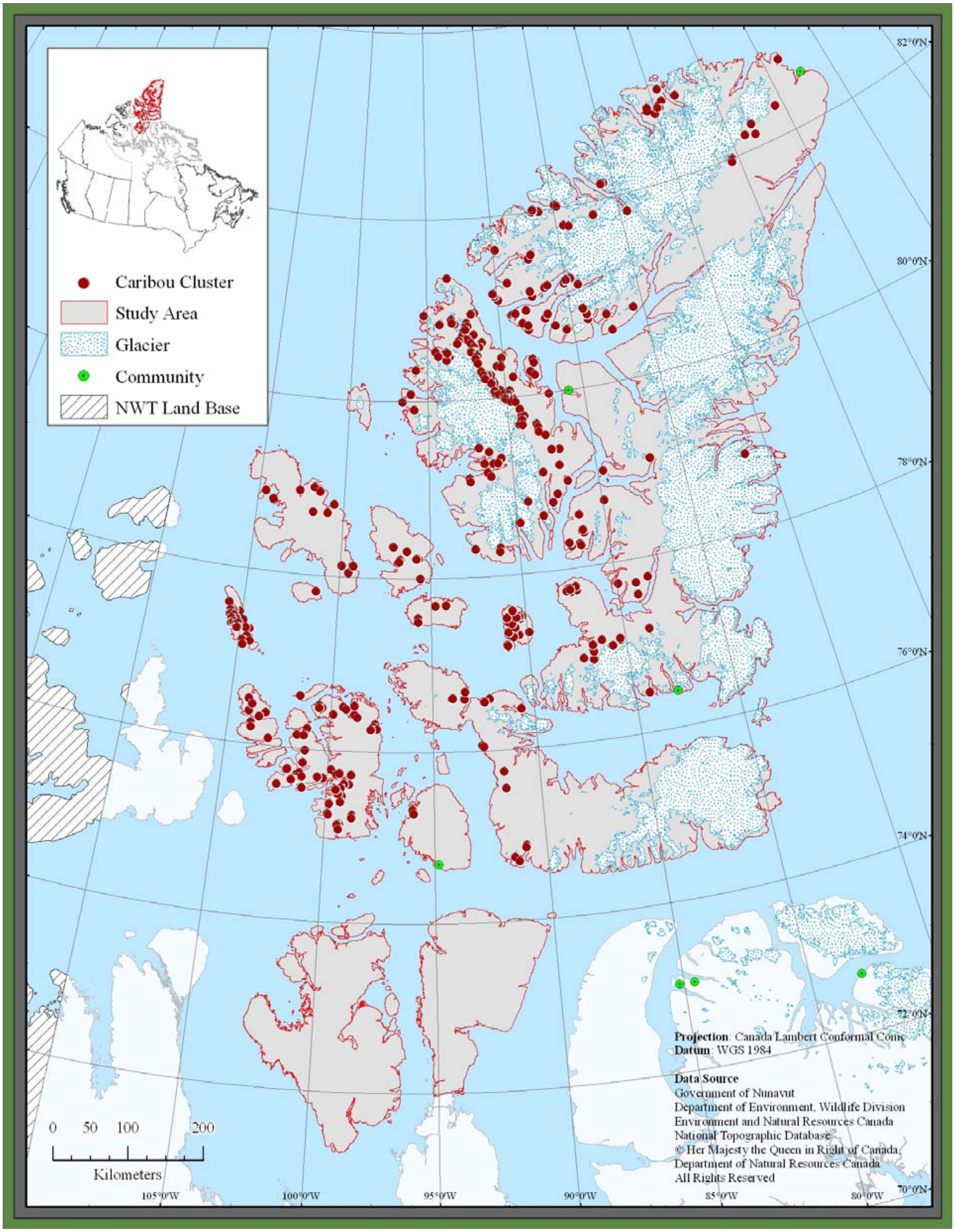


Figure 9: Peary caribou observations over the entire study area from 2001 to 2008.

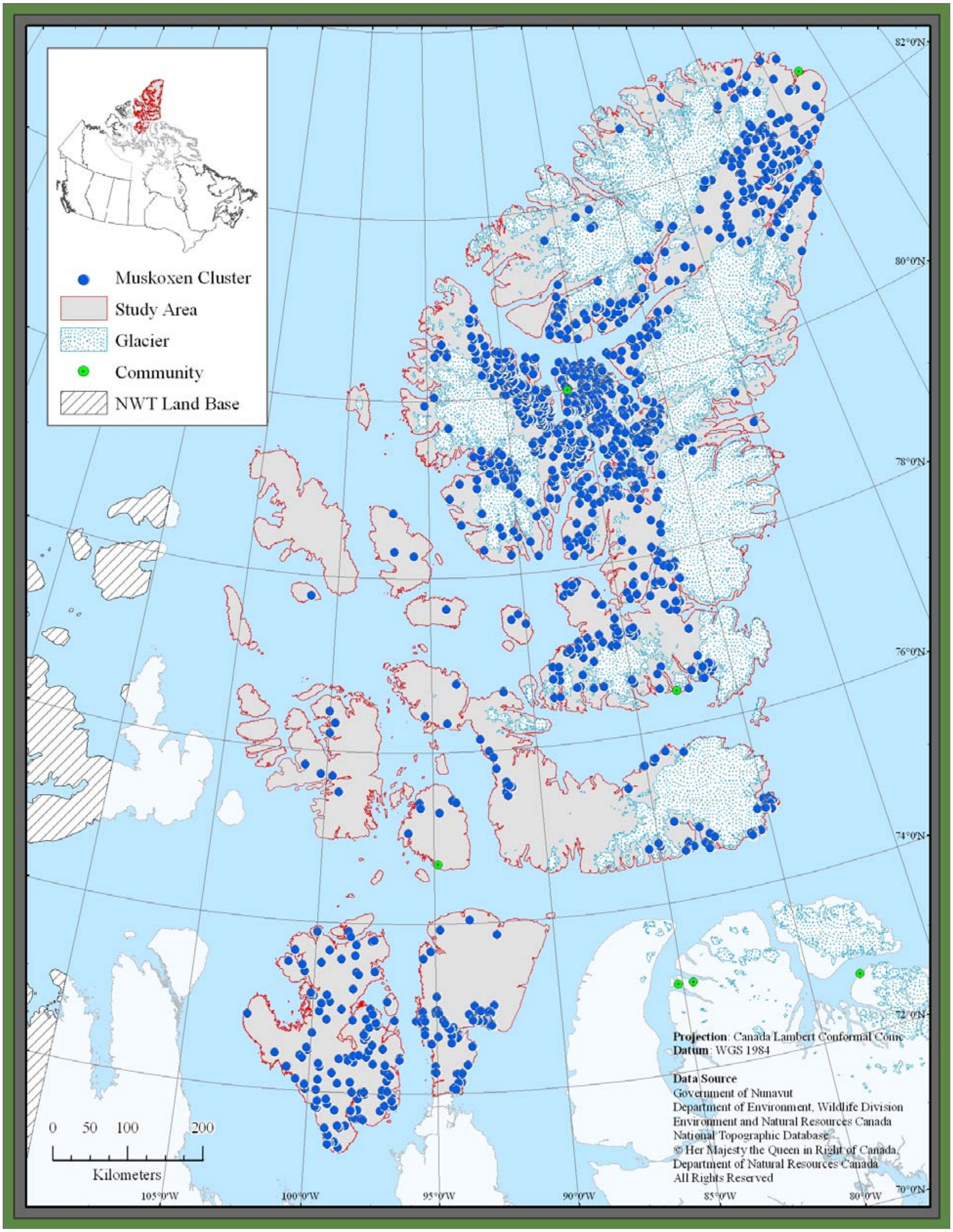


Figure 10: Muskox observations over the entire study area from 2001 to 2008.

Table 4: Peary caribou aerial survey observations, density and abundance estimates for 2001-2008, by Island Group.

STUDY AREA	Area (km sq)	Year	DATE		Effort (m)	ALL OBSERVATIONS			ON-TRANSECT			OFF-TRANSECT			B-TRANSECT (OFF)			Density	95% CI		CV	Abund.	95% CI	
			Start	Finish		# Cls.	# PC	# NB	# Cls.	# PC	# NB	# Cls.	# PC	# NB	# Cls.	# PC	# NB		LCI	UCI			LCI	UCI
Bathurst Island Group																								
Bathurst Island Complex	15,307	2001	15-May	31-May	2886113	67	152	10	24	52	5	8	11	0	35	89	5	0.0095	0.0053	0.0168	0.2957	145	81	257
Adjusted BIC	*19,644	" "	" "	" "	" "													" "	" "	" "	" "	*187	104	330
Cornwallis	3,411	2002	10-May	11-May	618640	1	1	0	1	1	0	0	0	0	0	0	0	1	Min Count			1	Min Count	
Devon Island Group																								
Baillie Hamilton	290	2002	28-May	28-May	54200	0	0	0	0	0	0	0	0	0	0	0	0	0	Min Count			0	Min Count	
West Devon	12,316	2002	08-May	30-May	2217730	13	35	0	5	18	0	3	6	0	5	11	0	35	Min Count			**40	Adjusted Min Count	
Devon	39,731	2008	22-Apr	10-May	7985397	4	17	0	4	17	0	0	0	0	N/A	N/A	N/A	17	Min Count			17	Min Count	
North Kent	440	2008	22-Apr	10-May	83115	0	0	0	0	0	0		0	0	N/A	N/A	N/A	0	Min Count			0	Min Count	
Baillie Hamilton	290	2008	22-Apr	10-May	53320	0	0	0	0	0	0		0	0	N/A	N/A	N/A	0	Min Count			0	Min Count	
Dundas/Margaret	61	2008	22-Apr	10-May	13577	0	0	0	0	0	0		0	0	N/A	N/A	N/A	0	Min Count			0	Min Count	
Prince of Wales - Somerset Island Group																								
Prince of Wales	34,765	2004	10-Apr	18-Apr	3430308	0	0	0	0	0	0	0	0	0	0	0	0	0	Min Count			0	Min Count	
Somerset	24,549	2004	20-Apr	25-Apr	2420364	0	0	0	0	0	0	0	0	0	0	0	0	0	Min Count			0	Min Count	
Ellesmere Island Group																								
S Ellesmere	23,767	2005	04-May	30-May	4299116	41	118	0	19	57	0	0	0	0	22	61	0	0.0092	0.0046	0.0186	0.3609	219	109	442
N Ellesmere	96,567	2006	06-Apr	22-May	17535130	86	413	0	72	344	0	2	7	0	12	62	0	0.0083	0.0055	0.0125	0.2103	802	531	1207
Axel Heiberg Island Group																								
Axel Heiberg	30,877	2007	19-Apr	03-May	5871988	124	658	0	120	642	0	4	16	0	N/A	N/A	N/A	0.0742	0.053	0.1039	0.172	2291	1636	3208
Ringnes Island Group																								
Amund Ringnes	5,364	2007	15-Apr	17-Apr	1063944	9	26	0	9	26	0	0	0	0	N/A	N/A	N/A							
Cornwall Island	2,273	2007	19-Apr	19-Apr	448344	4	16	0	4	16	0	0	0	0	N/A	N/A	N/A							
Ellef Ringnes	11,549	2007	06-Apr	15-Apr	2275504	16	32	0	14	26	0	2	6	0	N/A	N/A	N/A							
King Christian	647	2007	14-Apr	14-Apr	117421	1	6	0	1	6	0	0	0	0	N/A	N/A	N/A							
Meighen	849	2007	22-Apr	22-Apr	170546	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A							
Pooled Results	**20,682**				**4075759**	**30**	**80**	**0**	**28**	**74**	**0**	**2**	**6**	**0**	**N/A**	**N/A**	**N/A**	**0.0136**	**0.0076**	**0.02442**	**0.3**	**282**	**157**	**505**
Lougheed	1,415	2007	13-Apr	13-Apr	286882	32	131	0	32	131	0	0	0	0	N/A	N/A	N/A	0.2626	0.145	0.475	0.3	372	205	672

Notes: # Cls.= number of Peary caribou clusters. #PC= number of Peary caribou 10 months or older. # NB = number of newborn calves.
**Adjusted based on ground and aerial observations outside the aerial survey area on Bathurst Island. Area adjusted to incorporate all of Bathurst Island.*
*** Adjusted based on ground observations outside aerial survey area. The survey area could not be adjusted as the boundaries of the ground survey were not known.*

Table 5: Muskox aerial survey observations, density and abundance estimates for 2001-2008, by Island Group.

STUDY AREA	Area (km sq)	Year	DATE		Effort (m)	ALL OBSERVATIONS			ON-TRANSECT			OFF-TRANSECT			B-TRANSECT (OFF)			Density	95% CI		CV	Abund.	95%CL	
			Start	Finish		# Cls.	# MX	# NB	# Cls.	# MX	# NB	# Cls.	# MX	# NB	# Cls.	# MX	# NB		LCI	UCI			LCI	UCI
Bathurst Island Group																								
Bathurst Island Complex	15,307	2001	15-May	31-May	2886113	7	82	21	3	32	8	1	10	6	3	40	7	82	Min Count			82	Min Count	
Cornwallis	3411	2002	10-May	11-May	618640	7	18	0	5	15	0	0	0	0	2	3	0	18	Min Count					
Cornwallis (All)	7474**	" "																				22*	Adjusted Min Count	
Devon Island Group																								
West Devon	12316	2002	08-May	30-May	2217730	10	68	7	9	59	7	0	0	0	1	9	0	68	Min Count			68	Min Count	
Baillie Hamilton	290	2002	28-May	28-May	54200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Devon	39,731	2008	22-Apr	10-May	7985397	69	391	61	61	354	58	8	37	3	N/A	N/A	N/A	0.0129	0.0076	0.0218	0.267	513	302	864
North Kent	440	2008	22-Apr	10-May	83115	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A	0	Min Count			0		
Baillie Hamilton	290	2008	22-Apr	10-May	53320	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A	0	Min Count			0		
Dundas/Margaret	61	2008	22-Apr	10-May	13577	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A	0	Min Count			0		
Prince of Wales - Somerset Island Group																								
Prince of Wales	34,765	2004	10-Apr	18-Apr	3430308	111	1483	27	111	1483	27	0	0	0	0	0	0	0.0600	0.0455	0.0790	0.1386	2086	1582	2746
Somerset	24,549	2004	20-Apr	25-Apr	2420364	69	988	47	66	967	46	3	21	1	0	0	0	0.0778	0.0392	0.1545	0.3466	1910	962	3792
Ellesmere Island Group																								
S Ellesmere	23,767	2005	04-May	30-May	4299116	118	316	2	99	273	2	2	4	0	17	39	0	0.0192	0.0131	0.0282	0.1939	456	312	670
N Ellesmere	96,567	2006	06-Apr	22-May	17535130	666	5127	927	645	4999	907	14	77	9	7	51	11	0.0840	0.0687	0.1028	0.1028	8115	6632	9930
Axel Heiberg Island Group																								
Axel Heiberg	30,877	2007	19-Apr	03-May	5871988	309	2697	400	301	2653	396	8	44	4	N/A	N/A	N/A	0.1372	0.1092	0.1725	0.1162	4237	3371	5325
Ringnes Island Group																								
Amund Ringnes	5,364	2007	15-Apr	17-Apr	1063944	3	13	0	3	13	0	0	0	0	N/A	N/A	N/A	13	Min Count			13	Min Count	
Cornwall Island	2,273	2007	19-Apr	19-Apr	448344	1	6	0	1	6	0	0	0	0	N/A	N/A	N/A	6	Min Count			6	Min Count	
Ellef Ringnes	11,549	2007	06-Apr	15-Apr	2275504	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A	0	Min Count			0	Min Count	
King Christian	647	2007	14-Apr	14-Apr	117421	1	2	0	1	2	0	0	0	0	N/A	N/A	N/A	2	Min Count			2	Min Count	
Meighen	849	2007	22-Apr	22-Apr	170546	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A	0	Min Count			0	Min Count	
Lougheed Group	1,415	2007	13-Apr	13-Apr	286882	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A	0	Min Count			0	Min Count	

Notes: #Cls. = # of muskox clusters. #MX = number of muskoxen one year or older. #BN = number of newborn calves.
** Adjustment based on ground observations outside aerial survey area.*
*** Additional Area was surveyed using ground methods*

3.2 SURVEY FINDINGS BY ISLAND GROUP

3.2.1 Bathurst Island Group

(Survey Areas - *Bathurst Island Complex, and Cornwallis Group*)

3.2.1.1 Bathurst Island Complex Survey Area

Caribou

Ground Survey: In 2001, crews traveled 3,887 km^2 (Figure 11) on the Bathurst Island Complex (BIC) and observed 18 clusters of Peary caribou representing 50 individuals (4.6 clusters/1000 km surveyed) (Figure 11). Two clusters (four animals in total) were observed in areas that were excluded from the aerial survey. Tracks were recorded on 20 occasions and seven feeding sites were noted (Table 3).

Aerial Survey: The BIC aerial survey was conducted May 15-31, 2001. The total length of A transects flown was 2,886 km and the total area surveyed was approximately 15,305 km^2 (Table 4, Figure 12). The remaining area (approximately 4,339 km^2) was not surveyed based on information from concurrent ground surveys. A total of 24 clusters of caribou were observed on transect, including 24 female and 11 male adults, two yearlings, 15 calves or ‘short yearlings’ and five newborns. The first newborn observed was spotted on May 27, 2001. The proportion of calves or ‘short yearlings’ is 29% of those animals seen on transect (excluding newborns). The ratio of adult males to females was 46:100.

An additional 43 caribou clusters were observed off transect (not including those seen while ferrying to site), and these represented 100 caribou (10 months or older) and five newborns. These 105 caribou were located by following tracks, by maintaining a 1 km field of vision on either side of the transect (by eliminating topography) and by flying additional transects in areas where caribou were detected (G.Hope, personal communication, April 14, 2011). Given the flight effort to investigate caribou sightings and sign, and to eliminate topography as an obstacle to observations, the combination of on- and off-transect observations provides a thorough count of caribou in the survey area.

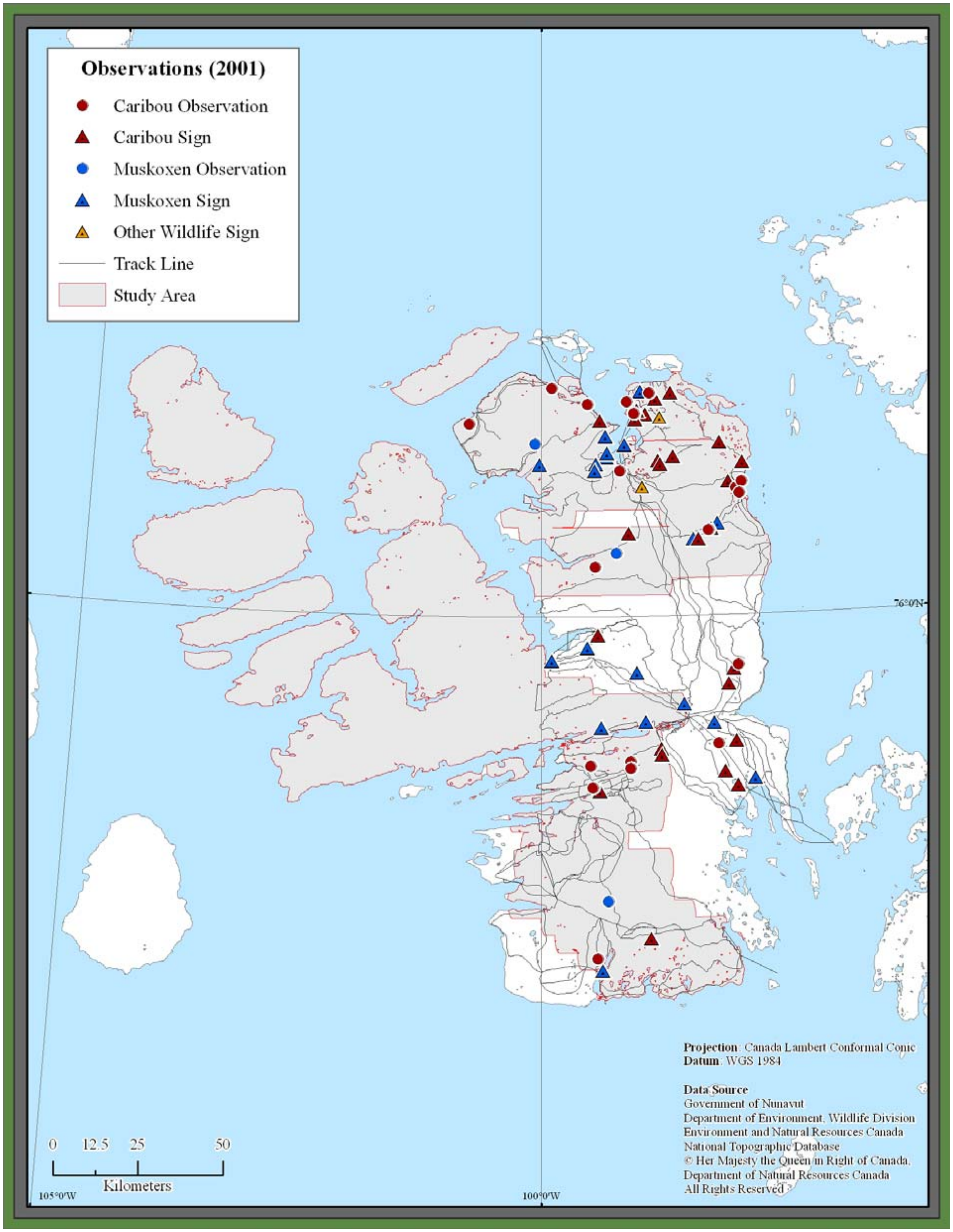


Figure 11: Ground survey observations within the Bathurst Island Complex (BIC) survey areas, 2001.

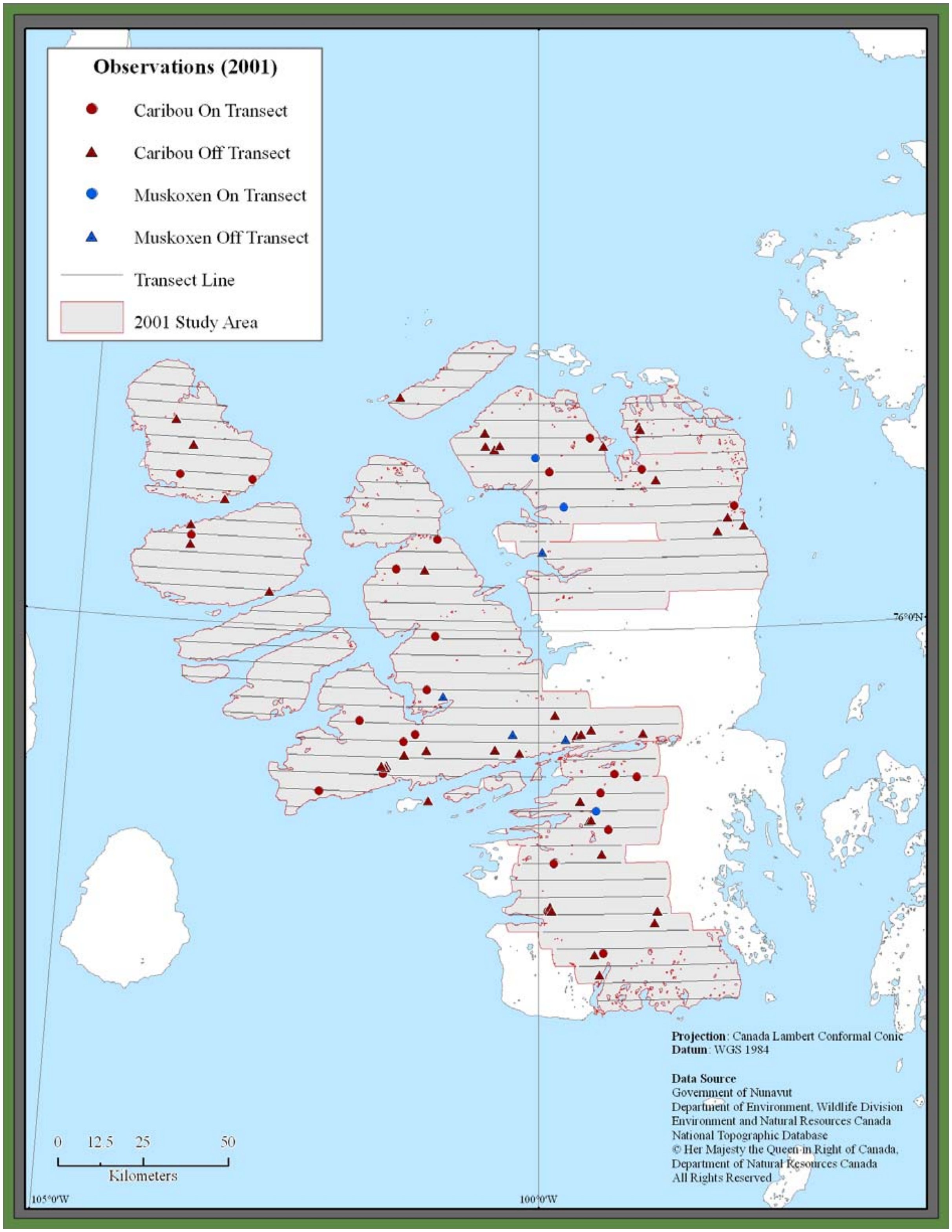


Figure 12: Aerial survey observations of Peary caribou and muskoxen clusters for the Bathurst Island Complex (BIC) survey area, 2001.

After fitting all recommended models to the data, the uniform key model with single order cosine adjustment was selected (Table 6). The selected model was characterized by a small shoulder (Figure 13) and a non-significant Chi-square Goodness of Fit test, suggesting good fit of the data (χ^2 =0.8164, p= 0.6486)

We estimated the probability of detecting a cluster of caribou on either side of the transect line as P_a = 0.660 (95% CI 0.472–0.922) and estimated the effective strip width (ESW) to be 876 m (95% CI 627–1224 m). The mean cluster size for the BIC survey area was 2.08 caribou/cluster (SE 0.29), and this was the smallest cluster size noted for all survey areas**.** The estimated density of caribou inhabiting the BIC survey area was 9.5 caribou/1000 km^2 (95% CI 5.3–16.8 caribou/1000 km^2) or 145 caribou (95% CI 77-260) approximately 10 months of age and older.

The original survey design specified that non-surveyed areas would represent space ‘not occupied by caribou’ and result in counts of zero caribou. On Bathurst Island, data from the ground survey indicates that there were some caribou in these areas (two non-repeat groups representing 4 caribou were detected) as did observations collected by aerial crew during flights to and from Bathurst Island (5 non-repeating observations representing 10 caribou). To address this, we applied the results (the density estimate) obtained in the covered areas across the non-surveyed areas of Bathurst Island and assumed that the detection function would be similar. This is reasonable given the lack of topography and barren landscape. Thus, the BIC area increased to 19,644 km^{2,} and generated an abundance estimate of 187 caribou (95% CI 104-330).

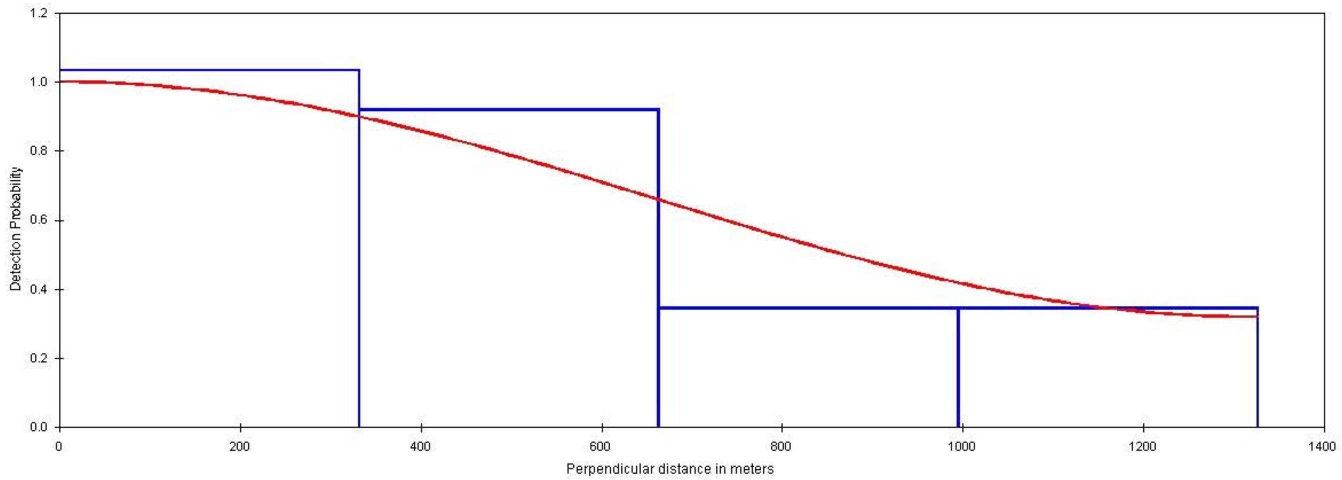


Figure 13: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou observed within the Bathurst Island Complex survey area, May 2001. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 332 m.

Table 6: Summary of candidate models used in the line-transect analysis for Peary caribou of the Bathurst Island Complex survey area, May 2001. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Bathurst Island Complex - Peary caribou					**Density**	**95% CI**		
Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**(caribou/km^2)**	**LCI**	**UCI**	**CV**
Uniform Cosine	1	0.00	329.28	875.75	0.0095	0.0053	0.0169	0.296
Half-normal Hermite Poly	1	0.83	330.11	929.97	0.0089	0.0050	0.0160	0.299
Half-normal Cosine	1	0.83	330.11	929.97	0.0084	0.0047	0.0150	0.297
Uniform Simple Poly	0	1.49	330.77	1327.00	0.0063	0.0039	0.0102	0.247
Hazard-rate Simple Poly	2	1.79	331.07	649.40	0.0102	0.0041	0.0252	0.472
Hazard-rate Cosine	2	1.79	331.07	649.40	0.0102	0.0041	0.0252	0.472

Muskoxen

Ground Survey: Ground crews reported seeing 3 clusters of muskoxen for a total of 30 animals after driving 3,887 km on the BIC or 0.77 clusters/1000 km traveled. Observations of muskox sign were also reported, including one carcass (Table 3, Figure 11).

Aerial Survey: A total of three clusters of muskoxen were observed on transect (Table 5, Figure 12) which included 32 muskoxen (one year or older) and eight newborn calves. The proportion of newborn calves was 20% of those animals seen on transect. Four additional groups were identified as off transect; these were observed while investigating other clusters, or following tracks, or when flying B transects

The scarcity of muskoxen and the overall lack of observations prevented calculating a density estimate. Instead, we report a minimum count of 82 muskoxen (one year or older) for the BIC survey area in 2001.

3.2.1.2 Cornwallis Survey Area

Caribou

Ground Survey: The ground crew observed no caribou during 1,566 km (Table 2, Figure 14) of snowmobile travel on Cornwallis Island in 2002. However, the crew recorded four observations of caribou sign, including two feeding sites and two observations of caribou tracks.

Aerial Survey: We flew 619 km of transect on May 10-11, 2002 during the aerial survey of Cornwallis, Little Cornwallis, Milne, Crozier and Baring Islands (Figure 15) and observed only two clusters of Peary caribou (Table 4). Field notes indicate that these clusters may, be a duplicate count of a single adult female caribou. No other caribou or their sign (e.g., incidental observations) were observed from the air. Some areas of Cornwallis Island were excluded from the aerial survey based on ground reconnaissance. These areas were identified as ”not occupied by caribou” with zero observations of caribou or caribou sign.

The observation of the single caribou limits the results to a minimum count of one caribou (10 months or older) in the Cornwallis Island Group survey area during 2002.

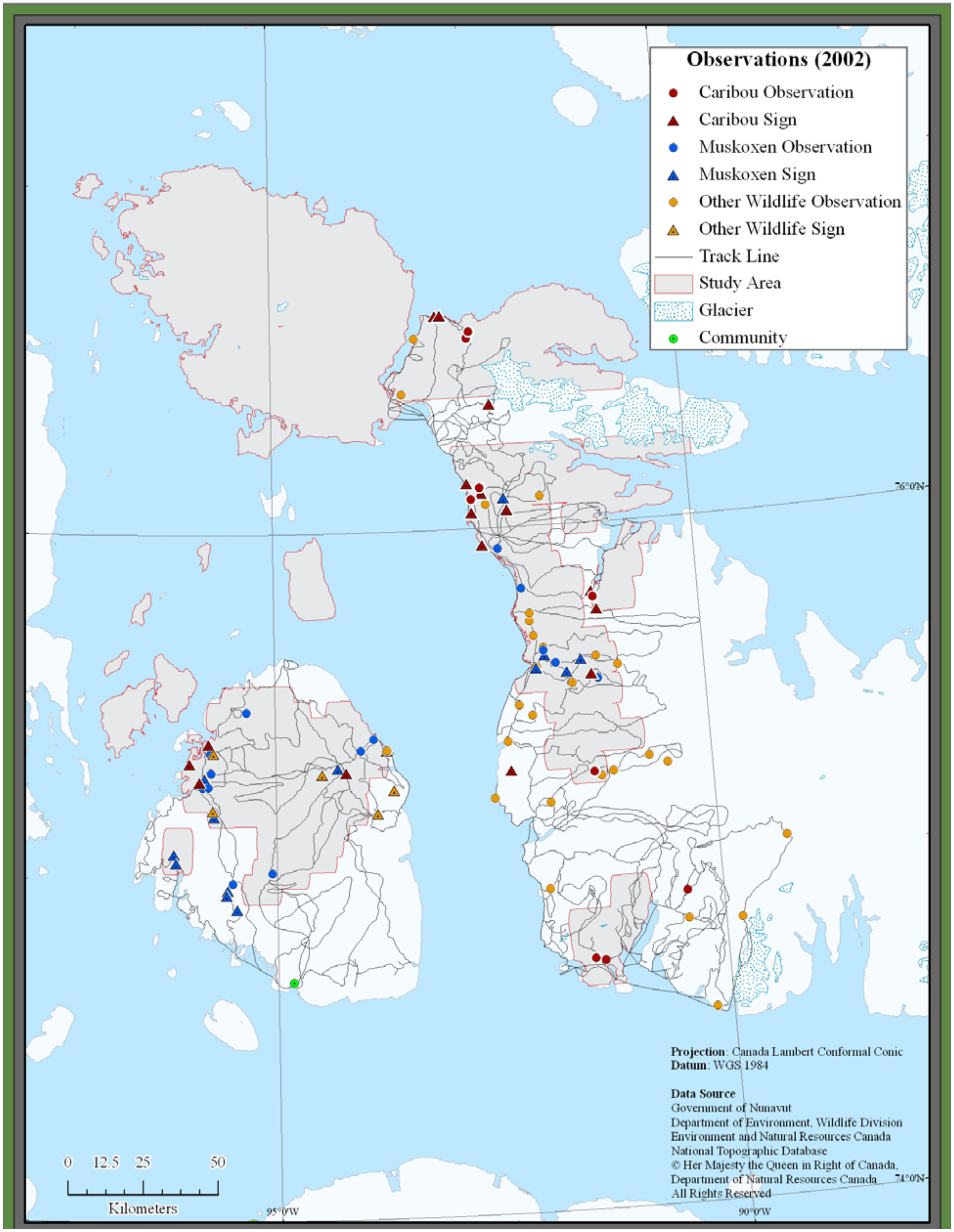


Figure 14: Ground survey observations within the Cornwallis Group and W. Devon survey area, 2002

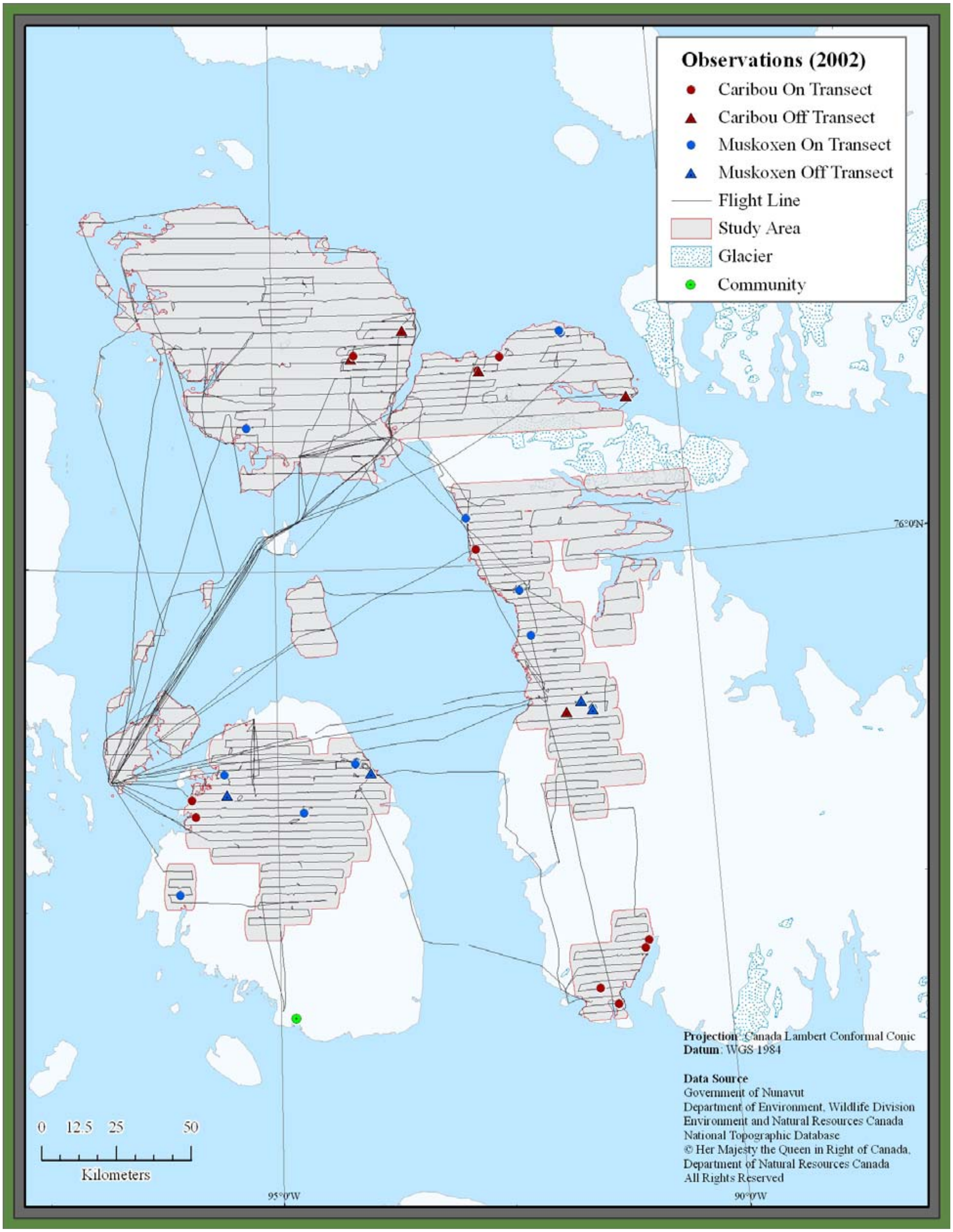


Figure 15: Aerial observations of Peary caribou and muskoxen clusters for the Cornwallis Group and W. Devon survey area, 2002.

Muskoxen

Ground Survey: In driving 1,566 km on Cornwallis Island, the ground crew observed eight clusters of muskoxen with 22 animals total (Table 3), or 5.11 clusters per 1000 km traveled. The crew also reported six observations of muskox tracks and nine feeding areas (Figure 14). One cluster of 4 adults and one newborn was observed in an area not surveyed by aerial methods. A minimum count of 4 is therefore reported for this area.

Aerial Survey: A total of seven clusters of muskoxen (18 animals with no newborns) were observed within the survey area during 619 km of flying (Table 5, Figure 15). Five of these clusters were observed on transect which is too few to derive a density estimate. Instead, we report a minimum count of 22 animals for the Cornwallis Island Group survey area in 2002, a figure which incorporates results from both the ground and aerial survey.

Of the muskoxen observed on transect, 15 were adults (1 year or older) and there were zero newborn calves. The proportion of newborn calves was 0% of those animals seen on transect

3.2.2 Devon Island Group

(Survey Areas - Devon, North Kent, Ballie Hamilton, and Dundas/Margaret Islands)

3.2.2.1 Devon Island Survey Area

Caribou

Ground Survey: After driving 3,642 km in 2002, the ground crew observed seven separate clusters of caribou for a total of 22 animals. This represents approximately 1.9 clusters/1000 km of ground surveyed. Caribou sign was also recorded, with tracks observed on five occasions, carcasses (or bones) recorded twice, and one feeding site noted (Table 2, Figure 14). One group of 5 caribou was observed in an area not surveyed by aerial methods in 2002.

Aerial Survey: Portions of the western coast of Devon Island were surveyed by air on May 8-30, 2002. A total of 2,218 km of (A) transects were flown and observations of Peary caribou and muskoxen recorded. Additional observations were collected during flights of secondary (B) transects and when following tracks (Figure 16). Within the survey area defined by the systematic A-transect design (12,316 km^2), 13 non-repeated clusters of Peary caribou were observed but only five of these were on transect (Figure 15). The total number of caribou was 35 animals (Table 4), with 18 seen on transect. Composition as estimated from the air was eight female and four male adults, three yearlings, three calves or ‘short yearlings’ and zero newborns. The proportion of calve or ‘short yearlings’ is 17% of those animals seen on transect. The ratio of adult males to females is 50:100.

Baille Hamilton Island was also surveyed in 2002 as part of the Devon Island Group (54 km of transect) and no caribou were observed.

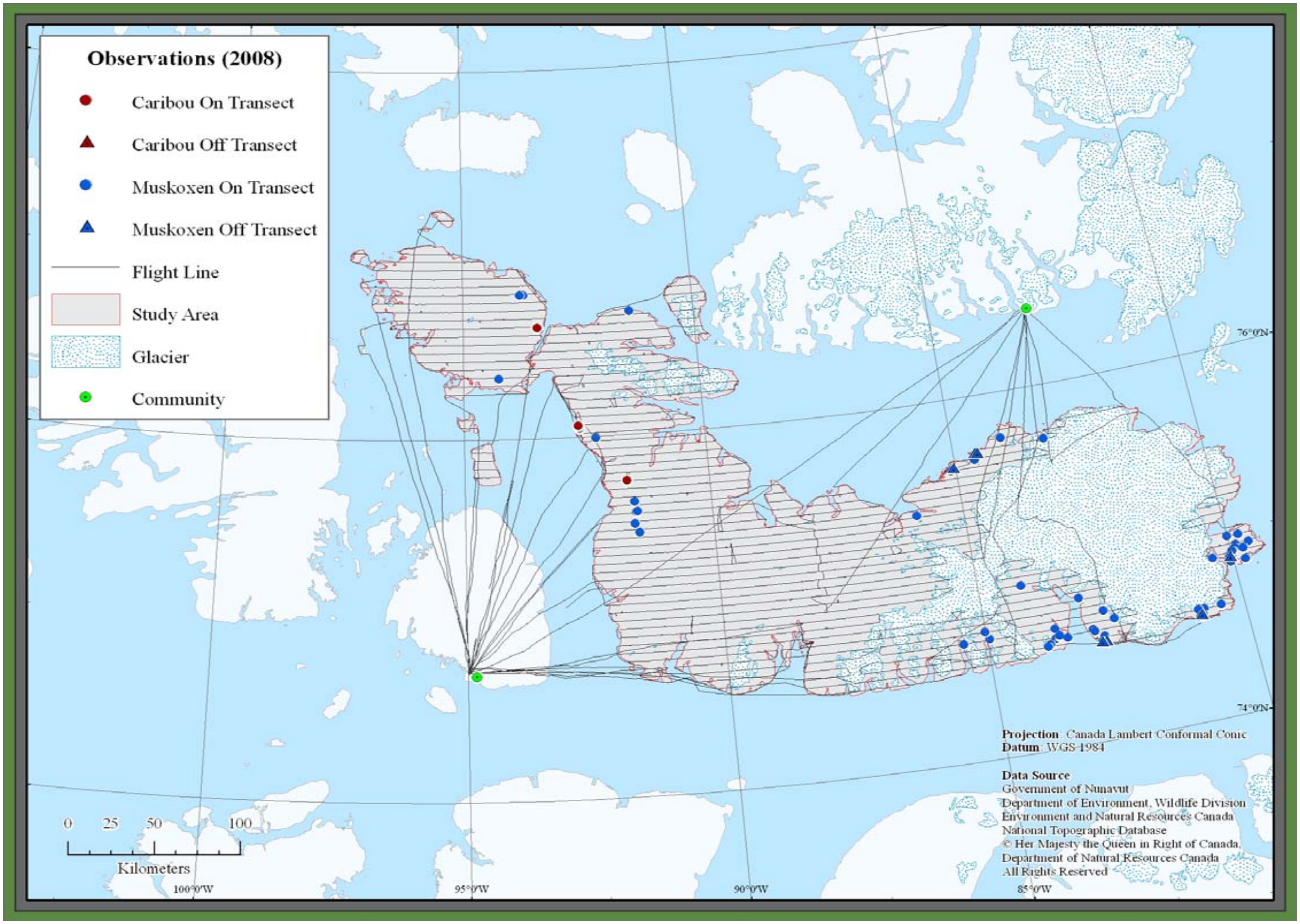


Figure 16: Aerial survey observations of Peary caribou and muskoxen clusters for the Devon Island Group, 2008.

Since there were so few observations of caribou clusters on transect, we were unable to use distance sampling methods to estimate caribou density. We report a minimum count of 40 caribou for the western coast of Devon Island in 2002. This result incorporates ground survey observations of caribou beyond the aerial survey area.

Given the overall size of Devon Island, the limited survey area covered in 2002, and Inuit reports of Peary caribou inhabiting other areas of the island (e.g., the Truelove Lowlands; Taylor 2005), a complete island survey was undertaken between April 22 and May 10, 2008. Flight effort (7,985 km) was applied systematically to all non-glaciated areas of Devon Island and small proximal islands (see Table 4). Additional flights totaling 150 km were made over North Kent, Baille Hamilton, Dundas and Margaret islands (Figure 16). Together, all flights yielded four observations of Peary caribou clusters representing 17 caribou in total, with all observations on transect and located in western Devon Island. Composition was eight female and 6 male adults, two yearlings, 1 calf or ‘short yearling’ and zero newborns. The proportion of calves or ‘short yearlings’ is 6 % of those animals seen on transect. The ratio of adult males to females is 75:100.

The scarcity of caribou and insufficient number of observations precluded estimation of population density and abundance. We report a minimum count of 17 caribou for the Devon Island Group in 2008.

Muskoxen

Ground Survey: After driving 3642 km in May 2002, 11 observations of muskoxen (a total of 54 animals including nine newborns) were recorded in west Devon Island (Table 3). This represents 3.02 clusters/1000 km traveled.

Aerial Survey: Portions of the west coast of Devon Island were surveyed by air from May 8-30, 2002. A total of 2,218 km of A transect were flown and 9 clusters of muskoxen, including 59 adults (one year or older) and 7 newborn calves were reported on transect. Unfortunately, due to the small number of observations, a density estimate could not be derived for muskoxen in this part of the Devon Island Group.

In 2008, as described above for caribou, the aerial survey was expanded across Devon Island (39,731 km^2, including small proximal islands) and to large off-shore islands (North Kent, Baille Hamilton, Dundas and Margaret; 945 km^2 in total for these). Between April 22 and May 10 of 2008, 61 observations of muskoxen were recorded on transect (354 adults [1 year or older] and 58 newborns): the proportion of newborn calves was 14%.

For analysis of muskoxen abundance in the Devon Island Group, we excluded the steep-walled islands of Baille Hamilton, North Kent, Dundas and Margaret, where no muskoxen were observed. We truncated the largest 10% of the distance data to address outliers and facilitate fitting the detection function. We selected the uniform model with single-order cosine adjustment as the best model (Table 7, Figure 17). This model had a non-significant goodness-of fit value ($\chi^2 = 0.5931$, p= 0.74338), which indicated good fit of the data.

We estimated the probability of detecting a cluster of muskoxen within the defined area as $P_a = 0.578$ (95% CI 0.498-0.670). The estimated ESW was 1,143 m (95% CI 986-1326 m). The expected cluster size was 4.21 muskoxen/cluster (SE 0.49), whereas mean cluster size was 5.51 muskoxen/cluster (SE 0.52). The estimated density of muskoxen was 12.9 /1000 km^2 (95% CI 7.6-21.8/1000 km^2). Based on findings in the survey area (39,731 km^2) we estimated that there were 513 muskoxen one year or older (95%CI 302-864) throughout the Devon Island Group.

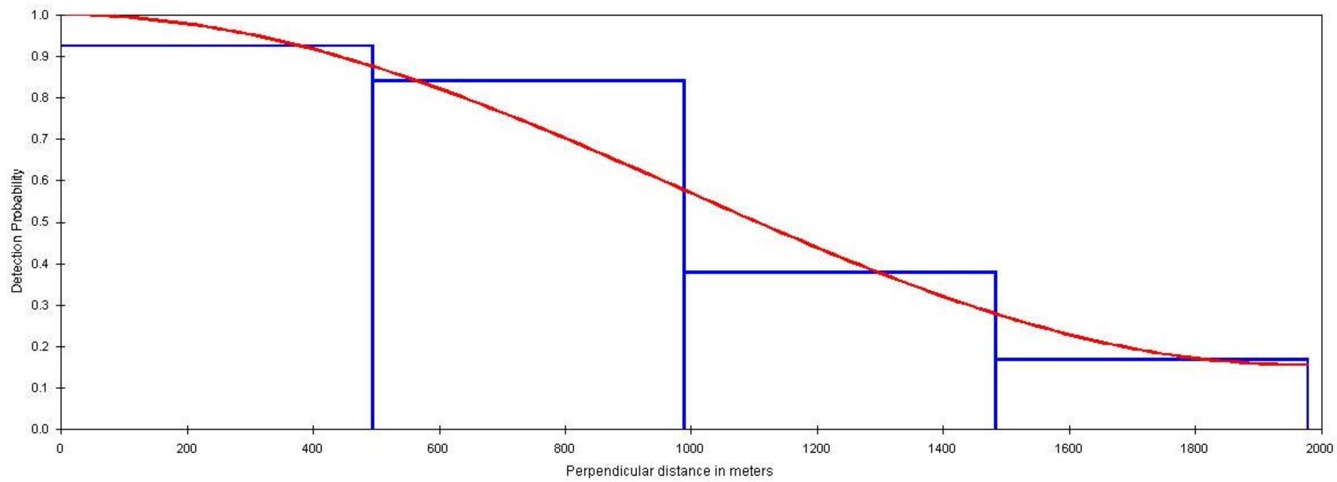


Figure 17: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Devon Island Group survey area, April-May 2008. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 495 m.

Table 7: Summary of candidate models used in the line-transect analysis for muskoxen of the Devon Island Group survey area, April-May 2008. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Devon - Muskoxen					**Density**			
Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Caribou/km^2**	**95% LCI**	**95% UCI**	**CV**
Uniform Cosine	1	0.00	818.94	1143.65	0.0129	0.0077	0.0218	0.267
Uniform Simple Poly	2	0.98	819.92	1126.65	0.0132	0.0076	0.0230	0.285
Half-normal Hermite Poly	1	1.47	820.41	1135.07	0.0130	0.0076	0.0222	0.275
Half-normal Cosine	1	1.47	820.41	1135.07	0.0130	0.0076	0.0222	0.275
Hazard-rate Simple Poly	2	1.67	820.61	1113.23	0.0137	0.0076	0.0248	0.307
Hazard-rate Cosine	2	1.67	820.61	1113.23	0.0137	0.0076	0.0248	0.307

3.2.3 Prince of Wales – Somerset Island Group

(*Survey Areas* - *Prince of* Wales*, Russell, and Somerset islands*)

3.2.3.1 Prince of Wales Survey Area (incl. Russell Island)

Caribou

Ground Survey: Ground surveyors reported no caribou or caribou sign during 1,968 km of snowmobile travel on Prince of Wales Island during April 2004 (zero clusters/1000 km of ground surveyed) (Table 2, Figure 18).

Aerial Survey: An aerial survey of Prince of Wales Island, as well as Russell, Prescott, and Pandora Islands, was completed April10-18, 2004. A total of 3,430 km of A transect was flown across the islands and we saw no Peary caribou (Table 4, Figure 19).

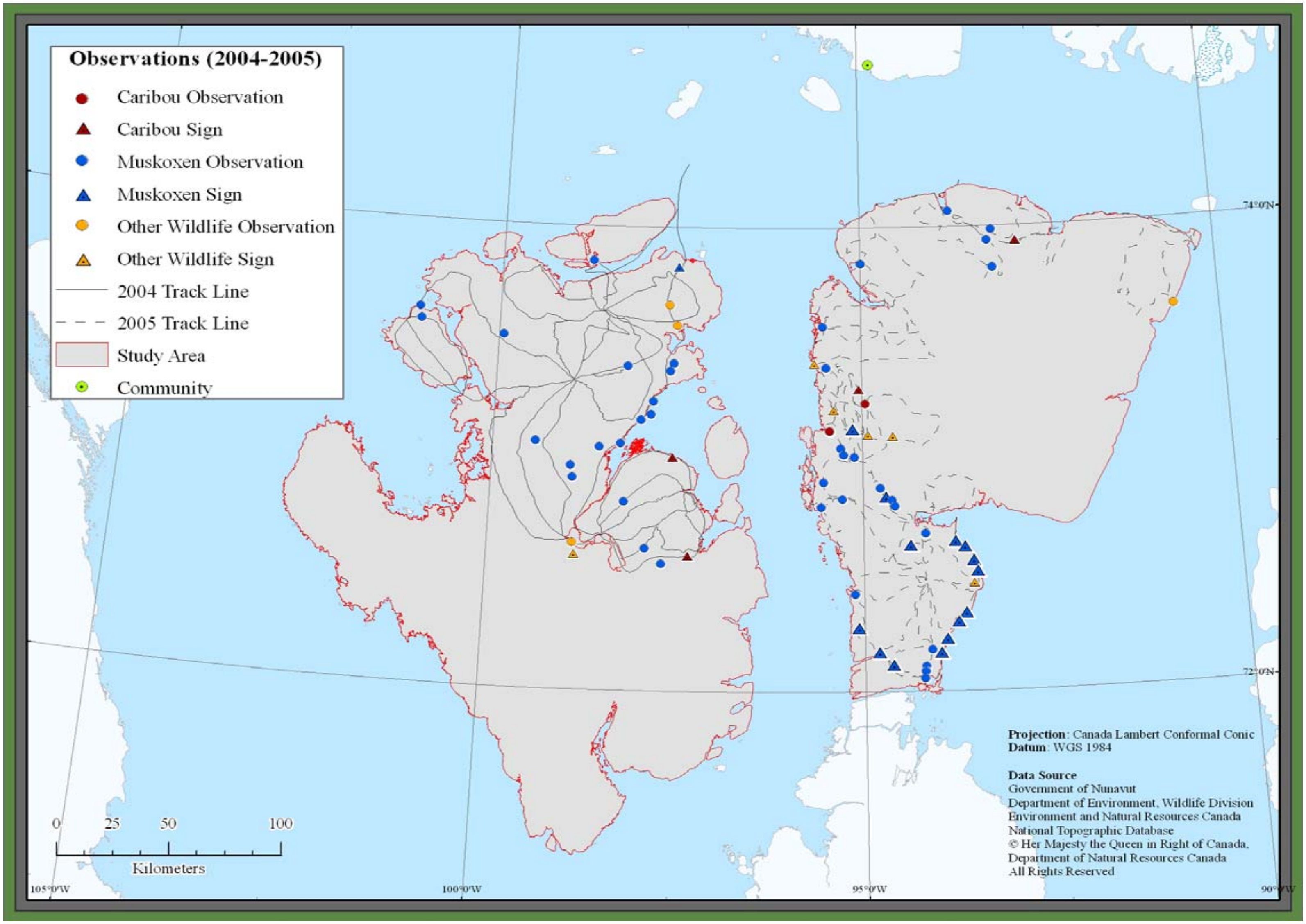


Figure 18: Ground survey observations within the Prince of Wales (2004) and Somerset Island (2005) survey areas.

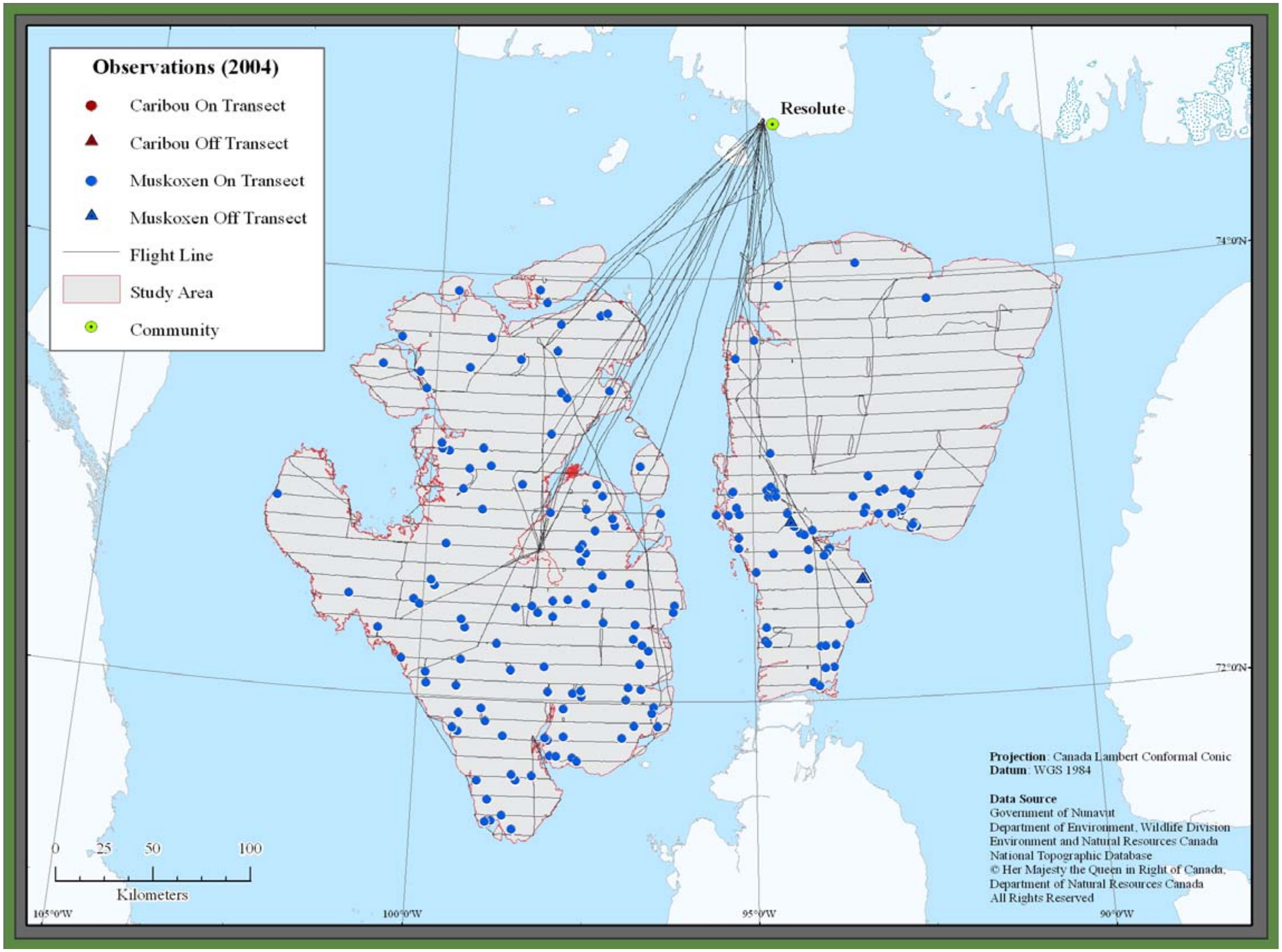


Figure 19: Aerial survey observations of Peary caribou and muskoxen clusters for the Prince of Wales - Somerset Island Group, 2004.

Muskoxen

Ground Survey: The ground crew recorded 14 clusters of muskoxen (160 individuals) on Prince of Wales Island during 1,968 km of snowmobiling in 2004 (Table 3, Figure 18). This represents an encounter rate of 7.11 muskoxen clusters/1000 km traveled. No other observations were recorded.

Aerial Survey: In April 2004, 111 clusters of muskoxen were observed on transect, in the Prince of Wales Island Group survey area with totals of 1,483 muskoxen (1 year or older) and 27 newborn calves (Table 5, Figure 19). The proportion of calves was 2%.

Preliminary analysis supported 5% truncation of the distance data. After truncation, the uniform key model with simple polynomial adjustment was selected as the final detection function (Table 8, Figure 20). The overall model χ^2 was non-significant, suggesting good fit of the data (χ^2 = 7.9149, p= 0.8491)

The probability of detecting a cluster of muskoxen in the defined area on either side of the transect in the Prince of Wales Island Group survey area was estimated as P_a = 0.736 (95% CI 0.656-0.827). The ESW was estimated to be 3438.5 m (95% CI 3062.5-3860.7 m). The expected cluster size was estimated at 13.39 muskoxen/cluster (SE 1.10), whereas mean cluster size was 13.49 muskoxen/cluster (SE 0.82).

The estimated density of muskoxen was 60/1000 km^2 (95% CI 45.5-79.0/1000 km^2). Given the survey area of 34,765 km^2 the estimated abundance was 2,086 (95% CI 1,582-2,746) muskoxen (one year and older) for the Prince of Wales Island Group in 2004.

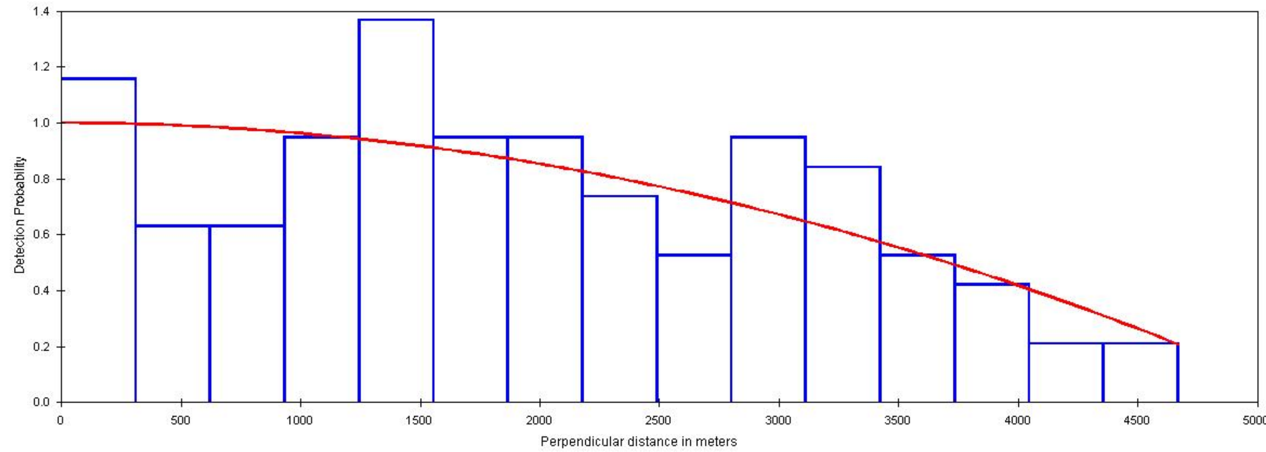


Figure 20: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen observed within in the Prince of Wales Island survey area, April 2004. The g(x) is estimated using a uniform model with simple polynomial adjustment. Bin size is 311 m.

Table 8: Summary of candidate models used in the line-transect analysis for muskoxen of the Prince of Wales Island survey area, April 2004. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Prince of Wales - Muskoxen **Name**	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Density Caribou/Km^2**	**95% LCI**	**95% UCI**	**CV**
Uniform Simple Poly	1	0.00	1764.18	3438.54	0.0600	0.0456	0.0790	0.139
Half-normal Hermite Poly	1	0.91	1765.09	3320.02	0.0622	0.0454	0.0851	0.159
Half-normal Cosine	1	0.91	1765.09	3320.02	0.0622	0.0454	0.0851	0.159
Hazard-rate Simple Poly	2	1.28	1765.46	3804.92	0.0542	0.0410	0.0718	0.142
Hazard-rate Cosine	2	1.28	1765.46	3804.92	0.0542	0.0410	0.0718	0.142
Uniform Cosine	2	1.93	1766.11	3457.14	0.0597	0.0403	0.0884	0.201

3.2.3.2 Somerset Island Survey Area

Caribou

Ground Survey: Ground surveyors observed two clusters of caribou (four individuals) during 2,863 km of travel on Somerset Island in 2005. This represents 0.7 clusters/1000 km of ground surveyed. One set of caribou tracks and one feeding site were also recorded (Table 2; Figure 18).

Aerial Survey: During April 20-25, 2004, an aerial survey of total transect length 2,420 km was conducted on Somerset Island. The survey crew detected no Peary caribou.

Muskoxen

Ground Survey: The ground crew reported 24 clusters of muskoxen (134 individuals) on Somerset Island in 2005. Given a survey effort of 2863 km, the estimated encounter rate is 6.98 clusters/1000 km. The crew observed 17 muskox carcasses (Table 3, Figure 18).

Aerial Survey: The aerial survey crew observed 66 clusters of muskoxen on transect in April 2004, representing 967 muskoxen (1 year or older) and 46 newborn calves (Table 5, Figure 19). The proportion of newborn calves was 5%.

Preliminary analysis of the distance data revealed no obvious outliers and right truncation at the largest observed distance from transect was applied. The uniform key model with single cosine adjustment was selected as the final detection function, with the lowest AIC score and a non-significant χ^2 value that suggested good fit of the data (χ^2 = 2.5576, p= 0.95899; Figure 21, Table 9)

The probability of detecting a cluster of muskoxen within the Somerset Island survey area was estimated as P_a = 0.610 (95% CI 0.511-0.729). The estimated ESW was 2193.9 m (95% CI 1836.5-2620.9 m). The expected cluster size was estimated at 12.5 muskoxen (SE= 1.35), whereas mean cluster size was 14.6 muskoxen (SE 1.49). The estimated density of muskoxen (one year and older) was 77.7/1000 km^2 (95% CI 39.2-154.5/1000 km^2). Based on finding in the Somerset Island survey area (24,549 km^2), the abundance estimate for muskoxen (one year and older) in 2004 was 1,910 (95% CI 962-3,792).

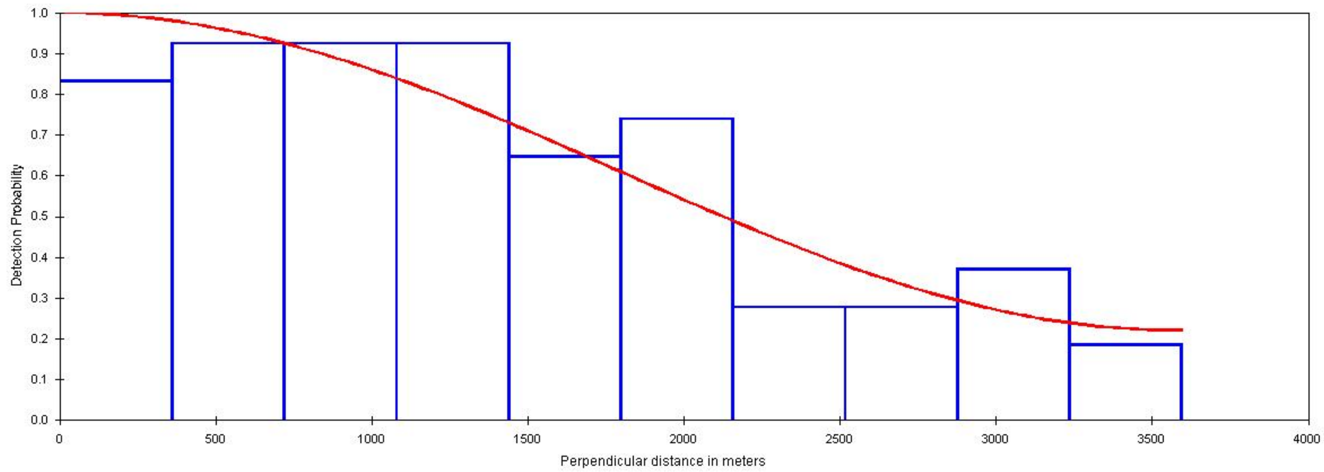


Figure 21: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Somerset Island survey area, April 2004. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 360 m.

Table 9: Summary of candidate models used in the line-transect analysis for muskoxen in the Somerset Island survey area, April 2004. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Somerset - Muskoxen Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Density Caribou/km²**	**95% LCI**	**95% UCI**	**CV**
Uniform Cosine	1	0.00	1069.07	2193.90	0.0778	0.0392	0.1545	0.347
Half-normal Hermite Poly	1	0.07	1069.14	2256.73	0.0764	0.0381	0.1529	0.352
Half-normal Cosine	1	0.07	1069.14	2256.73	0.0764	0.0381	0.1529	0.352
Uniform Simple Poly	1	1.15	1070.23	2553.26	0.0700	0.0357	0.1374	0.339
Hazard-rate Simple Poly	2	1.37	1070.45	2436.85	0.0732	0.0363	0.1476	0.357
Hazard-rate Cosine	2	1.37	1070.45	2436.85	0.0732	0.0363	0.1476	0.357

3.2.4 Ellesmere Island Group

(Survey Areas - S. Ellesmere (incl. Graham Island) and N. Ellesmere)

3.2.4.1 Southern Ellesmere Island Survey Area

Caribou

Ground Survey: In 2005, ground crews traveled 1,662 km on southern Ellesmere Island, primarily on the Bjorne Peninsula north of the Sydcap Icecap. Harsh weather and difficult terrain limited travel to other areas. The crews observed six clusters of caribou (17 individuals) for an encounter rate of 3.6 clusters/1000 km (Table 2, Figure 22).

Aerial Survey: In May 4-30, 2005, we flew a total of 4,299 km of A transect distributed across southern Ellesmere Island and Graham Island (Figure 23). The survey area encompassed the entire landmass except glaciers and ice fields. During the flights, 19 clusters of caribou were observed on transect, representing a total of 57 caribou (Table 4). The majority of observations were made on Graham Island. The composition was 36 female and 17 male adults, 3 yearlings, zero calves or 'short yearlings', and zero newborns. We recorded one adult of unknown sex. The proportion of calves or 'short yearlings' was zero, and the ratio of adult males to females was 47:100.

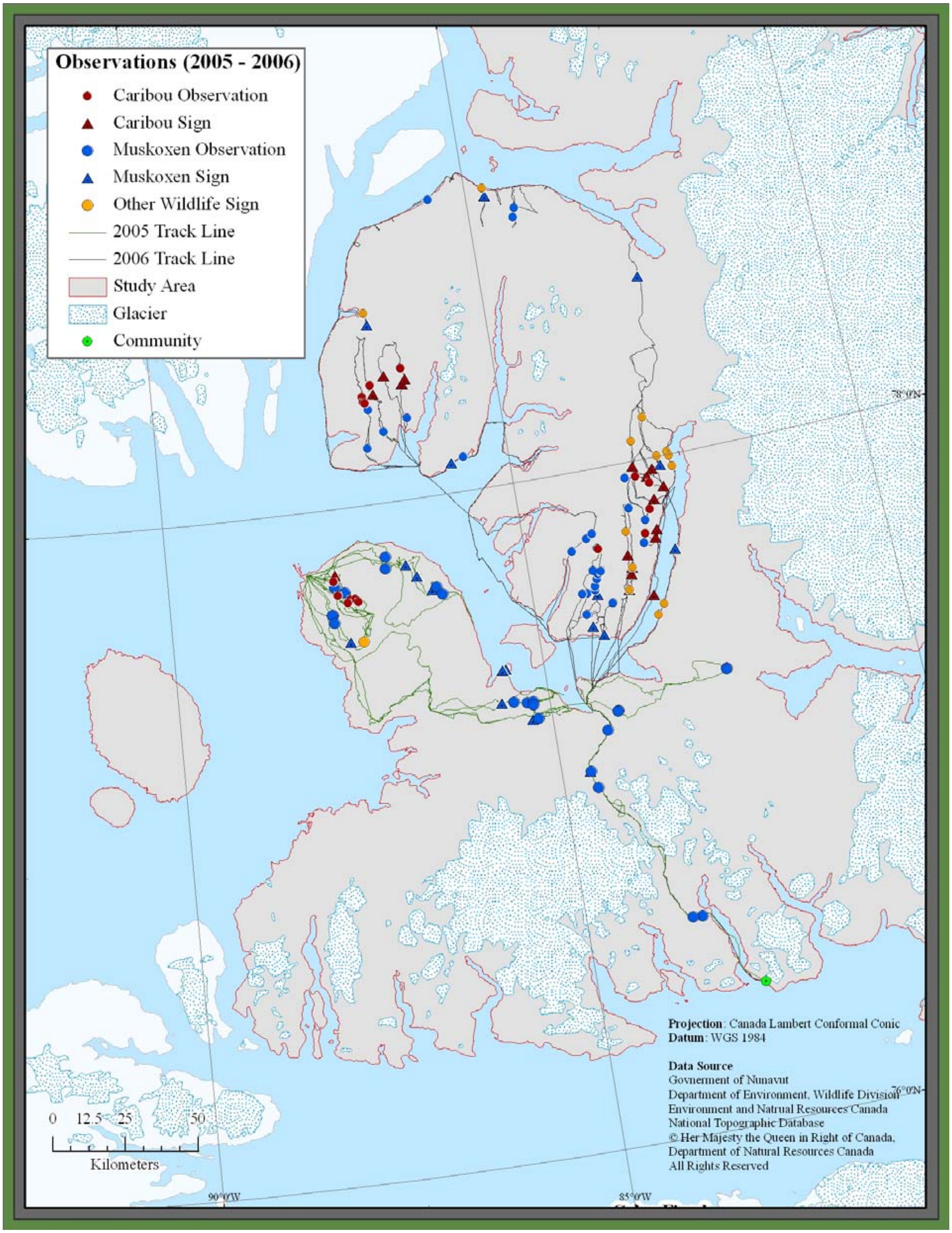


Figure 22: Ground survey observations within the Southern Ellesmere survey area, (2005) and Northern Ellesmere survey area (2006).

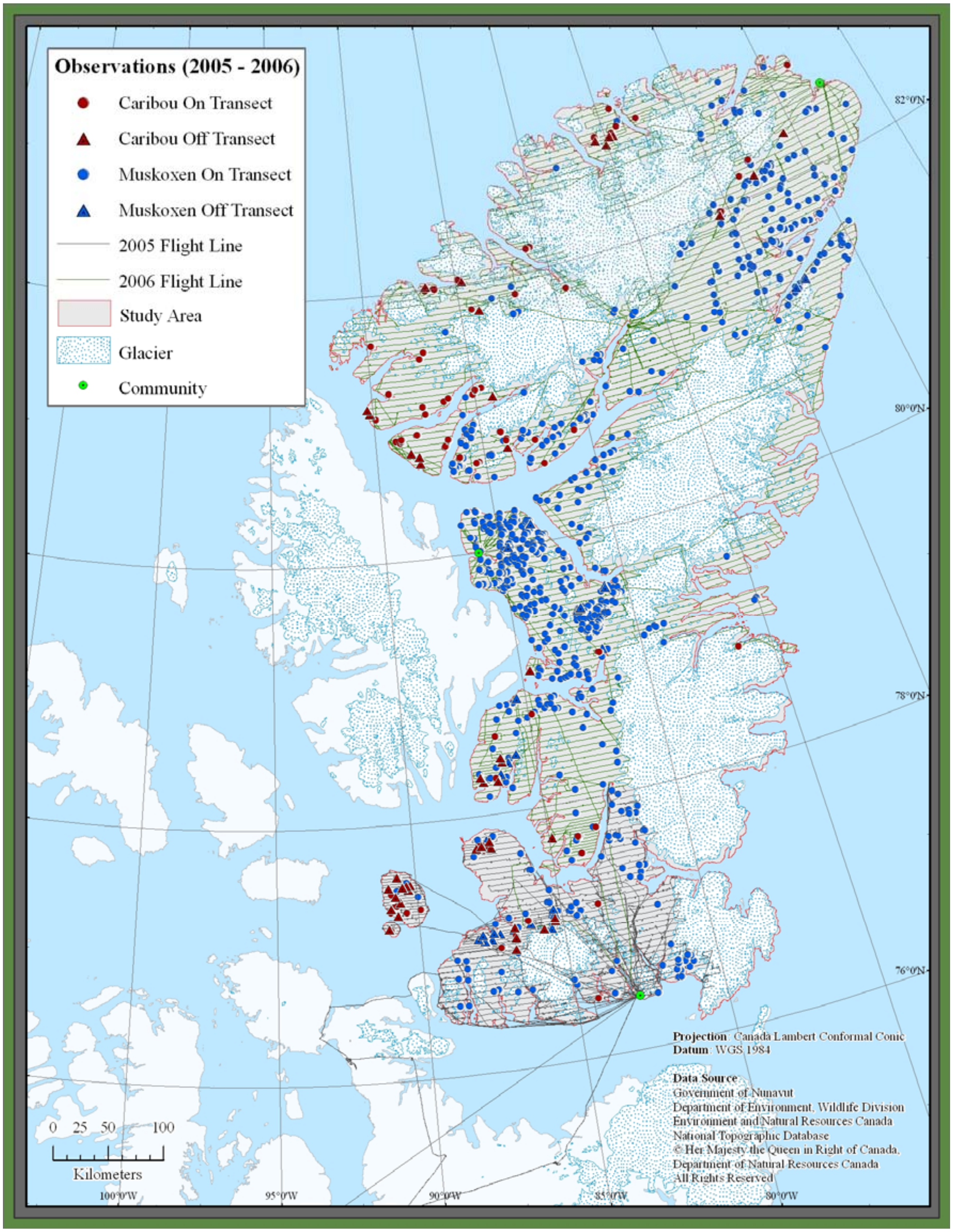


Figure 23: Peary caribou and muskox observations reported for aerial surveys of Southern Ellesmere survey area (2005) and Northern Ellesmere survey areas (2006).

Owing to the small number of observations and absence of outliers, the distance data were truncated at the largest distance from the transect line. We ran all recommended models (Buckland et al., 2001; Figure 24, Table 10) and the uniform key model with single-order cosine adjustment was selected as the final detection function. The selected model was non-significant, suggesting good fit of the data (χ^2 = 0.2394, p= 0.88720).

We estimated the probability of detecting a cluster of caribou on either side of any given transect line as P_a = 0.633 (95% CI 0.440–0.910). The ESW was estimated to be 655 m (95% CI 456–942 m). The expected cluster size was 2.75 caribou/cluster (SE 0.39), whereas mean cluster size was 3.0 caribou/cluster (SE 0.34). The estimated density of caribou in the Southern Ellesmere Island survey area was 9.2/1000 km^2 (95% CI 4.6–18.6/1000 km^2). Based on the area surveyed (23,767 km^2), the estimated abundance of caribou (10 months or older) throughout Southern Ellesmere Island in 2005 was 219 (95% CI 109-442).

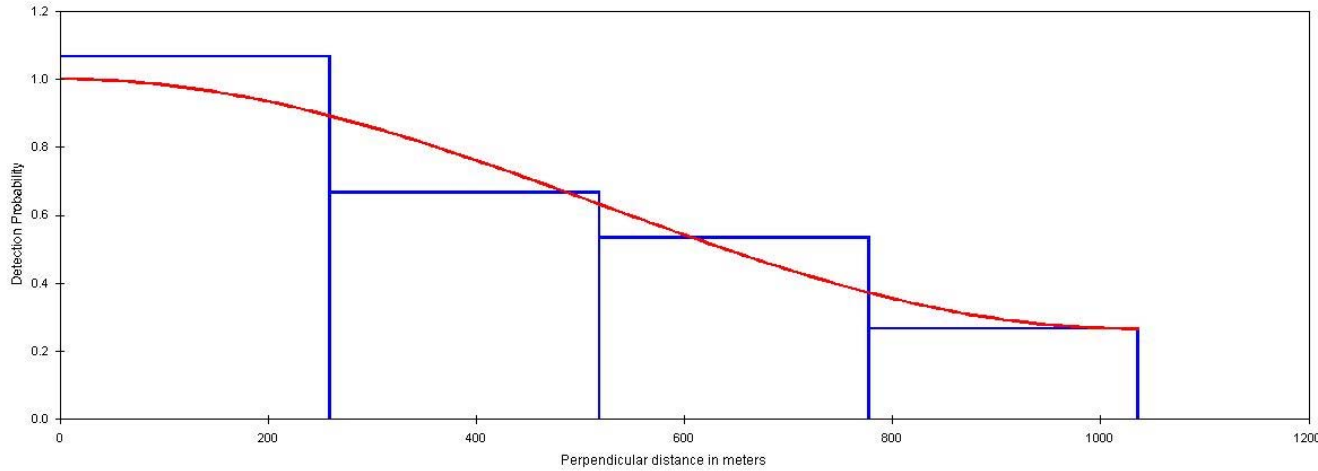


Figure 24: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou in the Southern Ellesmere Island survey area, May 2005. The g(x) is estimated using a uniform model with single cosine adjustment. Bin size is 259 m.

Table 10: Summary of candidate models used in the line-transect analysis for Peary caribou of the Southern Ellesmere Island survey area, May 2005. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Southern Ellesmere - Peary Caribou					**Density**			
Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Carbiou/km^2**	**95% LCI**	**95% UCI**	**CV**
Uniform Cosine	1	0.00	262.28	655.76	0.0092	0.0046	0.0186	0.361
Half-normal Hermite Poly	1	0.32	262.60	676.39	0.0091	0.0045	0.0185	0.367
Half-normal Cosine	1	0.32	262.60	676.39	0.0091	0.0045	0.0185	0.367
Uniform Simple Poly	1	1.02	263.30	780.66	0.0082	0.0042	0.0157	0.338
Hazard-rate Simple Poly	2	1.20	263.49	486.09	0.0113	0.0034	0.0375	0.640
Hazard-rate Cosine	2	1.20	263.49	486.09	0.0113	0.0034	0.0375	0.640

Muskoxen

Ground Survey: In 2005, ground crews traveled 1,662 km in the south of Ellesmere Island, primarily on the Bjorne Peninsula north of the Sydcap Icecap. Harsh weather and difficult terrain limited travel to other areas. The crews observed 23 clusters of muskoxen (56 individuals) for an encounter rate of 13.84 clusters/1000 km traveled (Table 3, Figure 22). They also observed six carcasses.

Aerial Survey: In 2005, during 4,299 km of flying in the southern part of Ellesmere Island (Figure 23), we observed 99 muskoxen clusters with 273 muskoxen (1 year or older) and two newborns, all on transect (Table 4).   The proportion of newborn calves is 2 %. Preliminary evaluation of the distance data supported truncating the largest 5% of these data. The half-normal key model with Hermite polynomial adjustment was selected as the final detection function, with the lowest AIC score and a non-significant $\chi 2$ that suggested good fit of the data ($\chi 2 = 10.877$, p= 0.5395; Figure 25, Table 11).

We estimated the probability of detecting a cluster of muskoxen on either side of any given transect line as $P_a = 0.695$ (95% CI 0.573–0.844). The estimated ESW was 1540.5 m (95% CI 1269.1–1869.9 m). The expected cluster size for the Southern Ellesmere Island survey area was 2.77 muskoxen/cluster (SE 0.20), whereas mean cluster size was 2.71 muskoxen/cluster (SE 0.38). The estimated density of muskoxen in the Southern Ellesmere Island survey area was 19.2/1000 km^2 (95% CI 13.1-

128.2/1000 km^2). Based on findings in this survey area (23,767 km^2), the estimated abundance of muskoxen (one year and older) throughout Southern Ellesmere Island in May 2005 was 456 (95% CI 312-670).

Notably, 19 separate clusters of muskox carcasses (20 carcasses total) were observed on transect during the aerial survey; a total of 40 muskox carcasses were reported during the 2005 aerial survey (Campbell 2006). Two observations of single adult muskoxen in very poor condition or dying were excluded from the analysis.

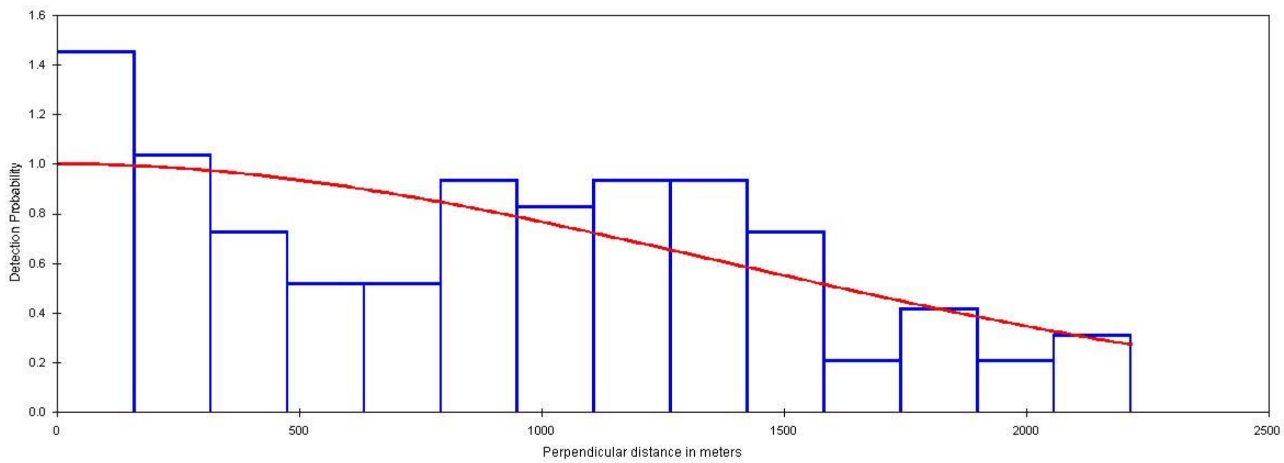


Figure 25: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Southern Ellesmere survey area, May 2005. The g(x) is estimated using a half-normal model with Hermite polynomial adjustment. Bin size is 158 m.

Table 11: Summary of candidate models used in the line-transect analysis for muskoxen of the Southern Ellesmere survey area, May, 2005. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Southern Ellesmere - Muskoxen					**Density**			
Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Caribou/km^2**	**95% LCI**	**95% UCI**	**CV**
Half-normal Hermite Poly	1	0.00	1438.82	1540.49	0.0192	0.0131	0.0282	0.194
Half-normal Cosine	1	0.00	1438.82	1540.49	0.0192	0.0131	0.0282	0.194
Uniform Simple Poly	1	0.12	1438.94	1639.92	0.0181	0.0127	0.0257	0.178
Uniform Cosine	1	0.53	1439.36	1479.07	0.0201	0.0137	0.0292	0.192
Hazard-rate Simple Poly	2	0.89	1439.72	1748.81	0.0170	0.0118	0.0244	0.185
Hazard-rate Cosine	2	0.89	1439.72	1748.81	0.0170	0.0118	0.0244	0.185

3.2.4.2 Northern Ellesmere Island Survey Area

Caribou

Ground Survey: In 2006, ground crews snowmobiled 2,924 km in the northern part of Ellesmere Island, primarily on the Svendson Peninsula and observed 11 clusters of Peary caribou (44 individuals, Figure 22) for an encounter rate of 3.8 clusters/1000 km traveled. They also reported finding three caribou carcasses (Table 2). Travel in northern Ellesmere was limited by the remote location, harsh weather and terrain (Jeffery Qaunaq, personal communication, Sept 2010).

Aerial Survey: Crews flew a total of 17,535 km of A transects across the northern part of Ellesmere Island in 2006 (Figure 23). They recorded 72 clusters of caribou on transect with a total of 344 individual caribou, including 191 female and 108 male adults, 26 yearlings, zero calves or ‘short yearlings’, and zero newborns. An additional 19 unclassified adults were recorded. The survey team also recorded an additional 14 caribou clusters off transect (Table 4). The proportion of calves or ‘short yearlings’ was 0% of those animals seen on transect. The ratio of adult males to females was 56:100

To facilitate modeling of the data, we truncated distance observations at 1500 m, where detection probability was approximately 0.15 (Buckland *et al*., 2001). A half-normal key model with single cosine adjustment was selected as the final detection function (Table 12). The selected model was characterized by a small shoulder (Figure

26) and the overall model was non-significant, suggesting good fit of the data (χ^2 = 3.4776, p= 0.32368).

We estimated the probability of detecting a caribou cluster on either side of any given A transect line in the Northern Ellesmere Island survey area as P_a = 0.59057 (95% CI 0.48100–0.72500). The ESW was estimated to be 885.85 m (95% CI 721.51–1087.6 m). The expected cluster size was 4.10 caribou/cluster (SE 0.39), whereas mean cluster size was 4.57 caribou/cluster (SE 0.38). The estimated density of caribou in the Northern Ellesmere Island survey area was 8.3/1000 km^2 (95% CI 5.5-12.5/1000 km^2). Based on the area surveyed (96,567 km^2), our abundance estimate for caribou (10 months or older) throughout Northern Ellesmere Island in 2006 was 802 animals (95% CI 531-1207).

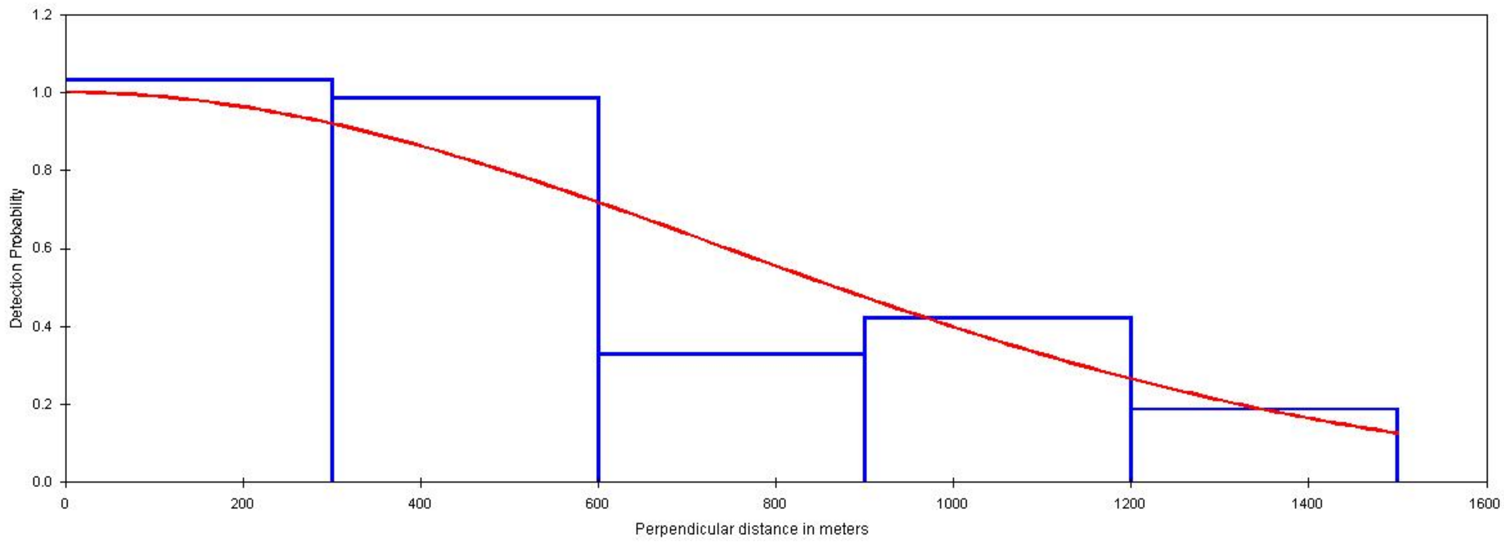


Figure 26: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou observed within the Northern Ellesmere survey area for April-May 2006. The g(x) is estimated using a half-normal key with cosine adjustment. Bin size is 300 m.

Table 12: Summary of candidate models used in the line-transect analysis for Peary caribou of the Northern Ellesmere survey area, April-May 2006. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Northern Ellesmere - Peary caribou					Density			
Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Caribou/km^2**	**95% LCI**	**95% UCI**	**CV**
Half-normal Cosine	1	0.00	906.60	885.85	0.0083	0.0055	0.0125	0.210
Half-normal Hermite Poly	1	0.00	906.60	885.85	0.0083	0.0055	0.0125	0.210
Uniform Cosine	1	0.29	906.89	891.02	0.0082	0.0056	0.0122	0.202
Uniform Simple Poly	1	1.22	907.82	1011.54	0.0076	0.0053	0.0111	0.191
Hazard-rate Simple Poly	2	1.51	908.11	791.05	0.0088	0.0050	0.0153	0.289
Hazard-rate Cosine	2	1.51	908.11	791.05	0.0088	0.0050	0.0153	0.289

Muskoxen

Ground Survey: In 2006, ground crews snowmobiled 2,924 km of the northern portion of Ellesmere Island, primarily on the Svendson Peninsula, and observed 27 clusters of muskoxen (203 individuals: Figure 22) for an encounter rate of 9.2 clusters/1000 km traveled. They also recorded three muskox carcasses (Table 3). Additional travel in the region was limited by the remote location, harsh weather and terrain (Jeffery Qaunaq, personal communication, Sept 2010)

Aerial Survey: Flights were conducted totaling 17,535 km of A transects across the north of Ellesmere Island (Figure 23) in 2006. The crews observed 645 clusters of muskoxen on transect with totals of 4,999 muskoxen (1 year or older) and 907 newborn calves (Table 5). Based on preliminary analysis of the observations, 5% of the observations farthest from the transect line were discarded. A half-normal key model with single cosine adjustment was selected as the final detection function (Table 13). The selected model was characterized by a shoulder (Figure 27) and the overall model was non-significant, suggesting good fit of the data (χ^2 = 2.4211, p = 0.93292).

We estimated the probability of detecting a cluster of muskoxen on either side of any given A transect as P_a = 0.494 (95% CI 0.445-0.549). The estimated ESW was 1381.7 m (95% CI 1244.4-1534.1 m). The expected cluster size was calculated at 6.64 muskoxen (SE 0.25), whereas mean cluster size was 7.51 muskoxen. The estimated density for muskoxen in the Northern Ellesmere Island survey area is 84.0/1000 km^2

(95% CI 68.7-102.8/1000 km^2). Based on the non-glaciated survey area (96,567 km^2), our estimate for abundance of muskoxen (one year and older) throughout Northern Ellesmere Island in 2006 was 8,115 (95% CI 6,632-9,930).

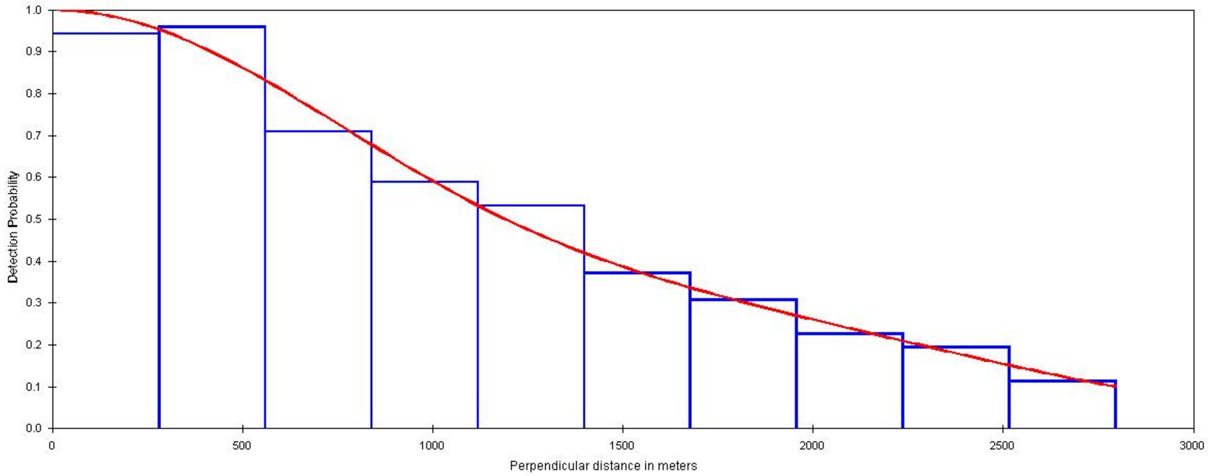


Figure 27: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Northern Ellesmere survey area, April-May 2006. The g(x) is estimated using a half-normal model with cosine adjustment. Bin size is 280 m.

Table 13: Summary of candidate models used in the line-transect analysis for muskoxen of the Northern Ellesmere survey area, April-May 2006. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Northern Ellesmere - Muskoxen Name	Par	Delta AIC	AIC	ESW (m)	Density Caribou/km²	95% LCI	95% UCI	CV
Half-normal Cosine	2	0.00	9518.26	1381.69	0.0840	0.0687	0.1028	0.103
Uniform Cosine	3	0.99	9519.25	1362.46	0.0848	0.0691	0.1040	0.104
Hazard-rate Simple Poly	3	1.88	9520.14	1432.48	0.0819	0.0658	0.1018	0.111
Hazard-rate Cosine	2	2.14	9520.40	1442.23	0.0816	0.0664	0.1003	0.105
Half-normal Hermite	1	4.16	9522.42	1550.12	0.0778	0.0647	0.0935	0.093
Uniform Simple Poly	3	5.65	9523.91	1491.84	0.0798	0.0660	0.0966	0.097

3.2.5 Axel Heiberg Island Group
(Survey Area - Axel Heiberg Island)

3.2.5.1 Axel Heiberg Survey Area

Caribou

Ground Survey: A ground survey was not completed within this Island Group.

Aerial Survey: In total 5,872 km of transect were flown across the Axel Heiberg Island Group in 2007 (Figure 28). We observed 120 clusters of caribou on transect, with a total of 642 individual caribou that included 379 female and 242 male adults (possibly some yearlings and short yearlings), 17 calves or ‘short yearlings’, and zero newborns. In addition, 4 adults of unknown sex where recorded. The proportion of calves or ‘short yearlings’ is uncertain as some groups were not aged due to rugged terrain and animal care protocols. The ratio of adult males to females is 64:100 (but may include members from other cohorts). An additional four caribou clusters were observed off transect (Table 4).

After preliminary analysis of the distance data, observations exceeding 1400 m from transect were discarded to address outliers. Several robust models were run and the half-normal key model with single-order cosine adjustment was selected as the final detection function in accordance with AIC (Figure 29, Table 14). The Chi-square goodness-of-fit test was non-significant, suggesting good fit of the data (χ^2= 2.21, p= 0.69634).

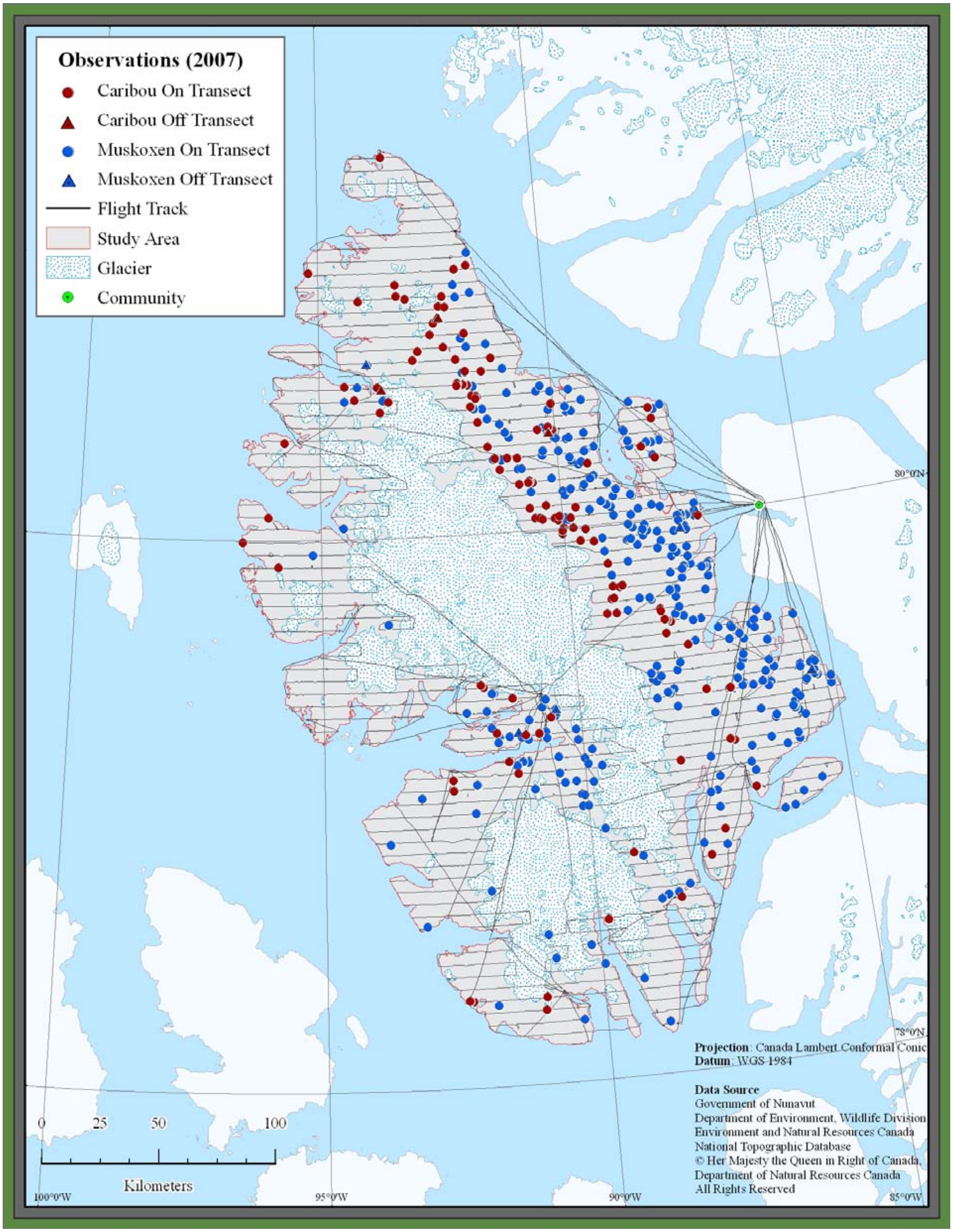


Figure 28: Aerial survey observations of Peary caribou and muskoxen clusters for the Axel Heiberg Island Group, 2007.

We estimated the probability of detecting a cluster of caribou on either side of any given A transect line as $P_a = 0.402$ (95% CI 0.325–0.498). The ESW was calculated as 563.59 m (95% CI 455.72–696.99 m). Mean cluster size was 5.31 caribou/cluster (SE 0.32), which was the largest value for this parameter among all survey strata in our entire study. The estimated density of caribou (approximately 10 months or older) in the Axel Heiberg Island Group survey area was 74.2/1000 km^2 (95% CI 53.1–103.9/1000 km^2). Based on the survey area of 30,877 km^2, the estimated abundance of Peary caribou inhabiting the Axel Heiberg Island Group in 2007 was 2,291 (95% CI 1,636-3,208).

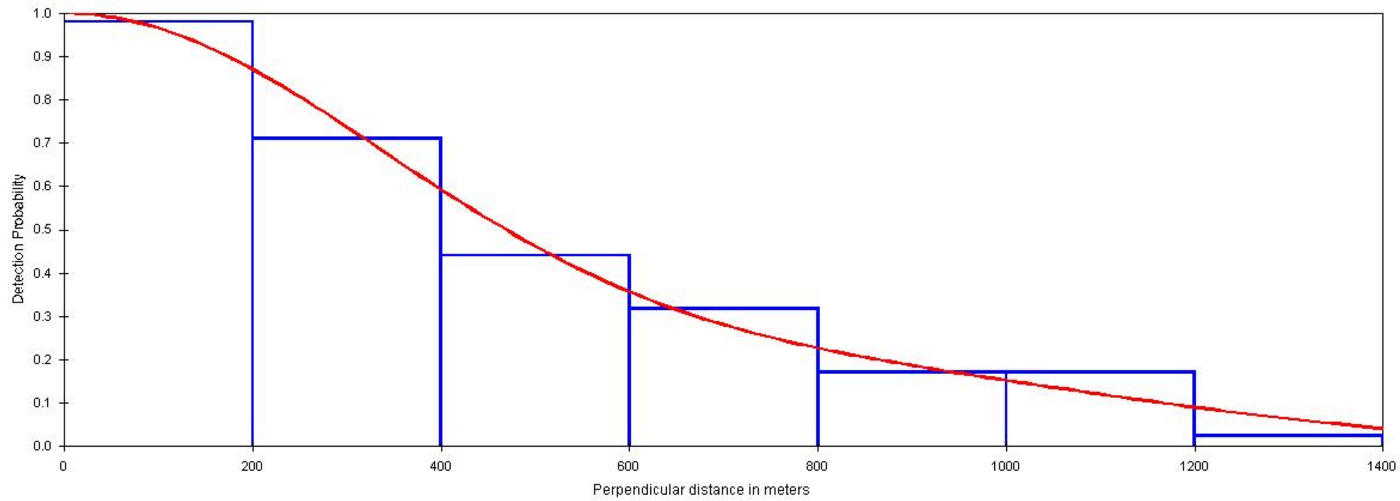


Figure 29: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou in the Axel Heiberg Island Group, April-May 2007. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 200 m.

Table 14: Summary of candidate models used in the line-transect analysis (October, 2009) for Peary caribou of the Axel Heiberg Island Group, April-May 2007. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score**.**

Axel Heiberg - Peary caribou Name	Par	Delta AIC	AIC	ESW (m)	Density Caribou/km^2	95% LCI	95% UCI	CV
Half-normal Cosine	2	0.00	1601.01	563.59	0.0742	0.0531	0.1039	0.172
Half-normal Hermite Poly	1	0.49	1601.50	655.79	0.0666	0.0496	0.0893	0.150
Uniform Cosine	3	0.72	1601.72	538.29	0.0769	0.0549	0.1077	0.172
Hazard-rate Simple Poly	2	1.78	1602.78	644.24	0.0686	0.0490	0.0960	0.172
Hazard-rate Cosine	2	1.78	1602.78	644.24	0.0686	0.0490	0.0960	0.172
Uniform Simple Poly	1	8.52	1609.53	853.86	0.0543	0.0414	0.0712	0.138

Muskoxen

Ground Survey: A ground survey was not completed within the Axel Heiberg Island Group.

Aerial Survey: In total 5,872 km of transect were flown across the Axel Heiberg Island Group in 2007 (Figure 28). During the survey, 301 clusters of muskoxen were observed on-transect, with totals of 2,653 muskoxen (1 year or older) and 396 newborn calves (Table 5). We encountered our first newborn on April 22, 2007 and the overall proportion of newborn calves was 13%.

Analysis of the distance data supported 5% right truncation. We considered several robust models of the detection function (Table 15, Figure 30) and used AIC, which identified a half-normal key function with Hermite polynomial adjustment as the best model. A non-significant goodness-of-fit test ($\chi 2$ = 9.0817, p = 0.82578) supported model selection.

We estimated the probability of detecting a muskox cluster on either side of an A transect as P_a = 0.636 (95%CI 0.573-0.705). The ESW was calculated as 1547.6 (95%CI 1395-1716.9). The expected cluster size was estimated at 8.68 muskoxen/cluster (SE 0.53), whereas the mean cluster size was 8.69 muskoxen/cluster (SE 0.43). The estimated density of muskoxen in the Axel Heiberg Island Group survey area was 137.2 muskoxen/1000 km^2 (95%CI 109.2 –172.5). Based on the area surveyed (30,877 km^2), the estimated abundance of muskoxen (1 year and older) throughout the Axel Heiberg Island Group in 2007 was 4,237 (95% CI 3,371-5,325).

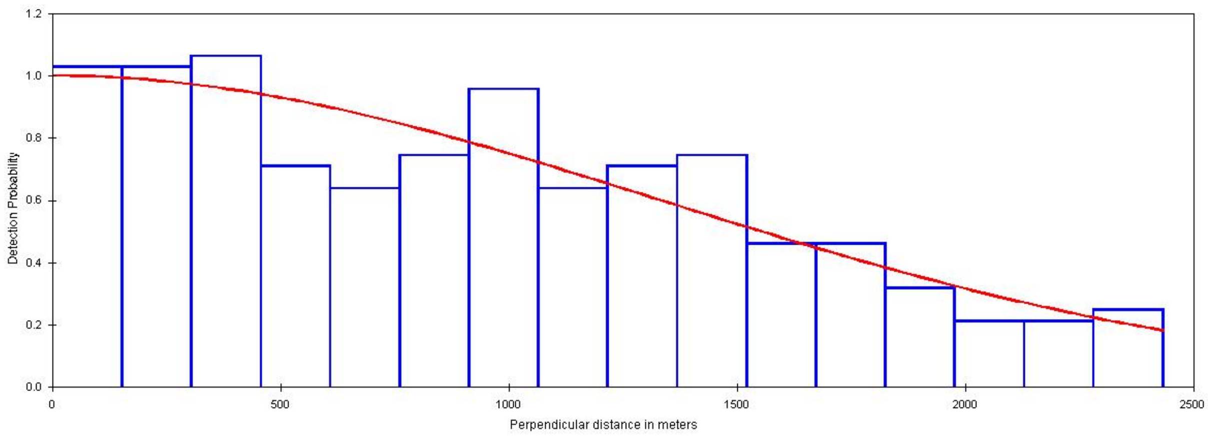


Figure 30: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Axel Heiberg Island Group survey area in April-May 2007. The g(x) is estimated using a half-normal model with Hermite polynomial adjustment. Bin size is 152 m.

Table 15: Summary of candidate models used in the line-transect analysis for muskoxen of the Axel Heiberg Island Group survey area, April-May 2007. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Axel Heiberg - Muskoxen Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Density Caribou/km^2**	**95% LCI**	**95% UCI**	**CV**
Half-normal Hermite Poly	1	0.00	4421.99	1547.60	0.1372	0.1092	0.1725	0.116
Half-normal Cosine	1	0.00	4421.99	1547.60	0.1372	0.1092	0.1725	0.116
Uniform Cosine	1	0.28	4422.27	1496.33	0.1419	0.1137	0.1772	0.113
Uniform Simple Poly	3	0.64	4422.63	1661.92	0.1278	0.0989	0.1651	0.131
Hazard-rate Simple Poly	2	1.90	4423.89	1756.59	0.1209	0.0964	0.1517	0.115
Hazard-rate Cosine	2	1.90	4423.89	1756.59	0.1209	0.0964	0.1517	0.115

<u>3.2.6 Ringnes Island Group</u>

(Survey Areas - *Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, Meighen, and Lougheed Islands)*

3.2.6.1 Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, and Meighen Survey Area

Caribou

Ground Survey: A ground survey was not completed in 2007 for this survey area.

Aerial Survey: During April 6-22, 2007, we flew 4,076 km of transect across Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, and Meighen Islands (Figure 31). The survey area encompassed all the landmasses except glaciers and ice fields. The crew observed 28 clusters of caribou (74 individual caribou) on transect, with a range of 0-14 observations per island (Table 4). The composition estimated from on-transect observations was 32 female and 32 male adults (possibly included some yearlings), 10 calves or ‘short yearlings’ and zero newborns. The proportion of calves or ‘short yearlings’ was 14% of those animals seen on transect. The ratio of adult males to females is 100:100.

We pooled the data across these islands and post-stratified our analysis by island to estimate a combined detection function, cluster size, and density. As preliminary analysis revealed no obvious outliers, we truncated the distance data at the largest perpendicular distance from the transect (Table 16, Figure 32). The uniform model with cosine adjustment was identified as the best model, characterized by a pronounced shoulder and a non-significant $\chi 2$, suggesting good fit of the data ($\chi 2$ = 0.6741, p= 0.95448). The probability of detecting a cluster of caribou on either side of the A transects was P_a = 0.575 (95% CI 0.453-0.729). The ESW was estimated at 665.59 m (95%CI524.96-843.88 m). The expected cluster size was 2.72 caribou/cluster (SE 0.35), whereas mean cluster size was 2.64 caribou/cluster (SE 0.28).

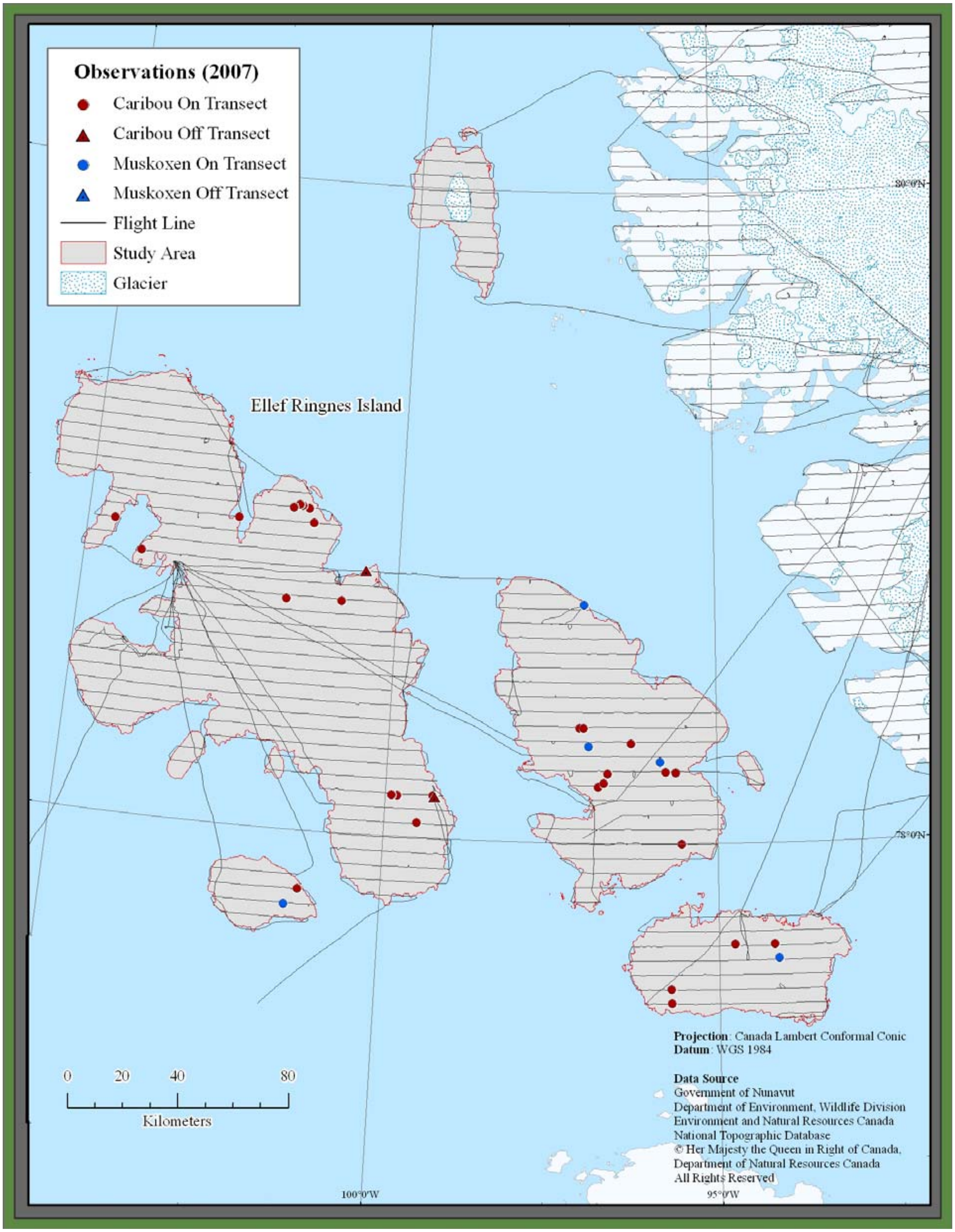


Figure 31: Aerial survey observations of Peary caribou and muskoxen clusters for the Ringnes Island Group survey area, 2007.

The estimated density of caribou detected in the Ringnes Island Group survey area was 13.6/1000 km^2 (95% CI 7.6-24.4/1000 km^2) and the estimated abundance of caribou (10 months or older) on the five islands in 2007 was 282 caribou (95% CI 157-505). Density estimates for each island were derived but not reported due to high uncertainty. This was a consequence of low encounter rates, small sample size, and the low number of observations per island.

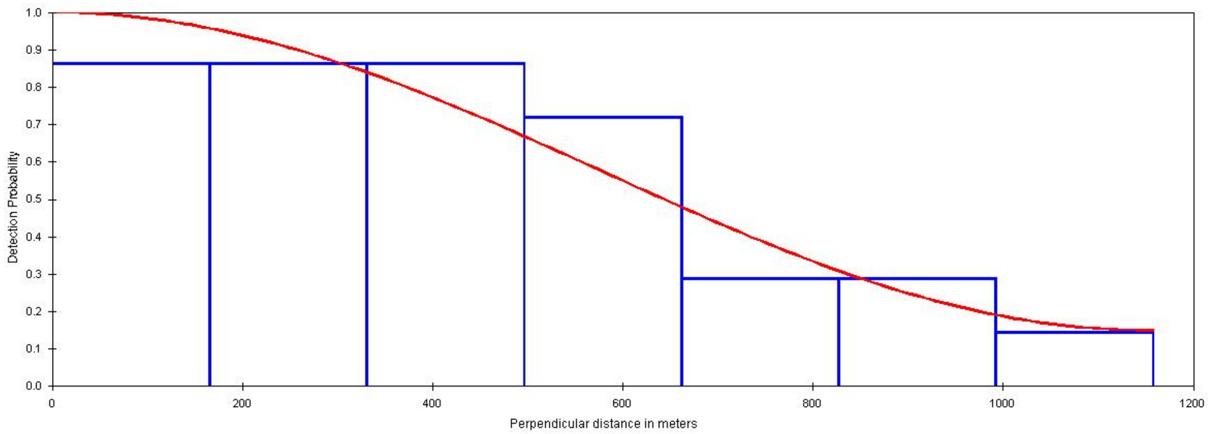


Figure 32: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou on the Ringnes Island Group survey area in April 2007. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 165 m.

Table 16: Summary of candidate models used in the line-transect analysis for Peary caribou of the Ringnes Island Group survey area, April 2007. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Ellef, Amund, King Christian, Cornwall, Meighen - Peary caribou					Density			
Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Caribou/km^2**	**95% LCI**	**95% UCI**	**CV**
Uniform Cosine	1	0.00	389.21	665.59	0.0136	0.0076	0.0244	0.300
Half-normal Hermite Poly	1	0.41	389.62	685.33	0.0132	0.0071	0.0246	0.319
Half-normal Cosine	1	0.41	389.62	685.33	0.0132	0.0071	0.0246	0.319
Uniform Simple Poly	2	1.58	390.79	655.67	0.0138	0.0075	0.0257	0.319
Hazard-rate Simple Poly	2	1.93	391.14	783.53	0.0116	0.0063	0.0214	0.318
Hazard-rate Cosine	2	1.93	391.14	783.53	0.0116	0.0063	0.0214	0.318

Muskoxen

Ground Survey: A ground survey was not completed in 2007

Aerial Survey: Throughout 4,076 km of transect flown across the five islands in the Ringnes Island Group in April 2007 (Figure 31), five clusters of muskoxen were observed (Ellef Ringnes zero clusters, Amund Ringnes three clusters, King Christian one cluster, Cornwall one cluster, and Meighen zero clusters) for a total of 21 individuals (one year and older). No newborn calves were observed. Due to scarcity of muskoxen and the small number of observations, it was not possible to derive a density estimate for this survey area. Instead, we report a minimum count of muskoxen for each island surveyed (Table 5).

3.2.6.2 Lougheed Island Survey Area

Caribou

Ground Survey: A ground survey was not carried out in the Lougheed Island Group.

Aerial Survey: On April 13, 2007 we flew 287 km across the Lougheed Island Group and observed 32 clusters of caribou (131 individuals) on transect (Figure 33). Composition was 62 female and 51 male adult caribou (possibly included yearlings), 18 calves or 'short yearlings' and zero newborns. The proportion of calves or 'short yearlings' is 14% of those animals seen on transect. The ratio of adult males to females was 82:100

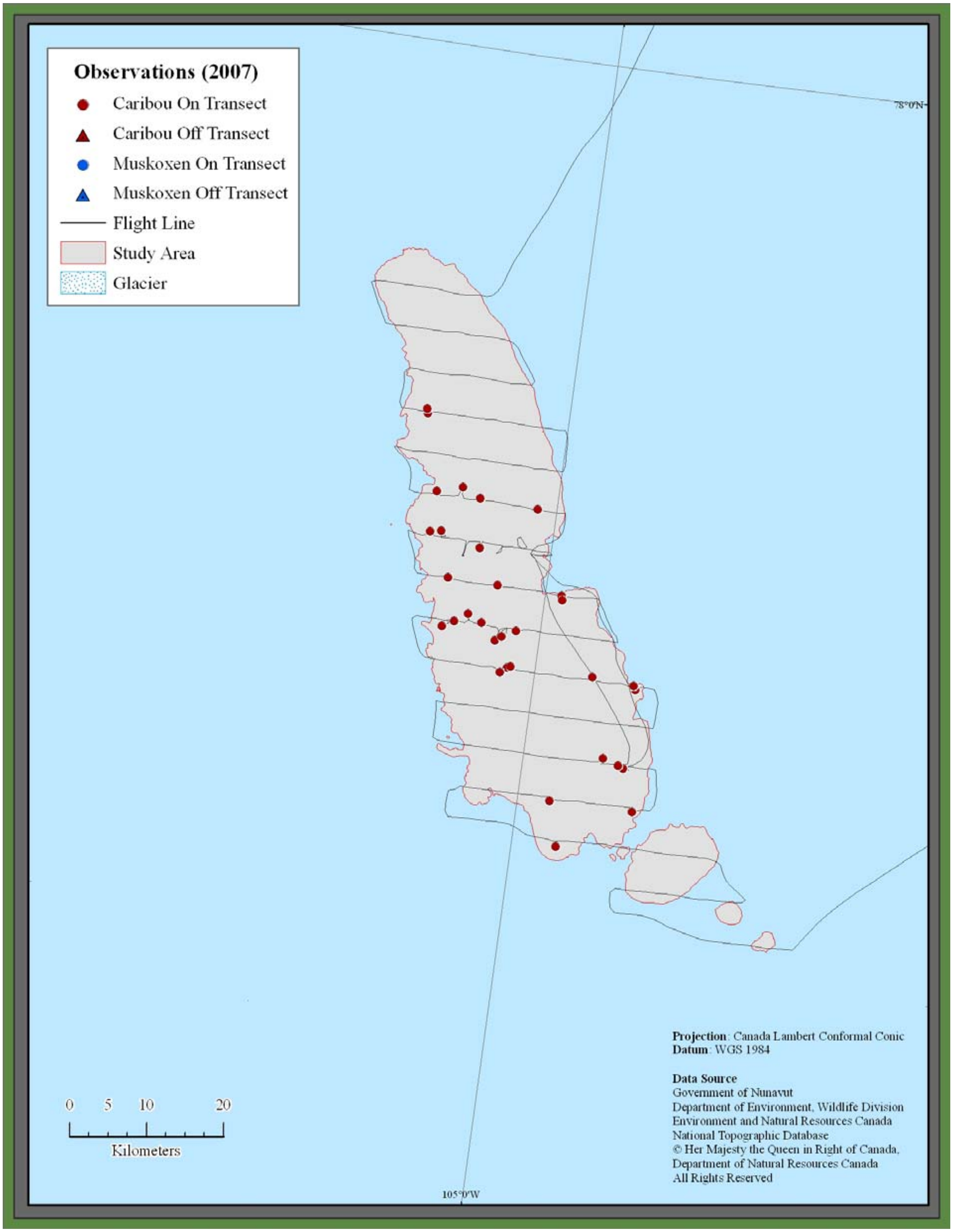


Figure 33: Peary caribou and muskox observations reported for aerial surveys of the Lougheed Island survey area in 2007.

For analysis, we applied 5% right truncation to address outliers (Buckland et al., 2001). From a series of models, we selected the uniform key model with single-order cosine adjustment as the final detection function (Table 17). This model was characterized by a small shoulder (Figure 34) and the Chi-square goodness-of-fit test was non-significant, suggesting good fit of the data (χ^2 = 0.1679, p= 0.98260).

The probability of detecting a cluster of caribou within the defined area on each side of the transect was estimated as P_a = 0.59524 (95%CI 0.47108-0.75212). The expected cluster size was 3.31 caribou/cluster (SE= 0.52), whereas mean cluster size was 4.07 caribou/cluster (SE 0.55). The ESW was estimated as 658.93 m (95% CI 521.49-832.6 m). The estimated density of caribou in the Lougheed Island Group survey area was 262.6/1000 km^2 (95% CI 145-475 caribou/1000 km^2). Based on the area surveyed (1,415 km^2), the estimated abundance of Peary caribou throughout the Lougheed Island Group in 2007 was 372 (95%CI 205-672).

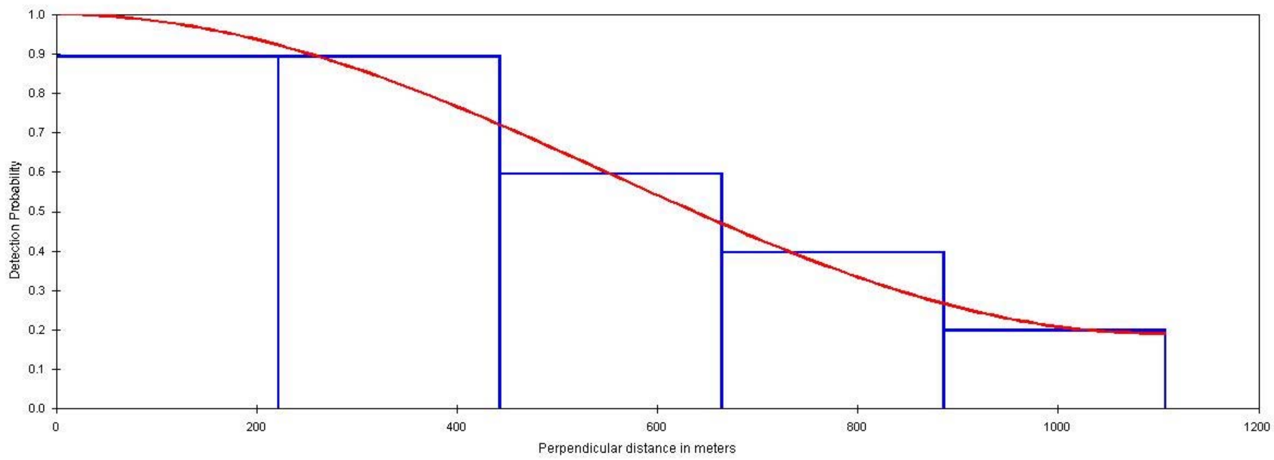


Figure 34: Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou in the Lougheed Island survey area, April 2007. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 221.

Table 17: Summary of candidate models used in the line-transect analysis for Peary caribou of the Lougheed Island survey area, April 2007. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

Lougheed - Peary caribou					**Denisty**			
Name	**Par**	**Delta AIC**	**AIC**	**ESW (m)**	**Caribou/km^2**	**95% LCI**	**95% UCI**	**CV**
Uniform Cosine	1	0.00	414.82	658.93	0.2626	0.1451	0.4754	0.300
Half-normal Hermite Poly	1	0.93	415.75	679.74	0.2616	0.1414	0.4839	0.312
Half-normal Cosine	1	0.93	415.75	679.74	0.2616	0.1414	0.4839	0.312
Uniform Simple Poly	2	1.35	416.17	643.55	0.2698	0.1400	0.5199	0.336
Hazard-rate Simple Poly	2	2.50	417.32	707.80	0.2681	0.1374	0.5230	0.343
Hazard-rate Cosine	2	2.50	417.32	707.80	0.2681	0.1374	0.5230	0.343

Muskoxen

Ground Survey: A ground survey was not carried out in the Lougheed Island Group.

Aerial Survey: No muskoxen were observed in the Lougheed Island Group survey area during the 2007 aerial survey (Table 5, Figure 33).

4.0 DISCUSSION

4.1 OVERVIEW

In 1961, Tener (1963) estimated that there were 25,845 Peary caribou and 7,421 muskoxen across the Queen Elizabeth Islands (QEI). For the QEI that are within Nunavut, Tener's estimates were 6,414 Peary caribou, distributed primarily in the Bathurst Island Complex (BIC; 56%), and 6,421 muskoxen, distributed on Ellesmere Island (62%), the BIC (19%) and Axel Heiberg Island (16%). Prince of Wales and Somerset Island, south of the QEI, were not surveyed until 1974. Results indicated that an additional 1,285 Peary caribou and 564 muskoxen occupied these islands (Fischer and Duncan, 1976). Our study reveals that the abundance and distribution of Peary caribou and muskoxen within the Arctic Archipelago, Nunavut has changed dramatically over the last five decades.

We estimated that there are approximately 4000 Peary caribou (combining estimates and minimum counts) within the 2001-2008 study area; the majority of which occurred within the Axel Heiberg Island Group (2,291 95% CI 1,636-3,208; 55%). For muskoxen, we estimated that the study area hosted approximately 17,500 (combining distance sampling estimates and minimum counts), with the majority in the Ellesmere Island Group, primarily the northern Ellesmere survey area (8115 95% CI 6632-9930; 47%). In contrast to Tener (1963), we found less than 5% of Peary caribou and 1% of muskoxen within the BIC. Trends in abundance by island group are discussed in detail in separate sections below.

Evaluating trends in abundance from 1961-2008 was hampered by differences in survey methods and design, and we discuss these issues in section 5.0 Management Implications. Notably, these challenges are not uncommon (Good 2007) and we present a history of the existing data, recognizing that 1) no other population estimates directly comparable to this study are available; 2) past estimates are generally based on strip sampling; 3) some past estimates are based on few data collected using low coverage.

4.2 PEARY CARIBOU

4.2.1 Bathurst Island Group

(Survey Areas - Bathurst Island Complex, Cornwallis Group)

Bathurst Island Complex

Within the QEI, the BIC has likely received the greatest interest and resources in terms of structured research programs, including 15 aerial surveys (including ours) between 1961 and 2001(Tener, 1963; Miller *et al*., 1977a; Fischer and Duncan, 1976; Ferguson, 1991; Miller, 1987a, 1989, 1992, 1993a, 1994, 1995b, 1997a, 1998; Gunn and Dragon, 2002). In part, this is a consequence of Teners' 1961 results, which highlighted the importance of the BIC to Peary caribou (Tener 1963). Interest has also focused on the BIC due to its importance as a caribou hunting area for the community of Resolute Bay (in the 1960s and 1970s, and again starting in the 1990s: Ferguson, 1991; Miller, 1993a, Miller 1995b), due to oil and gas exploration and development such as on Cameron Island (Bent Horn operation 1984-1996) and lead-zinc deposits on

Bathurst and Little Cornwallis (Babb and Bliss, 1974; Miller, 1977; Taylor, 2005), and planning for Tuktusiuqvialuk National Park.

Our results suggest that the Peary caribou population of the BIC has increased from the 1997 estimate of 78 ± 26 1-year-old and older caribou (Gunn and Dragon, 2002). However our estimated number is still small in relation to historical values that estimate a population size as large as 3,565 individuals (including calves) in 1961 and again in 1994 (Tener, 1963; Miller 1998).

Although evaluation of trends in abundance is complicated by differences in survey design and the inclusion or exclusion of calves, overall patterns are discernable. In the past four decades, the Peary caribou population on the BIC has fluctuated with steep declines in 1973-74, and again in 1995-1997. The first two surveys of the BIC were separated by 12 years (1961-1973) and revealed an 83% reduction in this caribou population from 3,565 (including calves; Tener, 1963) to 608 (including calves; Miller *et al.*, 1977a). Late winter and summer surveys in 1973 and 1974 identified a further reduction in caribou numbers to 228 (no calves were observed) in August 1974 (Miller *et al.*, 1977a). This additional 62% decline was attributed to deep snow cover and icing, which caused widespread mortality and resulted in little or no reproductive success (Miller *et al.*, 1977a). Subsequent surveys from 1985 to 1994 indicated a slow increase in population size, and by 1994 Peary caribou were estimated at 3100 on the BIC (Miller, 1998).

Aerial surveys in 1995, 1996, and 1997 revealed a second die-off with an all-time low estimate of 78 caribou in 1997 (Gunn and Dragon, 2002). Based on carcass counts, it was estimated that 85% of the overall decline was directly related to caribou mortality (and not movement) and coincided with exceedingly severe winter and spring conditions (deep snow and icing; Miller and Gunn, 2003a, 2003b).

Our estimate for the BIC survey area suggests that this population of caribou has increased since 1997. The annual rate of population increase (λ) over the 4 years between these estimates is 24% (λ = 1.24) although the 1997 and 2001 estimates of abundance may not be directly comparable. However, the finite rate of Increase suggested by this finding is not unexpected for the initial years of growth in a population that is well below carrying capacity and strongly female-biased in composition (Heard, 1990). The recent die-off (1994-97) was biased toward male and younger caribou and the surviving population in 1998 was 75% females (Miller and Gunn 2003b). Notably, the annual finite rate of increase for caribou immediately following the 1973-74 die-off is unknown, as comparable data for the BIC is not available until 1985. Abundance estimates for the period from 1985 to 1993 (Miller 1987a, 1989, 1992, 1993a, 1994, 1995b) indicate average annual rates of increase (λ) ranging from 1.103 (1975-1988) to 1.399 (1990-1993) (Table B, Appendix 1).

Bergerud (1978), suggested the annual rate of increase of λ = 1.35 (r = 0.30) as the Malthusian rate of increase for caribou (i.e., intrinsic natural rate of population growth in the absence of all density-dependent effects). Based on this, potentially, the

Peary caribou population on the BIC could return to levels experienced in the early 1960s and early 1990s (i.e., roughly 3,000 animals) in the next 10 to 15 years and in the absence of severe weather or other environmental conditions including predation. However, it took roughly 20 years before caribou abundance recovered from lows recorded in 1974. Observations made by the Bathurst Island National Park negotiating team during a reconnaissance flight across northern Bathurst Island in September 2010 (300-350 caribou counted) support an increasing trend (Joadamee Amagoalik, personal communications, Sept. 21, 2011).

The proportion of short yearlings (10-12 months) among caribou seen on transect in May 2001 was 29%. This is in line with historical values and generally supports an increasing trend although mortality rates are unknown. In June-July 1961, Tener (1963) reported that 19.8% of the caribou seen on-transect (on the BIC) were calves, while Miller *et al*. (1977a) observed no caribou calves during an aerial survey in August 1974. Between 1975 and 1993, when there was an overall increase in the BIC caribou population the proportions of calves observed were variable but ranged from 19% to 29% (Ferguson, 1981; Miller 1987a, 1989, 1992, 1993a, 1994, 1995b). Based on this, our 29% observed in the 2001 survey could be a sign of initial recovery

Since the 1950s, Inuit in Resolute Bay have harvested Peary caribou from the BIC and Cornwallis Island. In the early 1970s however, hunters reported animals in very poor condition and starving (Taylor, 2005). Concerned with the low abundance and poor condition of animals, the HTO suspended their harvesting of caribou on Bathurst Island in 1975 (Taylor, 2005). Harvesting was re-initiated in the late 1980s and has continued since that time (Taylor, 2005; Nancy Amarualik, personal communication, Sept 21, 2010). In the mid 1990s, hunters observed many caribou and muskoxen carcasses on Bathurst Island following freezing rain during the winter (Taylor, 2005). As much as 5 cm of ice was observed by local residents during the winter of 1995-96 (Jenkins *et al*., 2010a) and harvesters had to traveled to other islands (i.e., Somerset and Prince of Wales Islands) to support subsistence harvesting (Taylor, 2005). More recently, hunters have resumed harvesting on Bathurst Island, where they are able to successfully locate and harvest enough caribou to meet their needs (Nancy Amarualik, personal communication, Sept. 21, 2010). To date, harvest reporting has not been required and our limited harvest records (voluntary reports of harvest) are not sufficient to assess the potential impact of harvesting on population trends.

We note that our estimate of abundance of Peary caribou on Bathurst Island (187 95% CI 104–330) is low compared to the preliminary estimates of abundance independently calculated (using the same data) previously by McLoughlin *et al*. (2006) (272 95% CI 185–400 caribou), and M. Ferguson (279 with 95% CI 166–503; provided as a personal communication in COSEWIC 2004). This is likely because past analysis were derived with the inclusion of data from B-transects, which biased density estimates upwards. The inclusion of B-transects violated assumptions of random sampling, since B-transects were only flown after caribou were observed on A-transects. Thus, systematically increasing the effort in areas where animals are known to occur (areas of higher animal density) leads to the overestimation of abundance using conventional line transect estimators (Pollard *et al.,* 2002). Notably, both estimates are within our confidence intervals.

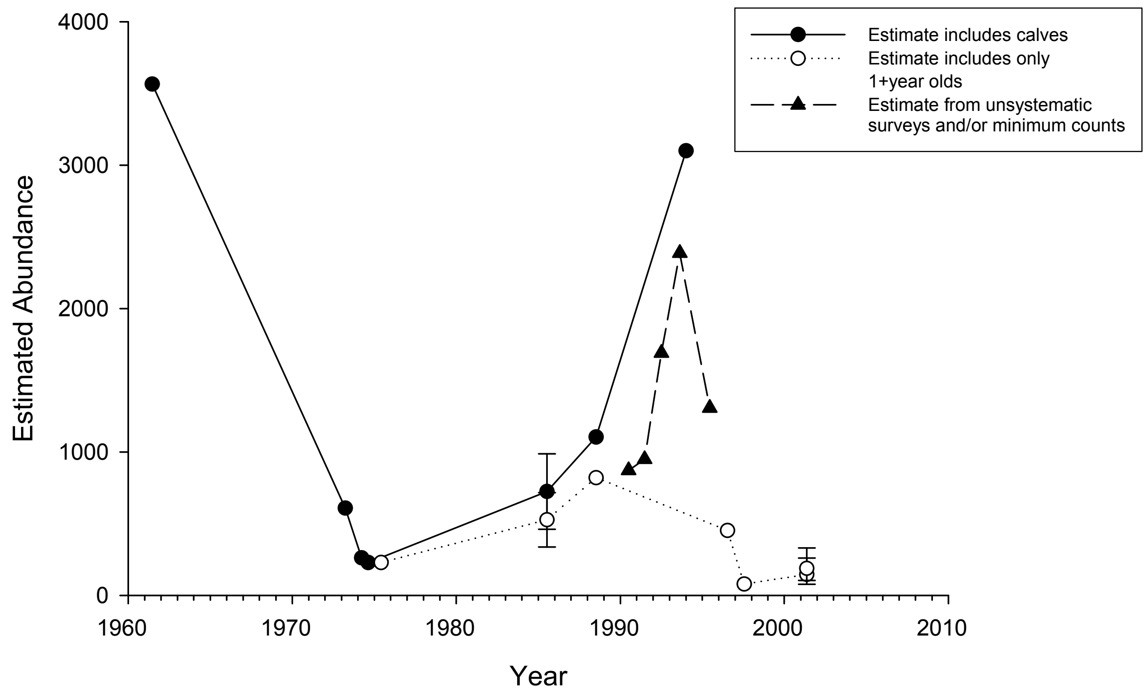


Figure 35: Peary caribou abundance for Bathurst Island Complex, 1961-2001. See Table B, Appendix 1 for information regarding survey details.

Cornwallis Survey Area

Peary caribou on the Cornwallis Island Group are probably migrants from adjacent Bathurst Island possibly seasonally as well as during severe winters (Miller 1998, Taylor 2005). During May 2001, the only observation of live caribou in the survey area was on northwest Cornwallis Island. Previous estimates that include both Cornwallis Island and Little Cornwallis Island are limited to summer 1961 and 1988, when 43 and 51caribou (with calves) were estimated, respectively; all animals were observed on Cornwallis Island (Tener, 1963; Miller, 1989). Additional surveys of Little

Cornwallis in 1973 and 1974, produced estimates of 8 and 12 caribou, respectively, with no calves observed (Miller *et al*., 1977a).

Although it is possible that higher numbers of caribou were present on Cornwallis Island prior to the settlement of Resolute Bay in 1953, RCMP records suggest that only a few caribou occurred on the island prior to 1950s (DIANA 1947-1950 in Taylor, 2005). By the mid- to late 1960s, Inuit reported that it was difficult to find caribou on this island and that none were observed from 1990 to 2003 (Taylor, 2005). These observations are consistent with our ground and aerial survey results from 2002. Notably, in October 1995, severe weather conditions on Bathurst Island may have forced the movement of approximately 100 caribou from Bathurst to Cornwallis Island near Resolute Bay, where they were harvested (Struzik, 1996; Miller, 1998; Taylor, 2005). Thus, it is likely that Cornwallis and Little Cornwallis Islands have historically provided important range to small numbers of resident caribou, but also to temporary migrants that leave Bathurst Island during unfavourable weather events with poor forage conditions.

4.2.2 Devon Island Group

(Survey areas – Devon Island, Baille Hamilton, Dundas/Margaret, North Kent)

The number of Peary caribou on Devon Island is extremely low (minimum count of 17 in 2008). The reasons for this are not immediately evident and historical information is limited. Only irregular surveys have been carried out and, to our knowledge, a full island survey has not been completed since 1961 (Tener, 1963). Most previous surveys have focused on muskoxen and the coastal wetland areas that they principally occupy (Freeman, 1971; Hubert, 1977; Pattie, 1990; Case, 1992). Tener (1963) estimated about 150 caribou on Devon Island in 1961. Inuit knowledge indicates that there have been caribou on the northeastern coast of Devon Island, on the Grinnell Peninsula, and that they can reliably be found along the western coast of the island (Taylor, 2005).

Minimum counts for western Devon Island in 2002 suggested that caribou numbers were low. These findings are consistent with our results for Bathurst Island Complex (2001) and Cornwallis Island Group (2002). However, movement patterns for caribou on Devon Island are not well understood and it was possible that there were caribou in other areas of the island at that time (e.g., the Truelove Lowlands; Taylor, 2005). Our extended survey coverage in 2008 yielded a minimum count of 17 caribou, confirming the extremely low abundance of caribou across Devon Island.

4.2.3 Ellesmere Island Group

(Survey Areas - Southern Ellesmere, Northern Ellesmere Island)

The Ellesmere Island Group makes up 41% of Nunavut's Peary caribou range (based on our study area). Our results revealed extremely low densities for Peary caribou (8-9 caribou/1000 km^2; north and south Ellesmere Island). Historical surveys of Ellesmere Island are infrequent and limited in their spatial coverage. Results from the first aerial survey in 1961 (Tener, 1963) suggested that there were approximately 200 caribou on Ellesmere Island; however, a mathematical estimate was not derived due to the small number of observations and low survey coverage. No island-wide aerial survey was undertaken since 1961.

Surveys in 1973 (Riewe, 1973) and 1989 (Case and Ellsworth, 1991) focused on southern Ellesmere (south from the Svendson Peninsula). The stratified survey in 1989 provided density estimates ranging from 6 caribou/km^2 on the Svendsen Peninsula stratum to lows of 2 caribou/1000 km^2 on the Bjorne Peninsula, on the area between Vendom Fiord and Makinson Inlet, and on Ellesmere Island south of Baumann Fiord (Case and Ellesworth, 1991). Overall, the estimated abundance was 89 caribou (90% CI 37-141) on southern Ellesmere Island in 1989 (Case and Ellesworth, 1991).

Our estimate for southern Ellesmere (9.2 caribou/1000 km^2 or 219 caribou) included Graham Island, which Inuit knowledge (Taylor 2005) and Riewe (1973) identified as Peary caribou range. We observed few caribou clusters which led to a low density estimate with wide confidence intervals (95% CI 4.6-18.6 caribou/1,000 km^2). Densities on Graham Island appeared higher than on the mainland, but data were not sufficient to derive local density estimates. In the early 1990s, the emaciated carcasses of one caribou and two muskoxen were observed on the sea ice off the west side of Bjorne Peninsula, and Inuit from Grise Fiord reported seeing caribou on Graham Island in the mid-1990s (Taylor, 2005). In the winter of 2002, additional observations of dead animals were reported after freezing rain that likely limited access to forage. However, by 2003, Inuit believed that numbers of caribou on southern Ellesmere were increasing (Taylor, 2005).

During our survey on southern Ellesmere in 2005, we observed 40 emaciated muskoxen carcasses and at the same time, hunters of Grise Fiord also reported muskoxen in poor condition (Campbell, 2006). No observations of Peary caribou carcasses were recorded by our aerial or ground crews. Weather conditions were identified as a possible causative factor (Jenkins *et al.* 2010b) although some local Inuit do not believe that snow and ice play a significant role in the population dynamics of Peary caribou on southern Ellesmere. Inuit knowledge indicates that muskoxen have difficulties in deep snow conditions and are sometimes found dead or dying of starvation, whereas caribou are rarely found in this condition (Jenkins *et al*., 2010b). Inuit state that the reason for this is that caribou seek refuge in high-elevation areas where precipitation is reduced and vegetation more exposed (Jenkins *et al*., 2010b). Miller *et al*. (2005a) have also postulated that the large rugged land base on Ellesmere and other eastern islands may be of great importance in the persistence of Peary caribou because of the numerous micro niches that are available. Due to the rugged terrain, most of Ellesmere Island experiences different climatic conditions than other arctic islands (Maxwell 1981). This includes reduced influence from cyclonic systems which plague islands such as Bathurst and Cornwallis (Maxwell 1981)

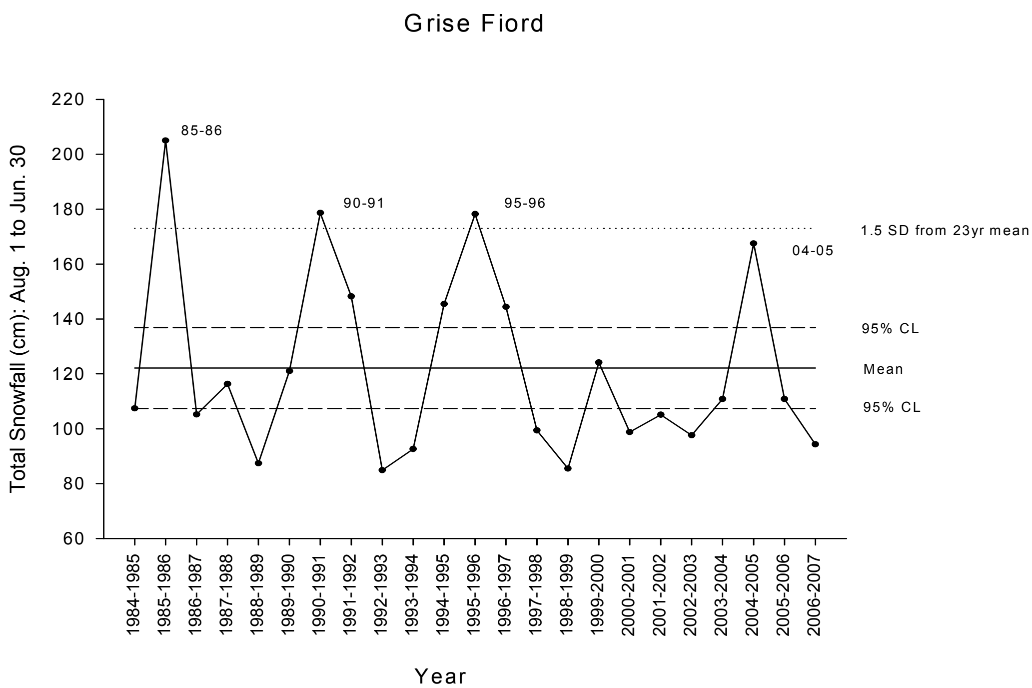
Lack of data limits our ability to drawing conclusions about any trends in abundance on Ellesmere Island. Our combined abundance estimate for the Ellesmere Island Group is approximately 1,000 animals, and this is comparable to the extrapolation presented in COSEWIC (2004). The estimated abundance is higher on northern Ellesmere than in the south, and this is explained in part by the larger area and the larger clusters we observed.

On Ellesmere, calf or short yearling recruitment was low in 2005 (no short yearlings among 57 caribou classified) and in 2006 (no short yearlings among 344 caribou classified). The 2004-2005 winter was marked by high snowfall, which may have reduced survival for the 2004-cohort and may have carried over to influence pregnancy rates and/or calf survival for the 2005 cohort as by early spring 2006, short yearlings were 0% and yearlings were only 7 %. Cow condition, which affects pregnancy rates (especially for young cows) and calf birth weights and hence calf survival, is influenced by food availability (Thomas 1982; Cameron *et al*., 1993). Thomas (1982) found a direct relationship between the fertility of female Peary caribou and fat reserves in late winter. The same author concluded that reproduction in Peary caribou in the western QEI nearly ceased from 1973-1974 to 1975-1976 because of the poor physical condition of female caribou. In barrenground caribou, early calf survival has also been linked to late-term maternal conditions (Cameron *et al*., 1993; Adam, 2003). Adams (1995, 2003) found that fat deposition and skeletal growth of caribou neonates were inversely related to late winter severity and that calves were smaller at birth following severe winters. Additionally, severe winter conditions were associated with reduced calf survival and increased calf susceptibility to predation (Adams, 1995).

In the western QEI, calf production has been proximately related to snow depth, the duration of snow cover from previous winters, and the occurrence of ground-fast ice

(Miller *et al*., 1977; Thomas, 1982; Ferguson, 1991; Miller and Gunn, 2003b). For example, Miller and Gunn (2003b) found that major to near-total calf crop losses in the western QEI were associated with winters that featured significantly greater than average total snowfall (measured between Sept-June). At Grise Fiord and Eureka, total snowfall in 2004-05 was greater than the 24-year mean annual snowfall recorded at each of these locations (Figure 36). Assuming these conditions were widespread on Ellesmere Island, significant snowfall may explain the lack of calf recruitment we observed in late winter 2005 and 2006.

(A)



(B)

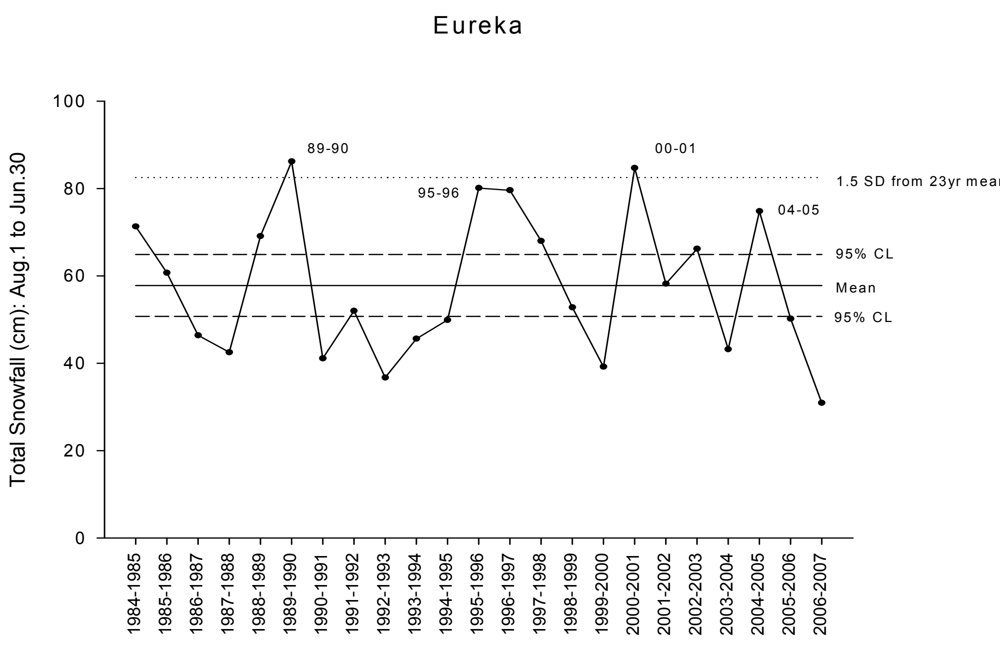


Figure 36: Total snowfall (cm) at Grise Fiord (A) and Eureka (B) from August 1 through June 30 (autumn through spring) by year from 1984 to 2007. Data obtained from Environment Canada (2010).

Historical values of calf production on Ellesmere Island are both variable and few. In 1961, Tener (1963) estimated the proportion of calves at 10.8 % for Ellesmere.Island while the proportion of calves in southern Ellesmere has ranged from 5.5 % in July 1973 (Riewe, 1973) to 22.0% in 1989 (Case and Ellsworth, 1991).

Aerial observations of caribou clusters in the Ellesmere Island Group suggest that population composition may be strongly female-biased in both southern and northern Ellesmere, although the average group size is larger in northern Ellesmere (4.6 (SE 0.37) vs. 3 (SE 0.34) caribou, respectively). The literature suggests that, in populations of *Rangifer* and other cervids, female-biased sex ratios may reflect greater mortality of males from a variety of factors including severe weather (Bergerud, 1971; Miller and Gunn 2003b; Barboza *et al*., 2004). For example, male caribou invest in reproduction at the same time as plant production declines; thus, body reserves may not be sufficient to support rutting activities as well as winter survival (Weladji *et al*., 2002; Barboza *et al*., 2004). Male-skewed harvesting is not a suspected factor, as much of the survey area is beyond the hunting range for Inuit harvesters (NWMB Data 1996-2001; Taylor, 2005).

4.2.4 Prince of Wales – Somerset Island Group

(Survey areas - Prince of Wales Island, Somerset Island)

During the 2004 aerial survey, we observed no Peary caribou on the Prince of Wales/Somerset Islands (POW/SI) Group. These results are consistent with ground surveys of Prince of Wales Island in 2004 and Somerset Island in 2005, in which crews reported only four caribou after traveling a combined distance of 4,831 km.

Peary caribou in the POW/SI Group declined from an estimated 5,682 caribou (one year or older) in 1974 (Fischer and Duncan, 1976) to a minimum count of two in 1996 (Miller, 1997b). Our results indicate that there has been no recovery since 1996.

Based on survey results from 1980 (5,097 caribou one year or older), Gunn and Decker (1984) concluded that this population was likely stable or declining slightly based on low recruitment and relatively high annual harvest (150-250 caribou per year). By the late 1980's and early 1990s, Inuit hunters had observed a decrease in the abundance of caribou and found it difficult to locate caribou for harvesting (Taylor, 2005, Gunn *et al*., 2006). Subsequent surveys in 1995 and 1996 yielded critically low numbers: seven caribou in 1995 (Gunn and Dragon 1998) and two caribou in 1996 (Miller, 1997b). Due to the 15-year delay between aerial survey studies, the causes for the significant decline could not be determined with certainty (Gunn *et al*., 2006).

Several factors likely explain the decline in caribou numbers through the 1980s and 1990s: 1) reduced survival rates for breeding females and calves (in the first year of life); 2) continued harvesting; 3) increased wolf predation (hypothesized as a consequence of increasing muskoxen numbers; Gunn *et al*., 2006). Contributing factors may have changed during the decline. It is possible that the severe winters of 1989-90 and 1994-95 extended to this island group and affected caribou numbers. Unfortunately, weather information for Prince of Wales/Somerset is not available although it is in the same climate region as Bathurst Island Group (Maxwell 1981).

Gunn and Dragon (1998) indicated that information on the abundance of predators, their diet, predation rates, and other parameters was not available for the POW/SI Group. However, the authors suggested that the increasing abundance of muskoxen (1980-1995) could likely support a higher number of wolves in the area.

In addition to predation, the POW/SI Group may have been subject to increased harvest during 1980-1995. As mentioned above (BIC section), Resolute Bay hunters instituted a voluntary hunting ban on Bathurst Island caribou from 1975-1989 and this resulted in a shift of harvesting activities to Prince of Wales and Somerset islands. This harvest pressure may have escalated when a voluntary hunting ban on southern Ellesmere Island caused the community of Grise Fiord to purchase caribou meat from the Resolute Bay Hunters and Trappers Association (Miller, 1990a). During this period, Inuit hunters from Taloyoak (Spence Bay) were also harvesting caribou on Prince of Wales and Somerset Islands (Gunn and Decker, 1984) as well as on the Boothia Peninsula. Based on the fact that an unknown portion of Peary caribou from the POW/SI Group used the Boothia Peninsula as part of their winter range, Miller (1990a) suggested that the high annual caribou harvest at Taloyoak (about 1000) could have impacted the POW/SI Group.

Inuit knowledge indicates that the decline in caribou on the POW/SI Group was associated with natural events, including overabundance in the 1980s (Taylor, 2005) predation, and weather (Gunn *et al.,* 2006). In the early 1980s, caribou were abundant on Prince of Wales, Somerset, and the smaller coastal islands (Taylor 2005). By the mid-1980s, hunters were observing tapeworm cysts (*Taenia krabbei*) in the muscle tissue of caribou from both Prince of Wales and Somerset Islands (Taylor, 2005; Jenkins *et al*., 2010a) and noticed muskoxen in areas previously occupied by caribou. Since wolves are the other host for this tape-worm, it is possible that wolf abundance and hence, predation, had increased in relation to the larger prey base (Gunn and Dragon, 1998; Gunn *et al.,* 2006). Hunters also observed carcasses of caribou and muskoxen on Somerset Island and Prince of Wales in the early 1990's following a period of freezing rain in the fall. Similarly, in 1989 Inuit reported that caribou harvested from Somerset Island were skinny (Taylor 2005) and that 21 dead caribou had been observed on the west coast of Somerset in March and May (Letter from Josh Hunter to M. Ferguson, 1989 in Gunn *et al*., 2006).

Assessment of potential limiting factors for the Prince of Wale/Somerset population is complicated by the fact that some Peary caribou also use or historically used Boothia Peninsula in the winter (Miller *et al.,* 2005b). Additionally, there are also some Peary caribou that are unique to Boothia Peninsula (Zittlau 2004). We know little about the spatial extent of Boothia Peary caribou, their current abundance, or interchange that occurs between this population and the Peary caribou of the POW/SI Group. Gunn and Dragon (1998) estimated 6,658 caribou (SE 1,728) on Boothia in July-

August 1995, but the surveyors did not differentiate between Peary and barrenground caribou that are known to occupy the area (Campbell, 2006 – NEM report on file). Miller (1997b) observed no Peary caribou on the northwest portion of Boothia in 1996 but did not survey the remainder of the Peninsula. During a muskoxen survey on the Boothia Peninsula in 2006, one caribou morphologically similar to Peary caribou was observed (Dumond, unpublished data).

The paucity of monitoring data between 1980 and 1995 make it difficult to evaluate with certainty the cause of the decline within the Prince of Wale/Somerset Group though it is clear that immediate management action will have to be taken if we are to conserve this population into the future.

4.2.5 Axel Heiberg Island Group

Our survey results are higher than the only previous description of caribou abundance for Axel Heiberg Island. Having surveyed less than 3% of the ice free area of Axel Heiberg, Tener (1963) estimated about 300 caribou on the island in 1961. No other surveys of the island have occurred since that time. Lack of data and this 50-year gap in monitoring make it impossible to discuss population status or trends for Peary caribou on Axel Heiberg Island.

The relative abundance of both caribou and muskoxen was greatest east of the Princess Margaret Range where snow cover appeared to be less than the western coast during the May 2007 survey. As mentioned previously, much of the central part of the island is permanently covered in ice (Muller Ice Cap and Steacie Ice Cap), and this, in conjunction with the central mountain range may fragment the population. Further research is needed to evaluate this.

The Axel Heiberg Group currently supports the largest population of Peary caribou in Nunavut, with an estimated 2,291 animals (95% CI 1636-3208) based on our 2007 survey results. This population accounts for more than 55% of the total estimated Peary caribou population in our entire study area. This may be a consequence of the local climate (Maxwell, 1981), biomass and diversity of vegetation (Edlund and Alt, 1989), the varied topography, and isolation from human disturbance (Taylor, 2005).

Axel Heiberg Island, particularly the eastern portion, may be a natural refugium for Peary caribou, much like the western coast of Ellesmere Island functions as a refugium for muskoxen (Thomas *et al.,* 1981; Ferguson, 1995). Eastern Axel Heiberg, including the central mountains, is in Climate Region V (Maxwell, 1981). Region V also includes most of Ellesmere Island (except the southeastern and northern coasts), and is distinguished by rugged mountainous terrain. Notably, west central Ellesmere Island and the eastern portion of Axel Heiberg are almost completely surrounded by mountains which provide protection from cyclonic activities and result in a rain shadow effect (Maxwell 1981). Hence, this 'interior' area of Region V is characterized by low precipitation, a wide temperature range (Maxwell, 1981) and is generally snow free by early to mid-June (Edlund and Alt, 1989). Consequently, vegetation is rich along the eastern coast of Axel Heiberg, transitioning from an enriched prostrate shrub zone at low elevations to a lower-diversity herb-shrub transition zone at high elevations (Edlund and Alt, 1989). In combination, the climate, diverse vegetation, and varied topography may be of benefit to Peary caribou, particularly in the face of accelerated climate change.

4.2.6 Ringnes Island Group

(Survey Areas - Ellef Ringnes, Amund Ringnes, King Christian, Cornwall, Meighen, Lougheed Islands)

Our 2007 survey of the Ringnes Island Group was the first concerted attempt to assess Peary caribou abundance in this region since Tener's work in 1961, and we estimated a total of 654 caribou. It is difficult to track populations in this area due to its remoteness and of these islands, only irregular surveys of Lougheed Island have occurred in the past five decades.

Our combined abundance estimate for Ellef Ringnes, Amund Ringnes, Cornwall, Meighen, and King Christian islands (282 caribou 95%CI 157-505) was much lower than the 1961 estimate of 832 caribou for these islands (Meighen excluded) (Tener, 1963). Our flight effort (i.e., linear distance flown) was double that of the 1961 survey (3,905 km vs. 1,953 km, respectively), and observer effort was also greater than in the 1961 survey (four observers vs. one, respectively). Thus, our systematic sampling design was robust and supported the detection of caribou.

Lougheed Island was surveyed in 1961, 1973, 1974, 1985, and most recently in 1997 (Tener, 1963; Miller *et al*., 1977a; Miller, 1987; Gunn and Dragon, 2002). Results from these investigations suggest that caribou abundance has fluctuated over time, with data indicating an overall reduction from an estimated 1,324 in summer 1961 (Tener, 1963) to 56 in April 1973 (Miller *et al*., 1977a). Only one caribou was observed in April 1974 (Miller *et al*., 1977a), and no caribou were reported by Miller (1987a) during an aerial survey in July 1985. Gunn and Dragon (2002) estimated 101 caribou (one year and older, SE 73) for Lougheed Island in July 1997, compared to our estimate of 372 (95% CI 205-672) in April 2007. Although not directly comparable our estimate suggests that either caribou are increasing on Lougheed Island or that its use is seasonal. From the existing data no patterns of seasonal use are discernable and caribou movement within this Island Group is unknown.

Overall, we caution that it is difficult to interpret population trends within this Island Group as survey information is limited, typical seasonal movement patterns are unknown, and surveys (e.g., Lougheed Island) have occurred at different times of year. Nonetheless, the overall proportion of calves (14%) that we observed is encouraging given the extreme northern latitude and the small calf crops we recorded for other survey areas.

Although Taylor (2005) documented Inuit knowledge on Peary caribou in Nunavut from 16 interviewees (all from Grise Fiord or Resolute Bay), the observations and information did not extend to the Ringnes Island Group. This likely reflects the remoteness of the area, which makes it inaccessible to most Inuit hunters (Taylor, 2005).

4.3 MUSKOXEN

4.3.1 Bathurst Island Group

(Survey Areas - Bathurst Island Complex, Cornwallis Group)

Bathurst Island Complex

In 1961, the Bathurst Island Complex had the second largest estimated population of muskoxen in the Queen Elizabeth Islands (1161, including calves). This figure included an estimated 25 muskoxen on the Governor General Islands after observing 3 animals (Tener, 1963).

Since the 1960s, muskox abundance on the BIC has fluctuated in parallel with Peary caribou abundance. There was a 40% decline from 1961 to 1973, followed by a significant die-off (approximately 75%) during the winter of 1973-74 (Miller *et al*., 1977). The number of muskoxen estimated on BIC then increased from 1974 to 1994 reaching levels similar to those recorded in 1961. Between 1995 and 1997, numbers declined by approximately 96% based on minimum counts and systematic surveys (Miller *et al*., 1977a; Ferguson, 1991; Miller, 1987a, 1989, 1995b, 1997a, 1998; Gunn and Dragon, 2002; Table C, Appendix 1).

This study followed the lowest ever estimate of muskoxen abundance for Bathurst Island Complex (124 ± SE 45, including calves; Gunn and Dragon, 2002), recorded in 1997. Also, aerial surveys in July of 1996 and 1997 suggested complete failure of the muskoxen calf crop on Bathurst Island Complex (Miller, 1998; Gunn and Dragon 2002). Our minimum count of 82 muskoxen (excluding newborn calves) or 103 (with newborn calves) suggests that although the population remains at low numbers, it is likely stable or increasing. We caution that although the sample size was small, the proportion of calves (ca. 20%) was encouraging.

In 2001, we did not observe muskoxen on any of the satellite islands which make up the Bathurst Island Complex (Cameron, Ile Vanier, Massey, Isle Marc, Alexander, Helena, Table 5). Muskoxen use of those islands has varied historically (Appendix 1, Table 3) although no muskoxen have ever been recorded on Ile Marc or Helena and only low counts of muskoxen have periodically been recorded on Vanier, Cameron, Massey, and Alexander (Tener, 1963; Miller, 1987a; 1989).

Cornwallis Survey Area

Few studies of muskoxen abundance have incorporated the Cornwallis Island Group. In 1961, Tener (1963) estimated 50 muskoxen on Cornwallis Island and reported no muskoxen on Little Cornwallis. The islands were not surveyed again as a pair until 1988, when estimates were 70 muskoxen on Cornwallis and zero on Little Cornwallis (Miller, 1989). Although our results are not directly comparable, the low number of animals observed during our aerial survey in 2002 (minimum count 18) suggests that this population has not grown.

Aerial surveys of Little Cornwallis Island in 1973 and 1974 demonstrated that small numbers of muskoxen occupied this island in the past. From April 1973 to August 1974, estimated abundance on Little Cornwallis dropped from 40 muskoxen to 12 (Miller *et al*., 1977a).

No regular seasonal large-scale movement of muskoxen to Little Cornwallis Island has been documented although movement between islands must occur for recolonization. The temporal and spatial scales of these movements are unknown. Limited radio telemetry data for muskoxen on Devon, Cornwallis and Bathurst Islands for the period 2003-2006 indicates no movement between these islands and no use of Little Cornwallis Island (Jenkins, in prep). The absence of muskoxen from Little Cornwallis in 1988 and 2001 suggests that either muskoxen have not permanently recolonized the island or that they were simply not present at the time of the survey.

4.3.2 Devon Island Group

(Survey Areas – Devon Island, Baille Hamilton, Dundas/Margaret, North Kent)

Tener (1963) completed the first aerial survey of Devon Island in 1961 and covered approximately 6% of the habitable portion of the island. After observing no muskoxen on transect and 23 animals off transect, Tener (1963) estimated that no more than 200 animals occupied the island. Since 1961, only infrequent partial surveys have been done. Freeman (1971) estimated 450 muskoxen on the Grinnell Peninsula and northern coast of Devon Island using ground sightings from 1966-1967. The same study yielded an estimate of 230 to 300 muskoxen from the north coast lowlands along the shore of Bear Bay. From 1970 to 1973, Hubert (1977) counted between 116 and 278 muskoxen on the north coast lowlands from Sverdrup Inlet to Sverdrup Glacier. Pattie (1990) investigated the same area roughly a decade later and documented a marked decline in muskoxen over 3 years, with estimates of 188 in 1984 and 76 in 1987.

In 1980, an aerial survey of the lowlands of southern and western Devon Island located 32 muskoxen in the Croker Bay/Dundas area, 14 in the Philpots Island area, and 46 inland from Baring Bay (Decker unpublished, in Case, 1992). Case (1992) surveyed lowland areas along the north, south, and western coasts of Devon Island and observed 366 muskoxen. A minimum estimate of 400 animals was subsequently established for Devon Island at that time (Case, 1992).

Based on our 2008 survey, muskoxen continue to inhabit discrete and highly fragmented low-lying areas of Devon Island. The majority of muskoxen were located along the southeastern coast of Devon Island, including Philpots Island where we counted 142 muskoxen including calves. This contrasts with previous reports that have indicated greatest abundance along the northeastern coast of Devon.

Inuit have consistently observed muskoxen on Devon Island, principally on the coastal lowlands in the northeast (the Truelove Lowlands) but also along the western coast (Baring Bay and Dragleybeck Inlet areas), on eastern Grinnell Peninsula, and along the southeastern coast (Dundas Harbour area)(Taylor, 2005). Our results suggest a decline in muskoxen along the northeast coast and increased muskoxen numbers in the east and southeast portions of the island.

4.3.3 Prince of Wales – Somerset Island Group

(Survey Areas - Prince of Wales Island, Somerset Island)

Prince of Wales (incl. Russell Island)

Our results suggest a significant overall decline in the Prince of Wales Island Group muskoxen population, from an estimated 5,257 (SE 414) in 1995 (Gunn and Dragon, 1998) to our estimate of 2,086 (95% CI 1582-2746) in 2004 (Table 4). This is a drop of approximately 60%.

The cause of this decline is unknown as there is a paucity of biological and abiotic data for this area. Inuit knowledge recorded by Taylor (2005) does not directly refer to a decline of muskoxen on Prince of Wales Island. The possible emigration of muskoxen from Prince of Wales Island to Somerset Island is documented as well as the loss of muskoxen on both Prince of Wales and Somerset in relation to freezing rain in the early 1990s (Taylor 2005). Regardless of these events, Inuit observations suggest that muskoxen numbers continued to rise on both islands in the early 2000s (Taylor, 2005).

The overall decline referred to above is consistent with other recent scientific studies in the western Arctic Archipelago that revealed a rapid drop in muskox abundance between 2001 and 2005 on Northwestern Victoria Island (Nagy *et al*., 2009a) and Banks Island (Nagy *et al*., 2009b). According to Nagy *et al*. (2009a, 2009b), it is likely that the principle cause of these declines was winter icing events.

Unfortunately, we are unable to determine the severity, timing or cause of the decline due to the paucity of survey data; specifically a 9 year gap in monitoring between 1995 and 2004.

Somerset Island

Muskox population studies on Somerset Island have been limited. The first aerial surveys in 1974 and 1975 located no muskoxen on Somerset Island (Fischer and Duncan, 1976). In 1980, three groups of muskoxen where counted on the island for a total of 29 animals with no calves (Gunn and Decker, 1984). No population estimate was derived from that assessment. The next aerial survey was not completed until 1995 when the abundance of muskoxen (one year or older) was estimated at 1,140 (SE 260) (Gunn and Dragon, 1998).

The results from our 2004 survey, although not directly comparable to the above, suggest that the population is likely stable with an estimated 1,910 (95% CI 962-3792) muskoxen (one year or older). The newborn calf crop appears low (5%), however, this finding is confounded by the timing of the survey. The survey was conducted in mid-April, which coincides with the beginning of calving. For muskoxen, calving can extend from April into June (Gray, 1987). In comparison, the proportion of yearlings was 13%, which is encouraging.

<u>4.3.4 Ellesmere Island Group</u>

(*Survey area - Southern Ellesmere, Northern Ellesmere)*

Northern Ellesmere Island

The results from our 2006 survey indicate that Northern Ellesmere Island supports the largest abundance of muskoxen in the entire study area, with 47% of the total estimated muskoxen population. The estimated density for Northern Ellesmere Island (84.0 muskoxen/1000 km^2 , 95% CI 68.7-102.8) was second only to the density on Axel Heiberg Island (137.2 muskoxen/1000km^2 , 95% CI 109.2 – 172.5). We observed muskoxen across the entire survey area, from the Svendson Peninsula in the south to areas north of Alert. Concentrations of animals were seen on the Lake Hazen-Alert Plateau, Raanes Peninsula, Svendson Peninsula, and along the north and southern coasts of Greely Fiord.

During our survey, the largest concentration of muskoxen was detected on the Fosheim Peninsula, and this is consistent with findings from the first aerial survey of Ellesmere Island in 1961 (Tener, 1963). The Fosheim Peninsula has previously been identified as a Wildlife Area of Special Interest (WASI) because of its special features, high biological diversity, and significance to muskoxen (Ferguson, 1995). During our aerial survey of Northern Ellesmere Island (April 6 to May 22, 2006), 56% of all the muskoxen that we observed on transect were on the Fosheim Peninsula (3,292 muskoxen), and of these 66% of the groups had newborns. Previous assessments on the Fosheim Peninsula in 1960 and 1961 yielded counts of 312 and 227 muskoxen, respectively (Tener, 1963).

The Fosheim Peninsula is considered an arctic refugium (Thomas *et al*., 1981) in the sense that it may support muskoxen even during periods of unfavourable climatic conditions in the Arctic Archipelago. In other words, animals may survive here when environmental conditions elsewhere are unfavourable for survival (Mackey *et al*., 2008). This also means that the muskoxen on the Fosheim Peninsula may be a source of animals that disperse and colonize or reoccupy other areas of less ideal habitat (e.g., areas where unfavourable climatic conditions may have extinguished local populations: Thomas *et al*., 1981).

We report a muskox newborn calf crop of 15% for Northern Ellesmere Island in 2006 however, this is likely a low estimate as the survey commenced in early April, before the expected onset of calving. Tener (1963) estimated the proportion of calves for Ellesmere at 12.4 % in June 1961, while calf crop ranged from 14% and 23% in Sverdrup Pass between 1981-1984 (Henry *et al*., 1986). This is comparable to our results for Southern Ellesmere where the proportion of newborn calves was only 1% in 2005 (May 4-May30: this study).

Tener (1963) reported approximately 4,000 animals for the entire island in 1961, and estimated that approximately 1,000 of these inhabited the Fosheim Peninsula and

Lake Hazen Alert Plateau. Our estimate of 8,115 (95% CI 6,632-9,930) is for Northern Ellesmere Island, which we defined as the area north of Vendom Fiord. Consequently, either Tener (1963) underestimated and or muskoxen in northern Ellesmere Island have increased since 1961.

Southern Ellesmere Island Group

Previous surveys of Ellesmere are few and limited in their spatial coverage. (Tener 1963) estimated that in 1961 Ellesmere had more muskoxen than the rest of the Queen Elizabeth Islands in total (ca. 4000 vs. 3421 respectively). Subsequent surveys were mostly limited to southern Ellesmere, where muskox harvesting was important to residents of Grise Fiord. Case and Ellsworth (1991) divided the area into five strata and reported density estimates ranging from a high of 121 muskoxen/1000km^2 on the Bjorne Peninsula to a low of 63.0 muskoxen/1000 km^2 in the area south and east of Bjorne Peninsula and Baumann Fiord. The resulting overall population estimate for 1989 (in an area comparable to our survey area minus Graham Island) was approximately 1,670 muskoxen (Strata I, III, IV, and V; Case and Ellsworth, 1991).

Our 2005 estimate for southern Ellesmere, 19.2 muskoxen/1000 km^2 or 456 muskoxen (95% CI 312-670) included Graham Island where a total of 8 muskoxen with no calves were observed in 3 groups on-transect. Thus, although not directly comparable, this information suggests that there has been a decline in the muskoxen population of Southern Ellesmere Island since 1989.

In the early 1990s, Inuit observed the emaciated carcasses of two dead muskoxen and a dead caribou on the sea ice off the west side of Bjorne Peninsula (Taylor, 2005). Further, in the winter of 2002, additional local observations of dead animals were reported after freezing rain that apparently limited access to forage (Taylor, 2005). During our aerial survey (2005), 40 emaciated muskoxen were observed across the study area and frequent reports of muskoxen in poor and/or starving condition were described by the hunters of Grise Fiord as well as the aerial survey crew (Campbell, 2006). Weather conditions were identified as a possible factor and local Inuit suggest that muskoxen have difficulties in deep snow conditions and are sometimes found dead or dying due to starvation (Jenkins *et al*., 2010b).

Only two newborn calves were observed across Southern Ellesmere Island in our 2005 aerial survey, which is a concern. On Ellesmere, Tener (1963) estimated 12.4 % muskox calves in 1961, second only to Melville Island at 17.22 %. The percentage of muskox calves on the Bjorne Peninsula in July 1973 was 15% (Riewe, 1973), and across southern Ellesmere was 17.3% in 1989 (Case and Ellsworth, 1991). Although the direct cause of the low calf crop is unknown, severe weather events have been identified as the primary cause of major to near-total calf crop losses in other muskoxen populations (i.e. particularly harsh winters of 1973/74, 1994/95, 1995/96 and 1996/97; Miller *et al*., 1977a; Miller 1997a, 1998; Gunn and Dragon, 2002). Miller and Gunn (2003b) found that all four of these winters were characterized by significantly greater total snowfall (as measured between September and June). This is consistent with snow records for Grise Fiord and Eureka for the winter of 2004-05 (Figure 36).

Deep snow can severely restrict access to forage which impacts survival and reproduction (Miller and Gunn, 2003b; Taylor, 2005). Indeed, snow cover has repeatedly been implicated in significant over-winter mortality of muskoxen (Parker *et al*., 1975; Miller *et al.,* 1977; Parker, 1978; Gunn *et al*., 1989; Miller and Gunn, 2003b). Local hunters on southern Ellesmere report that muskoxen have difficulty in deep snow and they sometimes come across muskoxen that have died of starvation (Taylor, 2005; Jenkins *et al*., 2010b).

Schaefer and Messier (1995) found that muskoxen on Victoria Island exhibited consistent preference for thin or soft snow cover and greater forage abundance when studied across a nested hierarchy of spatial scales from population range to travel routes, to feeding sites, to feeding crates and finally to diet. Rettie and Messier (2000) have suggested that selection patterns are linked to limiting factors. Specifically, limiting factors which are most important to a species will influence selection at coarser spatial scales while those less important will influence fine-scale decisions. Thus, for muskoxen, snow cover and snow hardness appear to be limiting factors, as muskoxen consistently selected for thinner and softer snow across spatial scales (Schaefer and Messier, 1995).

4.3.5 Axel Heiberg Island Group

Tener (1963) provided preliminary estimates of 1,000 muskoxen for Axel Heiberg Island in 1961. During an aerial reconnaissance survey in July 1973, 866 muskoxen were counted between Stang Bay and Whitsunday Bay on eastern Axel Heiberg, an area known as Mokka Fiord (Ferguson, 1995). Our 2007 results (4237 95% CI 3371-5325 muskoxen one year or older) indicate that muskoxen have likely increased since the 1961 survey although we caution that coverage in 1961 was low (<3%).

Our estimated proportion of newborn calves (13%) is likely biased low as the 2007 survey was completed in early May, before calving ended (Tener, 1965; Gray, 1987). For the eastern Arctic historical estimates of calf crop are limited. Calf percentages for the Fosheim Peninsula varied between 0 and 14.2 in 1954 and 1960 (Tener, 1965) while reported values for Sverdrup Pass range from 14% in 1984 to 23% in 1983 (Henry *et al*., 1986). At a larger spatial scale, Tener (1963) reported the proportion of calves on Ellesmere and Axel Heiberg in 1961 as 12.4 % and 7.3 % respectively. Overall, our data indicates that Axel Heiberg Island supports a larger population of muskoxen than was previously thought. Current trends are impossible to determine due to the lack of survey data. However, our results show that Axel Heiberg Island supports the highest density of muskoxen in the Arctic Archipelago, Nunavut and next to northern Ellesmere, the largest population. Notably, this muskox population is sympatric with the largest Peary caribou population in Nunavut.

4.3.6 Ringnes Island Group

(Survey area - Ellef Ringnes, Amund Ringnes, King Christian, Cornwall, Meighen, and Lougheed)

With the exception of Lougheed Island, our survey was the first since 1961 (Tener, 1963) to estimate muskoxen abundance across the Ringnes Island Group. Like Tener (1963), we observed, in 2007, too few muskoxen to derive a population estimate for individual islands. Tener (1963) provided a preliminary estimate of 10 animals for Amund Ringnes Island based on observation of four bull muskoxen. He observed no muskoxen on Ellef Ringnes, Lougheed, King Christian, or Cornwall Islands (Tener, 1963).

Our combined minimum count of 21 animals for the Ringnes Island Group suggests that these islands are still on the periphery of muskoxen range. No muskoxen were observed on Ellef Ringnes, Lougheed, and Meighen Islands. No communities harvest muskoxen from these islands.

5.0 IMPLICATIONS FOR MANAGEMENT

5.1 SURVEY DESIGN

We designed the surveys to be accurate by using Distance Sampling methodology which allowed us to model the probability of detection. The approach relaxes the assumption that we saw and counted every individual within a certain distance of the transects, which is the case with strip transects (Buckland et al. 2001). Thus, we made the strip very wide (unbounded), expected not to detect all the animals (except for those on or very close to the transect), and recorded all observations regardless of distance from the transect. This approach, particularly suited to populations of animals that are sparsely distributed over large areas (Buckland *et al*., 2001; Buckland *et al*., 2004), can increase the number of detections, resulting in a greater sample size (n) and more precise density estimates (Buckland *et al.,* 2001). We also designed the surveys to be relatively precise by flying enough transects (k) and by ensuring that the transects covered entire non-glaciated island areas so that both caribou and muskoxen had a chance of being seen and counted.

The analysis of abundance and trends in population size is important in wildlife management and our survey is a baseline against which future surveys can be compared. The analysis of trends requires density and abundance estimates with sufficient power to detect change over time. Attention to survey design is important in achieving this objective (Buckland *et. al.,* 2001; Zerbini 2006) and with *a priori* knowledge of encounter rates (e.g. number of caribou per 1,000 km flown), we will be able to estimate the line length (effort) necessary to achieve desired precision and design transect coverage accordingly.

This study demonstrates that for some populations, large scale surveys will be necessary to apply sufficient effort to yield an adequate sample size. Notably if the sample is too small, then precision is poor (Buckland *et. al.,* 2001). Abundance estimates with low and/or variable precision can constrain wildlife management and approaches to improve precision should be evaluated. Thus, future surveys of small populations would also benefit from reconnaissance surveys, to determine when and if encounter rates will support a full scale survey, and what effort is necessary to generate the required precision.

One approach to increasing precision is to use stratification. For example, stratification of Distance Sampling data through *a priori* methods or through post stratification, should be considered. Another promising alternative includes multiple covariate distance sampling (MCDS), which uses multiple covariates in the estimation of detection probability and has the advantage of potentially providing a more precise estimate than stratification (Buckland *et. al*. 2001; Marques *et al*., 2003; Zerbini 2006).

Notably, our shift in methodology from the previously used strip transect to distance sampling has limited our ability to measure population trends as comparative data is not available. However, the benefits of distance sampling, including associated possibilities of increased precision with improved survey design and MCDS, have significant positive implications for wildlife management (Marques *et al*. 2003; Marques *et. al*., 2006; Buckland *et al.* 2004; Zerbini 2006; Aars *et. al.* 2008)

5.2 SURVEY SCALE

Until additional information on population boundaries becomes available, future surveys of Peary caribou should continue at the scale of Island Groups. This approach recognizes what we know about inter-island movements and population structure, and increases the likelihood of detecting real changes in caribou and muskoxen numbers (Gunn *et al.* 1997; Zittlau 2004; Miller *et al*., 2005b).

Defining populations requires understanding of genetics, geographic distribution and demography (Wells and Richmond 1995). The collection and analyses of data on genetics and distribution is underway although considerable effort is required to complete the analyses. Currently, population structure is being evaluated using microsatellite DNA from 300 Peary caribou samples collected from six island groups during the recently completed surveys, as well as previous research efforts. This is the first time that many of these areas have been sampled as previous analyses were limited in areas sampled (Zittlau, 2004; Petersen *et al.,* 2010). With 16 to 18 locus genotypes from Peary caribou, the variation within and between island groups is being exposed (Jenkins in prep). Similar research is underway for muskoxen. Movement and space use are also being analyzed for a small sample of radio-collared Peary caribou and muskoxen on Devon Island, Cornwallis Island and the Bathurst Island Complex (Jenkins in prep).

5.3 SURVEY FREQUENCY, MONITORING, AND MANAGEMENT PROGRAMS

In the Arctic Archipelago, the lack of routine monitoring is likely the greatest impediment to evaluating trends in abundance. Our study highlights the paucity of monitoring data for most island groups of Peary caribou and muskoxen. Monitoring is particularly important in areas where populations are small, environmental stochasticity is high, and where there is interest in harvesting (Miller and Barry, 2009).

Small populations are of great conservation concern due to the potential risk of inbreeding and genetic drift, and the resulting loss of genetic variability. This may reduce the ability of caribou and muskoxen to respond to future environmental and anthropogenic changes (Caughley and Gunn 1996; Zittlau, 2004).

When caribou and muskoxen population sizes are severely reduced, the risk of extinction is greater due to natural variation or chance (demographic stochasticity, environmental stochasticity, genetic stochasticity; Caughley and Gunn, 1996; Krebs, 2001, Zittlau, 2004). Such populations are also more vulnerable to additional pressures, such as human harvest, industrial activities (mineral and petroleum exploration and development), and climate change (Caughley and Gunn, 1996; Gunn *et al*., 2006; Mackey *et al*., 2008).

Peary caribou and muskoxen are important to local communities and an adequate monitoring program is not in place to inform communities on the status of local populations and determine sustainable harvest levels. When populations are low, it is important to maintain the maximum number of animals to minimize vulnerability and allow for the fastest possible recovery (Miller and Gunn, 2003a).

Similarly, formal monitoring programs to detect large-scale changes in the abundance and distribution of Peary caribou and muskoxen are lacking as are comprehensive management programs to initiate appropriate conservation measures when / if numbers become unsustainably low. Peary caribou and muskoxen populations are subject to abrupt changes in size, and adaptive and collaborative measures are necessary to detect fluctuations in population size, to monitor population parameters, to establish and communicate sustainable harvest levels, and to evaluate the effects of predation, harvesting, land use activities and other natural and anthropogenic factors (Miller and Gunn, 2003b; Miller and Barry, 2009; Prowse *et al*., 2009). At present, muskox harvesting occurs under a quota system however, a formal harvest management system for Peary caribou has not yet been applied. While some HTAs (Hunter and Trapper Associations) have implemented voluntary harvest restrictions for certain populations in the past, further action should be taken. Given the significant reduction of some Peary caribou populations, and the importance of caribou to local communities and the ecosystem at large, a formal and comprehensive management system should be developed in conjunction with the local HTAs (Jenkins *et al*. 2010a, 2010b).

5.4 COMMUNITY-BASED MONITORING

Local harvesters have unique knowledge and skill, and a shared interest in preservation of viable wildlife populations (Ferguson *et al.,* 1997;Taylor, 2005; Brook *et* *al.,* 2009, Curry 2009, Jenkins 2009, Jenkins *et al*., 2010a, 2010b). Local harvesters have on-going contact with caribou and muskoxen and can provide important information on these species and on the ecosystem at large. The implications for management are to ensure that a collaborative program is strengthened and to make certain that Inuit knowledge is integrated into management planning.

A community based monitoring program will address some of the unique challenges of conducting northern research (i.e. information exchange, remote location), while engaging community members, wildlife managers, and scientists in a collaborative effort that combines resources and knowledge (Meier *et al.*, 2006; Brook *et al.,* 2009; Jenkins 2009; Merkel 2010). Communities in the Arctic Islands want input into scientific studies and to participate and develop research programs that address their needs and concerns (Jenkins *et al.,* 2010a, 2010b). This study was built on the shared understanding that population monitoring is critical to wildlife management and conservation. Members of the Resolute Bay and Grise Fiord Hunting and Trapping Associations were strong proponents for the ground surveys which were valuable. Their information (i.e. observations of caribou and muskoxen, group composition, wildlife sign) was used to assess the aerial survey results and led to the collection of non-invasive samples for DNA and diet analyses.

Environmental conditions, particularly, unfavourable snow and ice conditions, have been identified as a principle limiting factor of Peary caribou (Miller and Gunn, 2003a, 2003b; Miller and Barry 2009). Thus, ecological monitoring should be a priority and can be based on observations collected by Inuit hunters. A program to systematically collect those observations is an essential component of a Peary caribou conservation program.

5.5 LAND-USE PLANNING

Conservation and management planning for caribou will be ineffective without consideration for their range (McCarthy *et al.,* 1998; Miller and Gunn, 2003a, Hummel and Ray, 2008; Jenkins *et al.,* 2010b). Peary caribou are at low numbers; they experience stochastic fluctuations in their environment and they exhibit significant fluctuations in population size due to these events (Miller and Barry 2009). Thus, additional stressors that negatively impact habitat quality and/or quantity are of concern. Scientists and Inuit agree that conservation of habitat, including sea ice, is important (Miller and Gunn 2003a; Jenkins *et al*. 2010b). Inuit knowledge is that the overall range of Peary caribou must be considered given that intact habitat is necessary at all times of the caribou life cycle and that life requirements change throughout the year (Japettee Akeeagok, in Jenkins *et al.,* 2010b). Miller and Gunn (2003a) explain that *'the protection of the caribou range during the stressful part of the year will be of little value if the caribou cannot subsequently make back their body condition, make new growth and build up their body reserves during the favourable time of the year. Thus, caribou need to have sufficient amounts of forage and space available during all seasons of the year to foster their year-round long term survival.*'

The management implications are to ensure that Peary caribou ecology and conservation are integrated into land-use planning. This has started with an assessment of Peary caribou distribution and habitat use based on the data from the aerial surveys.

5.6 CLIMATE CHANGE

Climate change may act as a significant factor in population dynamics and numerous studies have highlighted the sensitivity of Peary caribou and muskoxen to climate. Historical data shows that Peary caribou and muskoxen in the High Arctic have experienced significant declines due to unfavourable weather conditions (Miller *et. al.,* 1977a; Miller, 1995b, Miller and Gunn, 2003b; Miller and Barry, 2009; Tews, 2007a) and climate warming may exacerbate these events (Tews *et al*., 2007b; Barber *et al*., 2008; Vors and Boyce, 2009).

Tews *et al*., (2007b) found that some populations of Peary caribou will be at a greater risk of extinction if the frequency and intensity of poor winter conditions increases. Populations such as those on Axel Heiberg and Ellesmere Island may be less vulnerable given the complexity of niches afforded by topographic relief (Miller *et al.,* 2005b; Jenkins *et al*., 2010b).

Some Peary caribou depend on perennial ice to access portions of their annual range, or to expand their range when they are displaced by severe winter events (Miller, 1990b, Miller *et al*., 2005a). Recent trends suggest a reduction in sea-ice over most of the Arctic Basin and a marked basin-wide thinning in sea-ice (Barber *et al.,* 2008). Scientists have already identified a tendency for fast ice areas to melt earlier and freeze up later (Barber *et al.,* 2008). Miller *et al*. (2005a) has suggested that increases in the ice-free period could critically modify the timing and even the opportunity for seasonal migrations between islands.

Another potential impact of thinning ice, and a shorter ice season, is an extension in the shipping season. There is increasing interest in shipping lanes through Arctic waters due to thinning ice and the decreasing extent of sea ice (Kubat *et al.,* 2007, Somanathan *et al*., 2009, Ho 2010). Ships are constructed that can manage ice year round and the feasibility of shipping in Canada's Arctic is under consideration (Ho 2010).

Ship traffic through the ice covered channels could influence or interrupt caribou movement (i.e. regular seasonal movements, desperation movements) and/or increase the risks for caribou crossing the ice (of injury or death to caribou), as well as affect the timing, pattern and structure of sea ice formation and breakup (Miller, 1990a, 1990b; Miller *et al.,* 2005a; Poole *et al.,* 2010). .

The potential consequences of climate change for caribou and muskoxen are extensive and are driven by changes in temperature, precipitation, land/water use, sea ice, vegetation, atmospheric carbon dioxide concentrations, invasive species, insects, disease and ecosystem dynamics to name a few (Sala *et al.,* 2000; Mackey *et al.,* 2008). Positive responses to climate change are possible (Nemanin *et al.,* 2003) which would include higher levels of plant biomass and a longer snow-free season. However; most trends suggest that stress will increase for many species and ecosystems (Mackey *et al*., 2008).

The management implications are to develop research and monitoring programs to help us understand and measure the impacts of climate change on caribou and muskoxen ecology, population dynamics, space use and movement. Another implication is to integrate the uncertainty of climate change and potential environmental impacts into land use planning and wildlife management.

6.0 ISLAND-GROUP MANAGEMENT RECOMMENDATIONS

Management and monitoring programs for caribou and muskoxen in the Arctic Islands should be developed in consultation with local communities (Jenkins *et al.* 2010a, 2010b). The following information is offered for consideration in this process.

6.1 PEARY CARIBOU

6.1.1 Bathurst Island Group

The Bathurst Island Complex and Cornwallis Island are a frequently used hunting area for residents of Resolute Bay. Our survey results suggest that the Peary caribou abundance was low in 2001 although the survey and subsequent sightings appear to indicate some recovery. Regular surveys of the Bathurst Island Complex, including Cornwallis Island should be undertaken to update this estimate and allow for the monitoring of population trends and harvest to be managed for long term sustainable use. Reports of unusual movements or carcasses should be investigated and treated as a trigger for island-wide surveys. Support for continuing the process for a national park on the Governor General Islands and northern Bathurst Island will protect ranges including wintering and calving areas for Peary caribou. The proposed national park also has to be part of a framework to provide a resilient landscape for Peary caribou throughout their seasonal cycle. The marine component (i.e. sea ice) of Peary caribou habitat should be recognized in these designations.

6.1.2 Devon Island Group

Harvesting of caribou on Devon Island continues (Jenkins *et al*., 2010b) and limited harvest reports suggest that, for the period of 1996-2001, harvest efforts focused on the north coast of Devon (Grise Fiord, NWMB data 1996-2001), with some effort by Resolute Bay harvesters on the western coast (Resolute Bay, NWMB data 1996-2001).

We have no evidence that Devon Island receives migrants from adjacent caribou populations (e.g., Somerset, Cornwallis, or Ellesmere Island; Taylor, 2005) and at extremely low numbers, risks increase through demographic, genetic, and environmental stochasticity (Caughley and Gunn, 1996; Krebs 2001). Given our results of low abundance and unknown trend, caribou on Devon Island will require careful monitoring and management to support recovery and determine trends.

6.1.3 Ellesmere Island Group

Since the mid-1990s, Inuit from Grise Fiord have annually harvested between 20 and 66 Peary caribou on southern Ellesmere Island (DoE Unpublished Data, Priest and Usher, 2004). Harvest information since the mid-1990s has been provided voluntarily. As such, it is not complete and may underestimate the actual harvest requirements.

Population trends suggest that the reported harvest level may not be sustainable over the long term. To maintain a harvestable population on southern Ellesmere, management initiatives are required to reduce losses and compensate for low calf recruitment. Management initiatives should be developed in consultation with the local community and be linked to routine monitoring of the Island Group (Jenkins *et al.,* 2010 a, 2010b).

6.1.4 Prince of Wales/Somerset Island Group

Peary caribou numbers continue to be extremely low suggesting that recovery is uncertain and immediate measures to conserve caribou on Prince of Wales/Somerset group are necessary. Because some Peary caribou on POW/SI are known to use Boothia Peninsula in the winter, these measures should also include the Peninsula. The conservation of this inter-island population must involve the full spatial extent of caribou range and all communities that harvest Peary caribou within the geographic area. Further work is needed to evaluate the population of Peary caribou on Boothia and to understand the interchange that occurs between Boothia Peary caribou and POW/SI Complex. All future caribou surveys of Prince of Wales and Somerset Island should include the Boothia Peninsula and, during these surveys, efforts should be made to distinguish between Peary and Barrenground caribou.

6.1.5 Axel Heiberg Island Group

Axel Heiberg Island is the largest remaining population of Peary caribou in Nunavut (and the NWT). Interest in the conservation of unique features and ecosystems on Axel Heiberg have been identified previously (Zoltai *et al.,* 1981; Ferguson, 1995) and portions of the island have been listed for consideration as a World Heritage Site (DoE 2006). Given the diverse vegetation, varied topography, and protection from cyclonic activity (primarily, in the east; Maxwell, 1981; Alt and Edlund,1983), Axel

Heiberg Island is of national interest in the conservation and recovery of Peary caribou, particularly in the face of accelerated climate change. Given that a fundamental goal of wildlife management is the maintenance of wildlife habitat, the designation of Axel Heiberg Island for wildlife conservation is recommended. The benefits include provision of sites for environmental monitoring (Ferguson, 1995) and ecological research where anthropogenic influences on wildlife and their habitat are limited.

6.1.6 Ringnes Island Group

Although this Island Group forms part of the northern extent of Peary caribou range, the area supports the third largest abundance of caribou. Miller et al., 2005 identify the area as a low density reserve that can benefit the recovery and long-term persistence of Peary caribou. This study highlights the importance of Lougheed Island, and that further research is necessary to understand habitat characteristics, and caribou space use and movement.

6.2 MUSKOXEN

6.2.1 Bathurst Island Group

Bathurst Island Complex Survey Area - The BIC is currently identified as Muskoxen Management Unit MX-01 and the current harvest quota is 40 animals per season. Typically, less than half that quota is used annually (DoE data, 1990-2009) but the current quota will impede any recovery in muskox abundance and consultations are needed to collaborate on the harvest level. This is important as human activities are increasing in the High Arctic and this could intensify interest in the harvesting of muskoxen.

Cornwallis Survey Area - The Cornwallis Island Group is not within the boundaries of any of Nunavut's current Muskoxen Management Units. Nonetheless, DoE harvesting records indicate that muskoxen have been harvested on Cornwallis Island, primarily for sport hunts out of Resolute Bay. Our results provide no evidence that the nearest harvest management unit should be expanded to include the Cornwallis Island Group.

6.2.2 Devon Island Group

The Devon Island Group is part of Muskoxen Management Unit 5 (MX-05) and three communities harvest muskoxen in this region: Grise Fiord, Resolute Bay, and Arctic Bay. Based on our findings, we believe that the current quota of 15 muskoxen for MX-05 is sustainable.

6.2.3 Ellesmere Island Group

Northern Ellesmere Survey Area - During our survey, the largest concentration of muskoxen was detected on the Fosheim Peninsula, and this is consistent with findings from the first aerial survey of Ellesmere Island in 1961 (Tener, 1963). The Fosheim Peninsula has previously been identified as a Wildlife Area of Special Interest (WASI) because of its special features, high biological diversity, and significance to muskoxen

(Ferguson, 1995). The results of our study support this designation and emphasize the critical value of this habitat to muskoxen and their young.

Southern Ellesmere Island - The people of Grise Fiord (including sport hunters) harvest muskoxen across southern Ellesmere Island, primarily south of Baumann Fiord (in what is currently MX-02), but also in areas west and east of the community (i.e. MX-03 and MX-04, respectively). In combination, the combined annual quota of 74 muskoxen has been identified for these areas. Our results demonstrate that the majority of muskoxen were distributed north of the designated muskoxen management units, with low densities and numbers across southern Ellesmere Island. Additionally, animals unable to stand or run were observed frequently in 2005 and over 40 emaciated recently dead carcasses were observed throughout the survey area (Campbell 2006). Thus, the current quota, non-quota limitations and management units should be reviewed with the local HTA. Efforts to redirect harvesting pressure to areas in Northern Ellesmere should be considered.

6.2.4 Prince of Wales - Somerest Island Group

Prince of Wales Survey Area - The population of muskoxen on the Prince of Wales Group is harvested primarily by hunters from Resolute Bay. The quota for Prince of Wales Group is currently combined with Somerset Islands at 20 animals. An independent quota should be established for the Prince of Wales Island Group given that muskoxen are likely a separate population based on sea and ice conditions and their effects as an obstacle to regular movements (Gunn and Jenkins, 2006). That is, muskoxen can swim but rarely do (Tener 1965, Gunn and Adamczewski, 2003) and seasonal movements of muskoxen between Prince of Wales Island Group and Somerset Island have not been documented (Miller *et al*., 1977b; Taylor, 2005). Limited information from marked or radio-collared muskoxen in other areas of the high Arctic revealed no seasonal inter-island movements and there are few observations of muskoxen crossing sea ice (Miller *et al.,* 1977a; Taylor, 2005; Gunn and Jenkins, 2006; Jenkins in prep). The decline measured on Prince of Wales Island is a concern and regular monitoring is necessary to direct management action.

Somerset Island Survey Area **-** Muskoxen on Somerset Island have mainly been harvested by hunters from Resolute Bay and occasionally by hunters from Arctic Bay. As noted above, the current quota of 20 is for both the Prince of Wales and Somerset Island. An independent quota should be established for Somerset Island muskoxen given that this is likely a separate population based on the sea and ice conditions and its impacts on movement. Muskoxen on Somerset Island are not known to make seasonal inter-island movements (Taylor, 2005). Although muskoxen must have crossed the sea ice on occasion to colonize or recolonize islands in the Arctic Archipelago, the spatial and temporal scale of these movements is likely beyond the time frame that harvest management actions must target.

6.2.5 Axel Heiberg

No communities are known to harvest muskoxen from Axel Heiberg Island. Axel Heiberg Island has the second largest muskoxen population in the Arctic Archipelago, Nunavut. Interest in the conservation of unique features and ecosystems on Axel Heiberg have been identified previously (Zoltai *et al.,* 1981; Ferguson, 1995) and portions of the island have been listed for consideration as a World Heritage Site (DoE 2006). Concentrations of muskoxen east of the Princess Margaret Islands have been highlighted as a Wildlife Areas of Special Interest (Ferguson, 1995). Given the diverse vegetation, varied topography, and protection from cyclonic activity, primarily in the east; (Maxwell, 1981; Alt and Edlund,1983), Axel Heiberg Island may be of national interest in the conservation of biological diversity in the Arctic Archipelago, particularly in the face of accelerated climate change.

6.2.6 Ringnes Island Group

Muskoxen are at extremely low numbers and absent from a number of these islands. This, in combination with the high northern latitude and sparse vegetation, Edlund and Alt (1989) suggest that the area may be unable to sustain large numbers of muskoxen year round.

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APPENDIX 1

Table A: Survey Area Calculations

Island (Group)	Year Surveyed	Area (km sq.)	Glaciated Area	Habitat (Survey Area)	Totals Only	Projection Specifics	Datum
Bathurst Island Group							
Bathurst Island Survey Area							
Bathurst Is.(survey area only)	2001	11693	0	11693			
Cameron	2001	1066	0	1066		CM101W; LoO76N	WGS1984
Vanier	2001	1136	0	1136			
Massey	2001	436	0	436			
Isle Marc	2001	57	0	57			
Alexander	2001	484	0	484			
Helena	2001	328	0	328			
Unnamed Bracebridge Inlet	2001	88	0	88			
Loney	2001	19	0	19			
Bathurst Is. Complex Survey		15307		15307			
Bathurst Island (all)	2001	16030	0	16030		CM101W; LoO76N	WGS1984
Cameron	2001	1066	0	1066			
Vanier	2001	1136	0	1136			
Massey	2001	436	0	436			
Isle Marc	2001	57	0	57			
Alexander	2001	484	0	484			
Helena	2001	328	0	328			
Unnamed Bracebridge Inlet	2001	88	0	88			
Loney	2001	19	0	19			
Bathurst Island Complex (all)	Adjusted	19644		19644	19644		

Table A: Con't.

Island (Group)	Year Surveyed	Area (km sq.)	Glaciated Area	Habitat (Survey Area)	Totals Only	Projection Specifics	Datum
Bathurst Island Group Con't.							
Cornwallis Survey Area							
Cornwallis Survey Area	2002	2949	0	2949		CM90W; LoO75N	WGS1984
Little Cornwallis	2002	381	0	381			
Milne	2002	25	0	25			
Crozier	2002	35	0	35			
Baring	2002	21	0	21			
Cornwallis Survey Area		3411		3411			
Cornwallis (All)	2002	7012	0	7012		CM90W; LoO75N	WGS1984
Little Cornwallis	2002	381	0	381			
Milne	2002	25	0	25			
Crozier	2002	35	0	35			
Baring	2002	21	0	21			
Cornwallis Group (All)	Adjusted	7474		7474	7474	CM90W; LoO75N	WGS1984

Table A: Con't.

Island (Group)	Year Surveyed	Area (km sq.)	Glaciated Area	Habitat (Survey Area)	Totals Only	Projection Specifics	Datum
Devon Island Group							
Western Devon Survey Area							
West Devon	2002	12316		12316			
Devon Island Survey Area							
Devon (includes Philpots Is.)	2002	55534	15993	39541		CM88W; LoO76N	WGS1984
Table&Ekins	2002	68	0	68			
Crescent	2002						
Pioneer	2002						
Spit	2002						
Herbert	2002						
John Barrow	2002						
Kerr	2002						
Fairholme	2002						
Isle of Mists	2002						
Hyde Parker	2002						
Dyer	2002						
Princess Royal Island	2002						
3 unnamed Islands	2002						
Total Small Islands	2002	122	0	122			
Survey Area Total	2008	55724		39731	39731		
North Kent	2008	594	154	440	440	CM88W; LoO76N	WGS1984
Baillie Hamilton	2008	290	0	290	290	CM88W; LoO76N	WGS1984
Dundas	2008	51	0	51	51	CM88W; LoO76N	WGS1984
Margaret	2008	10	0	10	10	CM88W; LoO76N	WGS1984

Table A: Con't.

Island (Group)	Year Surveyed	Area (km sq.)	Glaciated Area	Habitat (Survey Area)	Totals Only	Projection Specifics	Datum
Prince of Wales - Somerset Island Group							
Prince of Wales Survey Area							
Prince of Wales	2004	33274	0	33274		CM96W; LoO73N	WGS1984
Russell	2004	937	0	937			
Prescott Island	2004	412	0	412			
Pandora Island	2004	142	0	142			
Survey Area Total		34765		34765	34765		
Somerset Island Survey Area							
Somerset	2004	24549	0	24549	24549	CM96W; LoO73N	WGS1984
Ellesmere Island Group							
North Ellesmere Survey Area							
N Ellesmere	2006	165649	69399	96250		CM80W; LoO80N	WGS1984
Hoved Island	2006	115	0	115			
Pim Island	2006	84	0	84			
Krueger Island	2006	30	0	30			
Bromley Island	2006	26	0	26			
Marvin Islands	2006	9	2	7			
Miller Island	2006	19	0	19			
Bellot	2006	16	0	16			
(Small unnamed)	2006	20	0	20			
(Total small islands only)	2006			317			
Survey Area Total		165968		96567	96567		

Table A: Con't.

Island (Group)	Year Surveyed	Area (km sq.)	Glaciated Area	Habitat (Survey Area)	Totals Only	Projection Specifics	Datum
Ellesmere Island Group Con't.							
South Ellesmere Survey Area							
South Ellesmere	2005	31929	9723	22206		CM80W; LoO80N	WGS1984
Landslip Island	2005	36	0	36			
Graham	2005	1388	0	1388			
Buckingham	2005	137	0	137			
Survey Area Total		33490		23767	23767		
Axel Heiberg Island Group							
Axel Heiberg Survey Area							
Axel Heiberg	2007	42319	11974	30344		CM91W; LoO80N	WGS1984
Stor Island	2007	315	0	315			
Bjarnason	2007	128	0	128			
Ulvingen	2007	84	0	84			
Small Unnamed	2007	5	0	5			
Survey Area Total		42851		30877	30877		
Ringnes Island Group							
Ellef Ringnes Survey Area							
Ellef Ringnes	2007	11428	0	11428		CM100W; LoO79N	WGS1984
Thor	2007	121	0	121			
Survey Area Total		11549		11549	11549		
Amund Ringnes Survey Area							
Amund Ringnes	2007	5300	0	5299		CM100W; LoO79N	WGS1984
Haig Thomas	2007	65	0	65			
Survey AreaTotal		5364		5364	5364		

Table A: Con't.

Island (Group)	Year Surveyed	Area (km sq.)	Glaciated Area	Habitat (Survey Area)	Totals Only	Projection Specifics	Datum
Ringnes Island Group Con't.							
Cornwall Survey Area							
Cornwall	2007	2273	0	2273	2273	CM100W; LoO79N	WGS1984
King Christian Survey Area							
King Christian	2007	647	0	647	647	CM100W; LoO79N	WGS1984
Meighen Survey Area							
Meighen	2007	933	93	840		CM100W; LoO79N	WGS1984
Perley	2007	9	0	9			
Survey Area Total		943		849	849		
Lougheed Island Survey Area							
Lougheed	2007	1319	0	1319		CM105W; LoO77N	WGS1984
Edmund Walker	2007	82	0	82			WGS1984
Grosvenor	2007	7	0	7			WGS1984
Patterson	2007	5	0	5			WGS1984
Stupart	2007	2	0	2			
Survey Area Total		1415		1415	1415		
Total Ringnes Islands Group Survey Area				20682			
Arctic Island Study Area		**407600**			**300261**	**CM84W; LoO73N**	**WGS1984**

Note: All calculations conducted in the North Pole Lambert Azmimuthal Equal Area Projection; Datum 1984. The Projection was centered on each island or island group to increase precision.

APPENDIX 1: Table B: Historical Peary caribou surveys and abundance estimates.

		Estimate incl. calves			Estimate 1+ year					Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Minimum total counts; unsystematic surveys	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Bathurst Island Group																
Bathurst Island																
1961	19 Jun -7 Jul	2723						unk								Tener 1963
1973	29 Mar-3 Apr	527	79					N		-0.137	0.872					Miller et al. 1977
1974	25-31 Mar	226	59					N		-0.847	0.429	-0.191	0.826			Miller et al. 1977
1974	25-26 Aug				231	130		0								Miller et al. 1977
1981	10-13 Aug	289	93		234			19		0.002	1.002					Ferguson 1991
1985	10-25 Jul	495		253-737	352		184-521	26		0.102	1.107					Miller 1987a
1988	15-21 Jul	821	138		611	99		28		0.184	1.202	0.069	1.072			Miller 1989
1990	6-10 Jul							20	655						920min. Search effort	Miller 1992
1991	27-30 Jun							24	584	-0.115	0.892				547min. Search effort	Miller 1993
1992	5, 7, 8 Jul							29	1428	0.894	2.445				1025min. Search effort	Miller 1994
1993	17-21 Aug							28	2273	0.465	1.592	0.415	1.514		1765min. Serach effort	Miller 1995
1995	7-11 Jul							11	1084	-0.370	0.691			48	1107min. Search effort	Miller 1997a
1996	21-25 Jul				443	108		0						(287+/-68)		Miller 1998
1997	21-24 Jul				74	25		0		-1.790	0.167			(82+/-18)		Gunn and Dragon 2002
Ile Vanier																
1961	19 Jun -7 Jul	396						unk								Tener 1963
1973	4-Apr	20						N		-0.249	0.780					Miller et al. 1977
1974	1-Apr	15						N								Miller et al. 1977
1985	10-25 Jul	67		0-153	60		0-133	25								Miller 1987a
1988	13-Jul	85		29-140	63		25-101	25								Miller 1989
1989	22-Jul	72	34		55	23		21				-0.061	0.941			Miller 1991
1990	10-Jul							7	43						160min. Search effort	Miller 1992
1991	4-Jul							11	28						121min. Search effort	Miller 1993
1992	6-Jul							17	18						89min. Search effort	Miller 1994
1995	24-Jun							6	34					0	78min. Search effort	Miller 1997
1996	26-Jul				9	6		0						(224+/-54)		Miller 1998
1997	21-Jul				0			0				-0.501	0.606	(95+/-26)		Gunn and Dragon 2002
Cameron																
1961	19 Jun -7 Jul	235						unk								Tener 1963
1973	3-Apr	8						N		-0.282	0.755					Miller et al. 1977
1974	4-Apr	20						N								Miller et al. 1977
1985	10-25 Jul	51		0-131	47		0-122	7								Miller 1987a
1988	13-Jul	9		0-19	9		0-19	0								Miller 1989
1989	22-Jul	7	5		7	5		0				-0.125	0.882			Miller 1991
1990	17-Jun							0	13						50min. Search effort	Miller 1992
1991	5-Jul							0	2						182min. Search effort	Miller 1993
1992	21-Jun							0	5						151min. Search effort	Miller 1994
1995	24-Jun							0	0					7		Miller 1997
1996	26-Jul				0			0	0					(606+/-139)		Miller 1998
1997	21-22 Jul				0			0				-0.243	0.784	(188+/-30)		Gunn and Dragon 2002

Table B. Con't.: Historical Peary caribou surveys and abundance estimates.

		Estimate incl. calves			Estimate 1+ year					Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Minimum total counts; unsystematic surveys	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Bathurst Island Group																
Massey																
1961	19 Jun -7 Jul	13						unk								Tener 1963
1973	4-Apr	44						N		0.102	1.107					Miller et al. 1977
1974	1-Apr	0						N								Miller et al. 1977
1985	10-25 Jul	76		26-126	43		18-69	35								Miller 1987a
1988	14-Jul	84		39-131	55		23-87	36								Miller 1989
1989	22-Jul	108	27		68	17.4		39				0.076	1.079			Miller 1991
1990	7-Jul							27	56						91min. Search effort	Miller 1992
1991	4-Jul							33	123						91min. Search effort	Miller 1993
1992	6-Jul							33	101						82min. Search effort	Miller 1994
1993	16-Aug							43	28						65min. Search effort	Miller 1995
1995	24-Jun							41	49					0	61min. Search effort	Miller 1997
1996	26-Jul				0			0	0					(27+/-14)		Miller 1998
1997	21-Jul				4			0				-0.354	0.702	(13+/-11)		Gunn and Dragon 2002
Alexander																
1961	19 Jun -7 Jul	198						unk								Tener 1963
1973	4-Apr	0						N								Miller et al. 1977
1974	1-Apr	0						N								Miller et al. 1977
1985	10-25 Jul	38		0-136	27		0-95	21								Miller 1987a
1988	14-Jul	31		2.4-60	26		0.4-51	11								Miller 1989
1989	22-Jul	31	9.4		26	7.5		31				-0.066	0.936			Miller 1991
1990	8-Jul							14	113						107min. Search effort	Miller 1992
1991	4-Jul							15	82						106min. Search effort	Miller 1993
1992	6-Jul							26	92						98min. Search effort	Miller 1994
1993	16-Aug							22	63						65min. Search effort	Miller 1995
1995	24-Jun							11	84					0	87min. Search effort	Miller 1997
1996	13-Jul							0	4					2		Miller 1998
1997	21-Jul				0			0				-0.407	0.665	(5+/-5)		Gunn and Dragon 2002
Ile Marc																
1961															Not mentioned in report	Tener 1963
1973	4-Apr	9						N								Miller et al. 1977
1974	1-Apr	0						N								Miller et al. 1977
1985	10-25 Jul	NA						25	4							Miller 1987a
1988	14-Jul	4		0-10	4		0-10	0								Miller 1989
1989	22-Jul	8	5.5		8	5.5		0								Miller 1991
1990	15-Jun							0	15						16min. Search effort	Miller 1992
1991	7-Jul							20	5						16min. Search effort	Miller 1993
1992	6-Jul							11	5						8min. Search effort	Miller 1994
1993	16-Aug							17	23						22min. Search effort	Miller 1995
1995	24-Jun							14	7					0	28min. Search effort	Miller 1997
1996	26-Jul							0	0					2		Miller 1998
1997	21-Jul				0			0						(25+/-29)		Gunn and Dragon 2002

Table B. Con't.: Historical Peary caribou surveys and abundance estimates.

		Estimate incl. calves			Estimate 1+ year					Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Minimum total counts; unsystematic surveys	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Bathurst Island Group																
Helena																
1961															included in Bathurst	Tener 1963
1973	03-Apr	0			0			N								Miller et al. 1977
1974	31-Mar	4			4			N								Miller et al. 1977
1985	10-25 Jul	0						0								Miller 1987a
1988	20-Jul	17		0-42	12		0-28	25								Miller 1989
1990	24-Jun							9	23							Miller 1992
1991	07-Jun							27	22						50min. Search effort	Miller 1993
1992	27 Jun-5 Jul							28	46						66min. Search effort	Miller 1994
1995	18-Jun							2	49					0	72min. Search effort	Miller 1997
1997	22-Jul				0			0						0		Gunn and Dragon 2002
Bathurst Island Complex (Bathurst, Vanier, Cameron Alexander, Massey, and Marc)																
1961	19 Jun-7 Jul	3565						20								Tener 1963
1973	29 Mar-4 Apr	608						N		-0.147	0.863					Miller et al. 1977
1974	25 Mar-4 Apr	261						N		-0.846	0.429					Miller et al. 1977
1974	18-25 Aug	228						unk				-0.212	0.809			Miller et al. 1977
1975	Jun				228											Fischer and Duncan 1976 in Ferguson 1991
1985	10-25 Jul	724		460-987	526		337-716	24		0.084	1.087					Miller 1987a
1988	11-21 Jul	1103	146		820	105		27		0.148	1.160	0.098	1.103		Includes Cornwallis Island	Miller 1989
1990	6-10 July							19	871							Miller 1992
1991	27 Jun-5 Jul							22	949	0.086	1.090				1478min. Search effort	Miller 1993
1992	5-8 Jul							29	1690	0.577	1.781				1368min. Search effort	Miller 1994
1993	16-24 Aug							28	2387	0.345	1.412	0.336	1.399		Not including Cameron, Vanier, 1943min. Search effort	Miller 1995
1994		3100													Unsystematic estimate, increased by 100 to allow for possible numbers on Cornwallis Is.	Miller 1998 (Table 24)
1995	17 Jun-11 Jul							12	1307	-0.301	0.740			55	1433min. Search effort	Miller 1997a
1996	13-26 Jul				452			N						(1143+/-164)		Miller 1998
1997	21-24 Jul				78			0		-1.757	0.173			(408+/-53)		Gunn and Dragon 2002
2001	15-31 May				145		77-260					0.155	1.168			Jenkins et al. 2011
2001	15-31 May				187		104-330					estimate	1.24		Extrapolated to unsurveyed	Jenkins et al. 2011

Table B. Con't.: Historical Peary caribou surveys and abundance estimates.

		Estimate incl. calves			Estimate 1+ year					Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Minimum total counts; unsystematic surveys	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Bathurst Island Group																
Cornwallis																
1961	14-16 Jun	43						unk								Tener 1963
1988	11, 12 Jul	51		0-107	40		0-88	23		0.006	1.006					Miller 1989
2002	10-11 May	1						0		-0.281	0.755					Jenkins et al. 2011
Little Cornwallis																
1961	16-Jun	0						0								Tener 1963
1973	1-Apr	8						N								Miller et al. 1977
1974	23-Mar	0						N								Miller et al. 1977
1974	25-Aug	12						0								Miller et al. 1977
1988	12-Jul	0						0								Miller 1989
2002	10-11 May	0						0								Jenkins et al. 2011
Devon Island Group																
Devon Island																
1961	10-17 Jun	150						0							Extrapolation	Tener 1963
1990	3-7 Aug	0													Coastal lowlands	Case 1992
2002	8-30 May								35						West Devon	Jenkins et al. 2011
2008	22 Apr-10 May								17						All of Devon	Jenkins et al. 2011
Prince of Wales - Somerset Island Group																
Prince of Wales																
1974	18-Jun	1040														Fischer and Duncan 1976
1974	29-30 Jul	5437														Fischer and Duncan 1976
1975	13-16 Apr	2360														C. Elliott (CWS) in Gunn and Decker 1984
1975	4-14 Apr	581														Fischer and Duncan 1976
1975	Jun	3768										-0.367	0.693			Fischer and Duncan 1976
1980	12-22 Jul				3952	474		16		0.010	1.010					Gunn and Decker 1984
1995	21 Jul-3 Aug				NA				5							Gunn and Dragon 1998
1996	28 Apr-3 May				NA				0			-0.518	0.596			Miller 1997b
2004	10-18 Apr				0				0						Systematic	Jenkins et al. 2011
Somerset																
1974	3-9 Jun	245														Fischer and Duncan 1976 in Gunn and Decker 1984
1975	18-30 Mar	645														Fischer and Duncan 1976 in Gunn and Decker 1984
1975	23-24 Jun	903										1.304	3.686			Fischer and Duncan 1976 in Gunn and Decker 1984
1980	12-22 Jul				561	146		14		-0.095	0.909					Gunn and Decker 1984
1995	21 Jul-3 Aug				NA				2							Gunn and Dragon 1998
1996	28 Apr-3 May				NA				2			-0.352	0.703			Miller 1997b
2004	20-25 Apr								0						Systematic	Jenkins et al. 2011

Table B. Con't.: Historical Peary caribou surveys and abundance estimates.

		Estimate incl. calves			Estimate 1+ year					Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Minimum total counts; unsystematic surveys	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Prince of Wales - Somerset Island Group																
Russell																
1975	4-14 Apr				0											Fischer and Duncan 1976 in Gunn and Decker 1984
1975	Jun				159											Fischer and Duncan 1976 in Gunn and Decker 1984
1975	Jul				89											Fischer and Duncan 1976 in Gunn and Decker 1984
1980	12-22 Jul				584	90		11		0.376	1.457					Gunn and Decker 1984
1995	21 Jul-3 Aug				0					-0.425	0.654					Gunn and Dragon 1998
1996	28 Apr-3 May				NA				0							Miller 1997b
2004	10-18 Apr				0				0						Systematic	Jenkins et al. 2011
Boothia																
Boothia (some surveys refer to combined estimates for Peary caribou and barrenground caribou)																
1974	18 May-20 Jun	626													Estimate from 3 strata combined, surveyed over time period	Fischer and Duncan 1976
1974	1-3 Aug	561														Fischer and Duncan 1976
1975	18-25 Mar	1109														Fischer and Duncan 1976
1975	5-12 Jun	1739														Fischer and Duncan 1976
1985					4831	543										Gunn and Ashevak 1990 in Gunn and Dragon 1998
1995	21 Jul-3 Aug				6658	1728										Gunn and Dragon 1998
1996									0						Unsystematic (northwest)	Miller 1997
Ellesmere Island Group																
Ellesmere																
Entire Ellesmere Is.																
1961	30 Jul-11 Aug	200						11							Extrapolation	Tener 1963
Southern Ellesmere																
1973									150						Southeast unsystematic	Riewe 1973
1989	17-23 Jul	89	31					22				-0.029	0.971		Southern Ellesmere	Case and Ellsworth 1991
2005	4-30 May				219		109-442			0.064	1.066				Includes Graham Island	Jenkins et al. 2011
Northern Ellesmere																
2006	6 Apr-22 May				802		531-1207									Jenkins et al. 2011
Graham																
2005	4-30 May	See Southern Ellesmere Is.														Jenkins et al. 2011
Axel Heiberg Island Group																
Axel Heiberg																
1961	2-3 Aug	300						14							Extrapolation	Tener 1963

Table B. Con't.: Historical Peary caribou surveys and abundance estimates.

		Estimate incl. calves			Estimate 1+ year					Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Minimum total counts; unsystematic surveys	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Ringnes Island Group																
Ellef Ringnes																
1961	14-Aug	114						Y								Tener 1963
2007	6-15 Apr	See below														Jenkins et al. 2011
Amund Ringnes																
1961	15-Aug	452						Y								Tener 1963
2007	15-17 Apr	See below														Jenkins et al. 2011
Cornwall																
1961	15-Aug	266						25								Tener 1963
2007	19 Apr	See below														Jenkins et al. 2011
King Christian																
1961	15-Aug	too few							3							Tener 1963
2007	14 Apr	See below														Jenkins et al. 2011
Meighen																
2007	22 Apr	0							0							Jenkins et al. 2011
Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, and Meighen Islands																
2007	6-22 Apr				282		157-505								None on Meighen	Jenkins et al. 2011
Lougheed																
1961	18-Aug	1324						22								Tener 1963
1973	03-Apr	56								-0.264	0.768					Miller et al. 1977
1974	04-Apr	0							1	-4.025	0.018					Miller et al. 1977
1985	10-25 Jul	0							2						1 cow-calf pair	Miller 1987a
1997	21-Jul				101	73				0.385	1.469			(28+/-29)		Gunn and Dragon 2002
2007	13 Apr				372		205-672			0.130	1.139					Jenkins et al. 2011
Prime Minister Island Group (Northwest Territories)																
Mackenzie King																
1961	17-Aug	2192			(1710)			22								Tener 1963
1973	15-Apr	NA						N	3							Miller et al. 1977
1974	11-Apr	60						N				-0.277	0.758			Miller et al. 1977
1997	18-Jul				36	22		25						(24+/-14)	1 cow-calf pair	Gunn and Dragon 2002
Brock																
1961	17-Aug	190						unk							Partial survey fog -	Tener 1963
1973	15-Apr	24						N		-0.172	0.842					Miller et al. 1977
1997	18-Jul	0						0						0		Gunn and Dragon 2002
Borden																
1961	17-Aug	1630			(1271)			22								Tener 1963
1973	14-15 Apr	16						N		-0.385	0.680					Miller et al. 1977

Table 2. Con't.: Historical Peary caribou surveys and abundance estimates.

		Estimate incl. calves			Estimate 1+ year					Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Minimum total counts; unsystematic surveys	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Melville Island Group (Northwest Territories)																
Melville																
1961	8-22 Jul	12799						19								Tener 1963
1972	20 Mar-6 Apr	705	159					N								Miller et al. 1977
1972	13-24 Aug	2551	724					0		-0.147	0.864				Only strata I-VI	Miller et al. 1977
1973	19 Mar-7 Apr	1648	181					N								Miller et al. 1977
1973	5 Jul-2 Aug	3425	618					12		0.295	1.343					Miller et al. 1977
1974	4-21 Aug	1679	NA					1		-0.713	0.490				Extrapolated for 3 missed strata	Miller et al. 1977
1987	1-22 Jul	943	126		729	104		19		-0.044	0.957					Miller 1988
1997	2-20 Jul	787	97					0		-0.018	0.982	-0.077	0.925	(150+/-48)		Gunn and Dragon 2002
Byam Martin																
1972	22-23 Mar	4	3					N								Miller et al. 1977
1972	7-Aug	86	65					0								Miller et al. 1977
1973	27-Mar	34	13					N								Miller et al. 1977
1973	15-Jul	43	36					11								Miller et al. 1977
1974	1-Apr	6	2					N								Miller et al. 1977
1974	20-Aug	6	4					0				-1.331	0.264			Miller et al. 1977
1987	8-Jul	98	37		70	26		19		0.215	1.240					Miller 1988
1997	20-Jul	0						0		-0.425	0.654			(26+/-11)		Gunn and Dragon 2002
Prince Patrick																
1961	23-24 Jul	2254						20								Tener 1963
1973	8-15 Apr	1381	269					N								Miller et al. 1977
1973	28 Jul-21 Aug	807	259					11		-0.086	0.918					Miller et al. 1977
1974	10-16 Apr	1049	212					N								Miller et al. 1977
1974	18-25 Jul	621	177					7		-0.262	0.770					Miller et al. 1977
1986	4-13 Jul	151		12-182	106		11-114	30		-0.118	0.889					Miller 1987b
1997	29 Jun-1 Jul	84	34					0		-0.053	0.948	-0.091	0.913	(178+/-37)		Gunn and Dragon 2002
Eglinton																
1961	24-Jul	204						*31*							4 calves observed	Tener 1963
1972	4-Apr	574	122					N								Miller et al. 1977
1972	10-Aug	83	59					0		-0.082	0.921					Miller et al. 1977
1973	8-Apr	90	15					N								Miller et al. 1977
1973	8-Aug	12	9					0		-1.934	0.145					Miller et al. 1977
1974	Apr	301	60					N								Miller et al. 1977
1974	25-Jul	18	10					4		0.405	1.500				1 calf observed	Miller et al. 1977
1986	4-Jul	79		0-229	65		0-183	18		0.123	1.131					Miller 1987b
1997	2-Jul	0						0		-0.397	0.672	-0.148	0.863	0		Gunn and Dragon 2002
Emerald																
1961	24-Jul	161						3								Tener 1963
1973	15-Apr	0						N								Miller et al. 1977
1973	30-Jul	39						N		-0.118	0.889					Miller et al. 1977
1974	17-Apr	12						N								Miller et al. 1977
1986	4-Jul	14		0-49	11		0-37	25		-0.079	0.924					Miller 1987b
1997	19-Jul	0						0		-0.240	0.787	-0.141	0.868	(17+/-16)		Gunn and Dragon 2002

Table 2. Con't.: Historical Peary caribou surveys and abundance estimates.

		Estimate incl. calves			Estimate 1+ year					Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Minimum total counts; unsystematic surveys	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Banks Island (Northwest Territories)																
Banks																
1970	23-28 Jun	5300													Northern Banks	Kevan 1974
1972	Sep	12098						17		0.413	1.511					Urquhart 1973
1979-80					8000-9000					-0.032	0.968					Vincent and Gunn 1981
1982	4-10 Jul				7233	998									Calves not recorded	Latour 1985
1982	4-10 Jul				9036		6110-11370			0.031	1.031				Retrospective	Nagy et al. 2009a
1985	6-14 Jul				5000	910		15		-0.197	0.821				Calves likely minimum est.	McLean et al. 1986
1987	27-30 Jun				4500	660		23		-0.053	0.949					McLean 1992
1989	22-28 Jun				2600	340		26		-0.274	0.760			(300)	29 carcasses observed	McLean and Fraser 1992
1990	14-19 Sep				526	302		11		-	-					McLean et al. 1992
1991	27 Jun-3 Jul				888	151		5		-0.537	0.584			(60)	6 carcasses observed	Fraser at al. 1992
1992	21-30 Aug				1018	133	748-1288	29		0.137	1.146	-0.218	0.804	2		Nagy et al. 2009b
1994	Jul				742	132		8		-0.158	0.854			7		Nagy et al. 2006a
1998	Jul				451	60		19		-0.124	0.883			0		Nagy et al. 2006b
2001	7-15 Jul				1142	155	818-1466	26		0.304	1.355			0		Nagy et al. 2006
2005	24 Jul-1 Aug				929	143	640-1218	19		-0.052	0.950			0		Nagy et al. 2009c
2010	17-26 Jul				1097		754-1440	25		0.033	1.034					Davison et al. in prep.
Victoria Island (Northwest Territories)																
NW Victoria																
1980	5-20 Aug	4512	988												St A NW Victoria	Jakimchuk and Carruthers 1980
1987	Jun	3500			2600		Extrapolation	27							Extrapolation	Gunn 2005
1987	Jun				(643)	(172)	On CG only									Gunn and Fournier 2000
1992	24-26 Mar				170	54	116-224				0.766					Heard 1992
1993	18-20 Mar				144	22										Gunn 2005
1993	13-15 Jun				20	-		5		-2.140	0.118				Total observed; 1 calf	Gunn 2005
1994	5-17 June				39	28				0.668	1.950	-0.400	0.670		St IV of western Victoria	Nishi and Buckland 2000
1998	early Jul				95	29	35-155	12		0.223	1.249			0		Nagy et al. 2009d
2001	16-21 Jul				204	50	101-307	24		0.255	1.290			0		Nagy et al. 2009e
2005	6-8 Jul				66	30	5-127	28		-0.282	0.754			0		Nagy et al. 2009f
2010	28 Jul-15 Aug				150		46-254	12		0.093	1.097					Davison et al. in prep.

APPENDIX 1: Table C: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Bathurst Island Group																	
Bathurst Island																	
1961	18Jun-7 Jul	1136						9									Tener 1963
1973	29 Mar-3 Apr	672	194					N			-0.046	0.955					Miller et al. 1977
1974	25-26 Aug	164	70					0									Miller et al. 1977
1981	10-13 Aug	208						16			0.034	1.035	-0.086	0.918			Ferguson 1991
1985	10-25 Jul	521		230-812	418		191-645	17			0.230	1.258					Miller 1987a
1988	18-21 Jul	503	108		423	83		12			-0.012	0.988					Miller 1989
1993	17-20 Aug							18	(888)							Min. count	Miller 1995 App. 7
1995	17 Jun-12 Jul							4	(760)	14					45	Min. count	Miller 1997 App 3
1996	13-20 Jul	425			425	136		0							(625+/-215)		Miller 1998
1997	21-24 Jul	124			124	45		0	(36)	-96	-1.232	0.292			21		Gunn and Dragon 2002
2001	15-31 May							20	(82)							Calves based on 8 ca 32 ad	Jenkins et al. 2011
Ile Vanier																	
1961	18Jun-7 Jul	0															Tener 1963
1973	4-Apr	NA						N	6								Miller et al. 1977
1974	1-Apr	NA						N	5								Miller et al. 1977
1985	10-25 Jul	0							1								Miller 1987a
1988	13-Jul	6		0-12	6		0-12	0									Miller 1989
1995	17 Jun-12 Jul	NA						0	11						0		Miller 1997
1996	26-Jul	0													0		Miller 1998
1997	21-Jul	0													0		Gunn and Dragon 2002
2001	15-31 May	NA							0								Jenkins et al. 2011
Cameron																	
1961	18Jun-7 Jul	25						0								included Alexander	Tener 1963
1973	3 Apr	0						N	(5)								Miller et al. 1977
1974	4 Apr	0						N	(2)						3		Miller et al. 1977
1985	10-25 Jul	0							2								Miller 1987a
1988	13-Jul	7		0-15	7		0-15	0									Miller 1989
1995	17 Jun-12 Jul	NA						0	14						1		Miller 1997
1996	26-Jul	0													(17+/-13)		Miller 1998
1997	21-22 Jul	0													0		Gunn and Dragon 2002
2001	15-31 May	0							0								Jenkins et al. 2011

Table C. Con't.: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Bathurst Island Group																	
Massey																	
1961	18Jun-7 Jul	0															Tener 1963
1973	4 Apr	0							0								Miller et al. 1977
1974	1 Apr	0							0								Miller et al. 1977
1985	10-25 Jul	0															Miller 1987a
1988	14-Jul	0															Miller 1989
1995	17 Jun-12 Jul	NA						10	10						0		Miller 1997
1996	26-Jul	0													0		Miller 1998
1997	21-Jul	0													0		Gunn and Dragon 2002
2001	15-31 May	0							0								Jenkins et al. 2011
Alexander																	
1961	18Jun-7 Jul	0						0								Included with Cameron	Tener 1963
1973	4 Apr	0						N	9								Miller et al. 1977
1974	1 Apr	0						N	2								Miller et al. 1977
1985	10-25 Jul	27		0-86	27		0-86	21									Miller 1987a
1988	14-Jul	6		0-14	6		0-14	0									Miller 1989
1995	17 Jun-12 Jul	NA						0	46						4		Miller 1997
1996	26-Jul	0							6						0		Miller 1998
1997	21-Jul	0													0		Gunn and Dragon 2002
2001	15-31 May	0							0								Jenkins et al. 2011
Ile Marc																	
1961	18 Jun-7 Jul	NA														Not mentioned in report	Tener 1963
1973	4 Apr	0							0								Miller et al. 1977
1974	1 Apr	0							0								Miller et al. 1977
1985	10-25 Jul	0															Miller 1987a
1988	14 Jul	0															Miller 1989
1995	17 Jun-12 Jul	0													0		Miller 1997
1997	21 Jul	0													0		Gunn and Dragon 2002
2001	15-31 May	0							0								Jenkins et al. 2011
Helena																	
1961	18Jun-7 Jul	NA															
1973	3-Apr	0															Miller et al. 1977
1974	31-Mar	0															Miller et al. 1977
1985	10-25 Jul	0															Miller 1987a
1988	20-Jul	0															Miller 1989
1995	17 Jun-12 Jul	0													0		Miller 1997
1997	22-Jul	0													0		Gunn and Dragon 2002
2001	15-31 May	0							0								Jenkins et al. 2011

Table C. Con't.: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Bathurst Island Group																	
Bathurst Island Complex																	
1961	18Jun-7 Jul	1161						9								Includes GG Islands	Tener 1963
1973	29 Mar-3 Apr	672	194					N			-0.046	0.955					Miller et al. 1977 in Miller 1998
1974	25-26 Aug	164	70					0								includes 20 secondary satellite islands; excludes Cornwallis Island	Miller et al. 1977 in Miller 1998
1981	10-13 Aug																
1985	10-25 Jul	545		259-830				17								estimate for nine-island survey area	Miller 1987a in Miller 1998
1988	18-21 Jul	592	108		423	83		12			-0.012	0.988					Miller 1989 in Miller 1998
1993	17-20 Aug	1200						18									Miller 1995 in Miller 1998
1995	17 Jun-12 Jul	980														With or Without calves??	Miller 1998
1996	13-20 Jul				500										(625+/-215)	guestimate	Miller 1998
1997	21-24 Jul				124	45		0									Gunn and Dragon 2002
2001	15-31 May							20	(82)								Jenkins et al. 2011
Cornwallis																	
1961	14-16 Jun	50						0								Extrapolation	Tener 1963
1988	11, 12 Jul	70	34					19			0.012	1.013					Miller 1989
2002	10-11 May							0	(18)								Jenkins et al. 2011
Little Cornwallis																	
1961	16-Jun	0															Tener 1963
1973	01-Apr	40						N			0.307	1.360					Miller et al. 1977
1974	23-Mar	20						N									Miller et al. 1977
1974	25-Aug	12						0									Miller et al. 1977
1988	12-Jul	0											-0.246	0.782			Miller 1989
2002	10-11 May	0						0	0								Jenkins et al. 2011
Devon Island Group																	
Devon Island																	
1961	10, 12, 17 Jun								(200)							Extrapolation	Tener 1963
1967									(450)							North Devon Is.	Freeman 1971
1980									(400)				0.036	1.037		unsystematic	Decker unpubl in Urquhart 1982
1990	3-7 Aug	400						13								Coastal lowlands	Case 1992
2008	22 Apr-10 May				513		302-864	14								Systematic	Jenkins et al. 2011

Table C. Con't.: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Prince of Wales - Somerset Island Group																	
Prince of Wales																	
1974	18-Jun				564												Fischer and Duncan 1976 in Gunn and Decker 1984
1974	29-30 Jul				872			7-14									Fischer and Duncan 1976 in Gunn and Decker 1984
1975	4-14 Apr				2381												Fischer and Duncan 1976 in Gunn and Decker 1984
1975	13-16 Apr				907			15									C. Elliott in Gunn and Decker 1984
1975	Jun				313			11-15			-0.589	0.555					Fischer and Duncan 1976 in Gunn and Decker 1984
1980	12-22 Jul				1126	276		10-12			0.256	1.292					Gunn and Decker 1984
1995	21 Jul-3 Aug	5157	414					N								Includes 68 on Pandora	Gunn and Dragon 1998
2004	10-18 Apr				2086		1582-2746						0.026	1.026		Includes Russell and Pandora	Jenkins et al. 2011
Somerset																	
1974	3-9 Jun				0												Fischer and Duncan 1976 in Gunn and Decker 1984
1975	18-30 Mar				0												Fischer and Duncan 1976 in Gunn and Decker 1984
1975	23-24 Jun				0												Fischer and Duncan 1976 in Gunn and Decker 1984
1980	12-22 Jul				NA			0								29 MX seen; no estimate	Gunn and Decker 1984
1995	21 Jul-3 Aug				1140	260							0.352	1.422			Gunn and Dragon 1998
2004	20-25 Apr				1910		962-3792				0.057	1.059					Jenkins et al. 2011
Russell																	
1975	4-14 Apr				0												Fischer and Duncan 1976 in Gunn and Decker 1984
1975	13-16 Apr																C. Elliott in Gunn and Decker 1984
1975	Jun				0												Fischer and Duncan 1976 in Gunn and Decker 1984
1975	Jul				0												In Gunn and Decker 1980
1980	12-22 Jul				0			0									Gunn and Decker 1984
1995	21 Jul-3 Aug				102	54					0.308	1.361					Gunn and Dragon 1998

Table C. Con't.: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Boothia																	
Boothia																	
1974	18 May-20 Jun				0												Fischer and Duncan 1976
1974	1-3 Aug				0												Fischer and Duncan 1976
1975	18-25 Mar				0												Fischer and Duncan 1976
1975	5-12 Jun				0												Fischer and Duncan 1976
1985	31 May-3 Jun				0												Gunn and Ashevak 1990
Ellesmere Island Group																	
Ellesmere																	
Whole island																	
1961	30 Jul-7 Aug							12	(4000)							Extrapolation	Tener 1963
S. Ellesmere																	
1967									(470)		-0.357	0.700					Freeman 1971
1973	Jul	1060														southeast unsystematic	Riewe 1973
1989	17-23 Jul	2020	285					17			0.040	1.041				Southern Ellesmere	Case and Ellsworth 1991
2005	4-30 May				456		312-670								20	Syst. incl Graham	Jenkins et al. 2011
N. Ellesmere																	
2006	6 Apr-22 May				8115		6632-9930	18								Systematic	Jenkins et al. 2011
Graham																	
1967									(50)								Freeman 1971
Axel Heiberg Island Group																	
Axel Heiberg																	
1961	2-3 Aug							7	(1000)							Extrapolation	Tener 1963
2007	19 Apr-3 May				4237		3371-5323										Jenkins et al. 2011
Ringnes Island Group																	
Ellef Ringnes																	
1961	14-Aug	0															Tener 1963
Amund Ringnes																	
1961	15-Aug	4						0									Tener 1963
Cornwall																	
1961	15-Aug	0															Tener 1963
Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, and Meighen Islands																	
2007	6-22 Apr								(21)								Jenkins et al. 2011

Table C. Con't.: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Ringnes Island Group																	
Lougheed																	
1961	18-Aug	0															Tener 1963
1973	3 Apr	0															Miller et al. 1977
1974	4 Apr	0															Miller et al. 1977
1985	10-25 Jul	0															Miller 1987a
1997	21 Jul	0															Gunn and Dragon 2002
2007	13 Apr	0															Jenkins et al. 2011
Prime Minister Island Group (Northwest Territories)																	
Mackenzie King																	
1961	18Jun-7 Jul	0															Tener 1963
1973	15-Apr	0															Miller et al. 1977
1974	11-Apr	0							6								Miller et al. 1977
1997	18-Jul	0															Gunn and Dragon 2002
Brock																	
1961	18Jun-7 Jul	0														partial survey fog -	Tener 1963
1973	15-Apr	0															Miller et al. 1977
1997	18-Jul	0															Gunn and Dragon 2002
Borden																	
1961	18Jun-7 Jul	0															Tener 1963
1973	14-15 Apr	0															Miller et al. 1977
Melville Island Group (Northwest Territories)																	
Melville																	
1961	8-22 Jul	1000						17								Extrapolation	Tener 1963
1972	20 Mar-6 Apr	3394	478					N			0.111	1.117					Miller et al. 1977
1972	13-24 Aug	NA						10								986+/-264 only strata I-VI	Miller et al. 1977
1973	19 Mar-7 Apr	3025	455					N			-0.115	0.891					Miller et al. 1977
1973	5 Jul-2 Aug	3171	627					19									Miller et al. 1977
1974	4-21 Aug	2390	412					10			-0.283	0.754				extrapolated for 3 missed strata	Miller et al. 1977
1987	1-22 Jul	5652	464		4761	373		15			0.066	1.068	0.067	1.069			Miller 1988
1997	2-20 Jul				2258	268		0			-0.075	0.928			32		Gunn and Dragon 2002

Table C. Con't.: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Melville Island Group (Northwest Territories)																	
Byam Martin																	
1972	22-23 Mar	151	132					N									Miller et al. 1977
1972	7-Aug	61	61					2									Miller et al. 1977
1973	27-Mar	8	6					N									Miller et al. 1977
1973	15-Jul	117	84					24			0.651	1.918					Miller et al. 1977
1974	1-Apr	28	8					N							8		Miller et al. 1977
1974	20-Aug	NA						0	8								Miller et al. 1977
1987	8-Jul	100	61		96	59		3					-0.027	0.973			Miller 1988
1997	20-Jul				0			0			-0.461	0.631			1		Gunn and Dragon 2002
Prince Patrick																	
1961	23-24 Jul	0						0									Tener 1963
1973	8-15 Apr	86	43					N									Miller et al. 1977
1973	28 Jul-21 Aug	152	101					16			0.419	1.520					Miller et al. 1977
1974	10-16 Apr	91	57					N									Miller et al. 1977
1974	18-25 Jul	114	63					6			-0.288	0.750					Miller et al. 1977
1986	4-13 Jul	62		7-154	62		7-154	0			-0.051	0.951	0.165	1.179	6		Miller 1987b
1997	29 Jun-1 Jul				96	42		0			0.040	1.041			3		Gunn and Dragon 2002
Eglinton																	
1961	24-Jul	0						*0*									Tener 1963
1972	4-Apr	12	10					N									Miller et al. 1977
1972	10-Aug	4	4					7			0.126	1.134					Miller et al. 1977
1973	8-Apr	22	14					N									Miller et al. 1977
1973	8-Aug	26	18					14			1.872	6.500					Miller et al. 1977
1974	Apr	44	18					N									Miller et al. 1977
1974	25-Jul	16	11					19			-0.486	0.615					Miller et al. 1977
1986	4-Jul	101		7-195	94		6-181	7			0.154	1.166	0.185	1.203			Miller 1987b
1997	2-Jul				37	21		0			-0.085	0.919					Gunn and Dragon 2002
Emerald																	
1961	24-Jul	0						0									Tener 1963
1973	15-Apr	0						0									Miller et al. 1977
1973	30-Jul	0						0									Miller et al. 1977
1974	17-Apr	0						0									Miller et al. 1977
1986	4-Jul	0						0									Miller 1987b
1997	19-Jul	0						0									Gunn and Dragon 2002

Table C. Con't.: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Banks Island (Northwest Territories)																	
Banks																	
1970	23-28 Jun				1567											Northern Banks	Kevan 1974
1972					3800						0.443	1.557					Urquhart 1973
1980	Mar 1979-80	18328	4132		N											Over 2 years	Vincent and Gunn 1981
1982	4-10 Jul				9393	1054									30		Latour 1985
1982	4-10 Jul				12481		9433-14913				0.119	1.126				Retrospective	Nagy et al. 2009a
1985	6-14 Jul				25700	2050		12			0.241	1.272			20		McLean et al. 1986
1989	22-28 Jun				34270	2360		13			0.072	1.075			120 (685)		McLean and Fraser 1992
1991	27 Jun-3 Jul				47670	3971		15			0.165	1.179			(80)		Fraser at al. 1992
1992	21-30 Aug				53526	1968	49494-57558	17			0.116	1.123			35		Nagy et al. 2009b
1994					64680	2009					0.095	1.099					Fig. 6 in Nagy et al. 2006
1998					~46000						-0.085	0.918					Fig. 6 in Nagy et al. 2006
2001	7-15 Jul				68585	3452	65133-72037	15			0.133	1.142	0.122	1.130	31		Nagy et al. 2006
2005	24 Jul-1 Aug				47209	1978	43212-51206	10			-0.093	0.911			Not counted	2004 icing event	Nagy et al. 2009c
2010	17-26 Jul				36676		32645-40707	10			-0.050	0.951	-0.07	0.933			Davison et al. in prep
Victoria Island (Northwest Territories)																	
NW Victoria (survey areas didn't always match)																	
1980					9540			27									Jakimchuk and Carruthers 1980
1983	8-17 Aug				6430	498		16			-0.132	0.877					Jingfors 1985
1989	19-31 Aug				12850	1260		10			0.115	1.122					Gunn unpubl in Fournier and Gunn 1998
1992	24-26 Mar	8900	820		N											Minto Inlet area north	Heard 1992
1994	5-16 Jun				19989	3786		--			0.088	1.092	0.053	1.054		From Fournier and Gunn 1998	Nishi in Fournier and Gunn 1998
1998	early Jul				18795	1393	402-20188	18			-0.015	0.985			4		Nagy et al. 2009d
2001	16-21 Jul				19282	1607	061-22503	11			0.009	1.009			0		Nagy et al. 2009e
2005	6-8 Jul				12062	1051	906-14218	15			-0.117	0.889			0		Nagy et al. 2009f
2010	28 Jun-15 Aug				11442		9805-13079	1			-0.011	0.990	-0.035	0.966		31 calves/2273 adults	Davison et al. in prep

Table C. Con't.: Historical Muskox survey and abundance estimates.

		Estimate incl. calves			Estimate 1+ year						Consecutive surveys		Range of surveys				
Survey Year	Season	Estimate incl. calves	SE	95% CI	Estimate 1+ year	SE	95% CI	% Calves or Not Observed	Off transect sightings or (minimal count)	% Change	Exponential rate of change	Lambda	Exponential rate of change	Lambda	Carcass counts (estimates)	Survey Comments	Reference
Victoria Island (Northwest Territories)																	
SW Victoria (survey areas didn't always match)																	
1980					896	387										From Fournier and Gunn 1998	Jakimchuk and Carruthers 1980
1983					135	51					-0.631	0.532				From Fournier and Gunn 1998	Poole 1985
1988	Mar	1072	129													From Fournier and Gunn 1998	Gunn in prep
1993	Mar	2008	356								0.126	1.134				From Fournier and Gunn 1998	Gunn in prep
1994	10-17 Jun				3934	1225							0.106	1.111		From Fournier and Gunn 1998	Nishi in prep
SE Victoria																	
1980					1760			27								From Fournier and Gunn 1998	Jakimchuk and Carruthers 1980
1983	13-19 Mar	3300	345					16									Jingfors 1984
1988	21 Mar-3 Apr	13031	1121					N			0.275	1.316				Repeated Jingfors survey area	Gunn and Patterson in prep
1993	6-10 Mar	12563	1254					N			-0.007	0.993				Repeated Jingfors survey area	Gunn and Patterson in prep
1999	12-20 Mar	18290	1100					N			0.063	1.065	0.107	1.113		Repeated Jingfors survey area	Gunn and Patterson in prep
NE Victoria																	
1990	10-17 Aug				5451	521		11									Gunn and Lee 2000

APPENDIX 2:

Participants in the Peary Caribou & Muskoxen Ground Surveys, 2001-2006

Bathurst Island 2001

Resolute Bay HTA
Norman Idlout
Samson Simeonie
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Steven Nungaq
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Cornwallis Island 2002

Resolute Bay HTA
Norman Idlout
Hans Aronsen
Ross Pudluk
Saroomie Manik
Enookie Idlout
Joadamee Iqaluk

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West Devon Island 2002

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Norman Idlout
Samson Simeonie
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Steven Akeeagok (Iviq HTO, Grise Fiord)
Joadamee Iqaluk
Enookie Idlout
Ross Pudluk
Katsak Manik (Replaced Enookie Idlout)
Terrance Nungaq (Replaced Hans Aronsen)

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Prince of Wales Island 2004

Resolute Bay HTA
Norman Idlout
Sam Idlout
Clyde Kalluk
Steven Nungaq
Jeff Amarualik
Peter Jr Amarualik
Stevie Amarualik
Joadamee Iqaluk

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Participants in the Peary Caribou & Muskoxen Ground Surveys, 2001-2006 Cont'd

Somerset Island 2005

Resolute Bay HTA	Department of Environment
Norman Idlout	Tabitha Mullin
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Peter Jr. Amarualik	

Southern Ellesmere Island 2005

Iviq HTO, Grise Fiord	Department of Environment
Aron Qaunaq	Jeffrey Qaunaq
David Watsko	
Steven Akeeagok	
Pauloosie Killiktee	
Randy Pijamini	
Mosha Kiguktak	

Southern Ellesmere Island 2006

Iviq HTO, Grise Fiord	Department of Environment
Pauloosie Killiktee	Seeglook Akeeagok
Benjamin Akeeagok	
Randy Pijamini	
Jimmy Nungaq	
Patrick Audlaluk	

Participants in the Peary Caribou & Muskoxen Aerial Surveys, 2001-2008

Bathurst Island 2001

Resolute Bay HTA	Department of Sustainable Development
Matthew Manik	Mike Ferguson
Babah Kalluk	Grigor Hope
Samson Idlout	

Cornwallis Island 2002

Resolute Bay HTA	Department of Sustainable Development
Joadamee Amagoalik	Mike Ferguson
	Grigor Hope

West Devon Island 2002

Resolute Bay HTA	Department of Sustainable Development
Joadamee Amagoalik	Mike Ferguson
	Grigor Hope

Prince of Wales Island & Somerset Island 2004

Resolute Bay HTA	Department of Sustainable Development
Martha Allakariallak	Mike Ferguson
Mark Amaraulik	Grigor Hope

Southern Ellesmere Island 2005

Iviq HTO, Grise Fiord	Department of Environment	RCMP
Lymieky Pijamini	Mitch Campbell	Louis Jenvenne
Mosha Kiguktak	Grigor Hope	
Jaypeetee Akeeagok	Mike Ferguson	
Tom Kiguktak	Seeglook Akeeagok	
	Jeffrey Qaunaq	

Ellesmere Island 2006

Iviq HTO, Grise Fiord	Department of Environment	Parks Canada
Aron Qaunaq	Mitch Campbell	Gary Mouland
	Grigor Hope	Jason Hudson
		Doug Stern

Ellef & Amund Ringnes, Lougheed, King Christian, Cornwall & Axel Heiberg Islands 2007

Iviq HTO, Grise Fiord	Department of Environment
Tom Kiguktak	Debbie Jenkins
	Grigor Hope
	Mitch Campbell

Devon Island 2008

Resolute Bay HTA	Department of Environment	Iviq HTO, Grise Fiord
Jeffrey Amaraulik	Debbie Jenkins	Tom Kiguktak
Peter Jr. Amaraulik	Grigor Hope	
Tom Kiguktak		