# MOVEMENTS AND HABITAT USE OF MUSKOXEN (*Ovibos moschatus*) ON BATHURST, CORNWALLIS, AND DEVON ISLANDS, 2003-2006


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Version: 23 December 2016


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STATUS REPORT 2016-08
NUNAVUT DEPARTMENT OF ENVIRONMENT
WILDLIFE RESEARCH SECTION
IGLOOLIK, NU

**Summary**

Eleven muskoxen (*Ovibos moschatus*) were fitted with satellite collars in summer 2003 to investigate habitat preferences and movement parameters in areas where they are sympatric with Peary caribou on Bathurst, Cornwallis, and Devon islands. Collars collected locations every 4 days until May 2006, with 4 muskoxen on Bathurst Island collared, 2 muskoxen collared on Cornwallis Island, and 5 muskoxen collared on western Devon Island. Only 5-29% of the satellite locations were associated with an estimated error of less than 150 m (Argos Class 3 locations).

Muskoxen in this study used low-lying valleys and coastal areas with abundant vegetation on all 3 islands, in agreement with previous studies in other areas and Inuit qaujimajatuqangit. They often selected tussock graminoid tundra, moist/dry non-tussock graminoid/dwarf shrub tundra, wet sedge, and sparsely vegetated till/colluvium sites. Minimum convex polygon home ranges representing 100% of the locations with <150 m error include these movements between core areas, and ranged from 233 $km^2$ to 2494 $km^2$ for all collared muskoxen over the 3 years, but these home ranges include large areas of unused habitat separating discrete patches of good habitat where most locations were clustered. Several home ranges overlapped, which is not surprising, since muskoxen are not territorial.

Muskoxen moved among habitat patches within and between seasons. Some appeared to exhibit a repeated cycle of annual movements, but most muskoxen rotated among core areas without an obvious seasonal pattern. Although minimum daily displacement was somewhat higher in summer, there was substantial individual variation, and the time between location fixes meant that movements made at the scale of hours or a day were averaged out; the reported displacements are only a proxy for actual daily displacements. Average daily displacements for collared muskoxen were 1 km, although the maximum estimated daily displacement was 42 km. One muskox crossed sea ice to islands in Bracebridge Inlet, and another on Devon Island likely crossed Eidsbotn Fiord.

[Inuktitut summary]

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**Introduction**

Muskoxen are widespread across the Canadian Arctic, inhabiting the mainland and most Arctic Islands, with the exception of Baffin Island (Lent 1999). They are well-adapted to year-round occupancy in the long cold winters and short cool summers typical of their range, with a short, stout stature and long shaggy pelage. Muskoxen occur in small groups (usually bulls) and in larger mixed groups of cows, calves, and young bulls, typically defended by a dominant bull (Gray 1980, Lent 1999). Their main predators across their range are wolves and humans. Disease outbreaks may play a role in declining muskox populations in the western Arctic, including Banks and Victoria islands (Kutz et al. 2004, Kutz et al. 2015), but the pathogens are not present in High Arctic populations (Government of Nunavut, unpubl. data).

In the High Arctic, catastrophic die-offs occur sporadically due to severe winter weather and freezing rain, which result in ice layers preventing access to forage (Miller 1998). The most recent known die-offs in the south-central Queen Elizabeth Islands (Figure 1) were over 3 winters from 1994-1997, when the muskox population declined from an estimated 1200 animals in 1993 (Miller 1995) to 124 adults in 1997 (Gunn and Dragon 2002). An aerial survey of the Bathurst Island Complex in 2001 reported a minimum count of only 82 muskoxen (Anderson 2013). The most recent aerial survey, in 2013, confirmed the population recovery originally noticed and reported by hunters in Resolute Bay, with a population estimate for Bathurst and Cornwallis islands of 1889 muskoxen.

The die-offs of muskoxen and Peary caribou on Bathurst Island in the 1990s prompted more research into the ecology and interactions of the two species. In an effort to understand Peary caribou and muskox range use and movements in the south-central Queen Elizabeth Islands, the Government of Nunavut undertook a satellite telemetry program, deploying satellite collars on 11 female caribou in May 2003 and 12 female muskox in June-July 2003. A preliminary examination of movement characteristics of the collared caribou is provided in Jenkins and Lecomte (2012). The objective of this report is to provide an overview of range use and movement for the collared muskoxen from satellite telemetry data collected from 2003 to 2006.

The study took place in the south-central Queen Elizabeth Islands in the Arctic Archipelago, on Bathurst, Cornwallis, and Devon islands. Although eastern Devon Island is characterized by rugged topography and the Devon Ice Cap, Grinnell Peninsula and parts of the shoreline on western Devon Island are typified by low rolling terrain. Bathurst Island and the Governor General Group (the satellite islands to the northwest of Bathurst Island), are also typified by rolling topography and maximum elevation that rarely exceeds 300 m AMSL. The area is classified as High Arctic desert and semi-desert (Walker et al. 2005), with sparse vegetation primarily concentrated along river valleys. Cornwallis Island is dominated by a barren plateau in the center of the island, but lowlands in the northeast and northwest are more productive. Caribou and muskoxen are known to move among islands on the sea ice, although they are also capable of swimming in the summer (Resolute Bay HTA and Iviq HTA, pers. comm.).

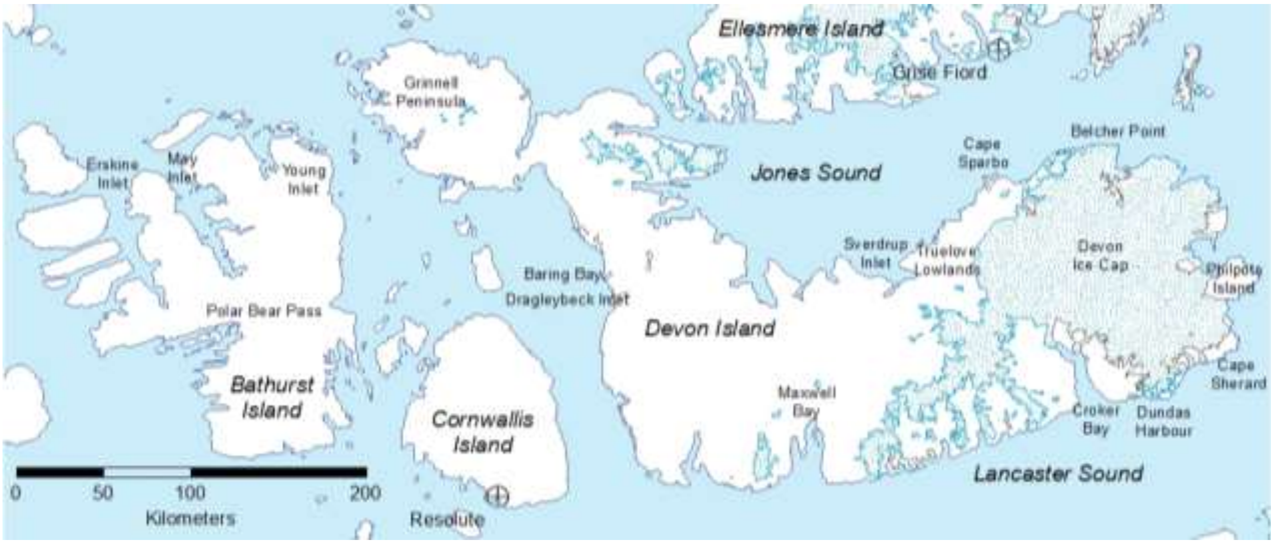

Figure 1. Study area for a muskox telemetry project undertaken by the Government of Nunavut, 2003-2006. Four muskoxen were collared on Bathurst Island, two on Cornwallis Island, and four on Devon Island.

**Methods**

*Study area*

On Devon Island (Figure 1), muskoxen inhabit discrete lowland habitats along the coastline. These include Baring Bay on the west coast, lowlands along the south coast (Maxwell Bay, Croker Bay, Dundas Harbor, Cape Sherard) and the Truelove lowlands on the north coast along Jones Sound (Case 1992). Inuit have reported muskoxen mostly along the Truelove Lowlands on the north coast, Baring Bay and Dragleybeck Inlet on the west coast, eastern Grinnell Peninsula, and Dundas Harbor on the southeast coast (Taylor 2005, Iviq HTA pers. comm.).

Devon Island has been intermittently surveyed since 1961. Tener (1958) estimated 200 muskoxen on the island in 1958, and surveyed the island in 1961 with no muskoxen seen on transect and 23 off-transect. He extrapolated an estimate of 200 muskoxen for the island (Tener 1963). Ground observations in 1966 and 1967 on the north coast of Devon Island and the Grinnell Peninsula estimated 450 muskoxen, including 230-300 along Bear Bay (Freeman 1971). Hubert (1977) observed between 116 and 278 muskoxen in 1970-73 from Sverdrup Inlet to Sverdrup Glacier. In 1980, Decker (in Case 1992) observed 32 muskoxen from Croker Bay to Dundas Harbor, 14 muskoxen around Philpots Island, and 46 muskoxen inland from Baring Bay. Ten years later, Case (1992) observed 72 muskoxen from Croker Bay east to Cape Sherard, 281 in Truelove Lowlands, and 13 at Baring Bay, leading to a minimum estimate of 400 muskoxen on the island. In 1984, Pattie (1990) found 188 muskoxen in the same areas, but only 71 in 1987. Survey crews on western Devon Island east to Maxwell Bay (excluding the Grinnell Peninsula) observed 75 muskoxen in 2002 (Government of Nunavut, unpublished data). In 2008, a systematic aerial survey covered Devon Island and estimated 518 muskoxen (302-864, 95% CI), mostly along the southeast coast, including 142 muskoxen (including calves) observed on Philpots Island (Jenkins et al. 2011). The population has since increased, with the highest reported abundance estimate for muskoxen on the island in March 2016 (1,963 ± SE343, Anderson 2016).

Previous surveys and observational work on Bathurst Island indicted that most muskoxen concentrated in lowlands and valleys, particularly in Polar Bear Pass, but they were generally absent from the Governor

General Group (Cameron, Vanier, Massey, Marc, Alexander islands). Bathurst Island and the Governor General Group (collectively the Bathurst Island Complex) were first surveyed in 1961, with an estimated 1136 muskoxen on Bathurst Island (Tener 1963). Miller et al. (1977) estimated 672±SE194 on Bathurst Island in spring 1973. There was a severe icing event in winter 1973-74, and with groundfast ice preventing access to forage, the muskox population crashed the next year to between 164±SE70 (Miller et al. 1977) and 246 muskoxen (Fischer and Duncan 1976). In April 1975, Fischer and Duncan (1976) estimated 313 muskoxen, although the estimate decreased to 69 by June of the same year. Ferguson (1987) estimated 208 muskoxen in August 1981, and Miller (1987) estimated 545 (95% CI 259-830) in July 1985. Miller (1989) estimated 592±SE108 (423±SE83 1+ year olds), which increased to an estimated 1200 muskoxen by 1993 (Miller 1995). A series of severe winters from 1994 to 1997 caused the population to decline again, to 980 in summer 1995 (Miller 1998), 425±SE136 (Miller 1998) in summer 1996, to 124± SE45 (Gunn and Dragon 2002) in July 1997. A minimum count of 82 was recorded in aerial surveys in 2001 (Jenkins et al. 2011). By May 2013, the population had recovered to 1888±979 (SE) 1+ year-old muskoxen on Bathurst and Cornwallis islands (Anderson 2014). Community observations from 2014-2016 were of continued high population densities of muskoxen on Bathurst and Cornwallis islands.

Use of the Governor General Group by muskoxen appears to be sporadic, although these islands have not been surveyed as frequently as Bathurst Island. Tener (1963) estimated 25 muskoxen on Cameron Island in 1961 and Miller (1989) estimated 7 adults, but other surveys did not detect muskoxen on the island. île Vanier had an estimate of 6 1+ year old muskoxen in 1988 (Miller 1989). In July 1985, there were 27 muskoxen on Alexander Island (Miller 1987), and 6 muskoxen on the island in July 1988 (Miller 1989). No surveys have detected muskoxen on Massey Island, île Marc, or Helena Island (not part of the Governor General Group but often surveyed as part of the Bathurst Island Complex). No muskoxen were observed on the Governor General Group in 2013 (Anderson 2014).

Cornwallis Island can be considered a major satellite island of Bathurst Island, and caribou and muskoxen move between those islands (Miller 1998). It has been surveyed infrequently, beginning in 1961 with Tener’s (1963) extrapolation of 50 muskoxen. In July 1988, 70±34 muskoxen were estimated on the island (Miller 1989). No muskoxen were seen on Cornwallis Island in 2002 (Jenkins et al. 2011), but 98 muskoxen were seen on Cornwallis Island in 2013 (Anderson 2013). They have also been observed historically on Little Cornwallis Island, between Cornwallis and Bathurst islands, with an estimate of 40 in April 1973, 20 in March 1974, and 12 by August 1974 (Miller et al. 1977). Residents of Resolute generally see them in the lowlands along the northeast and northwest coasts of the islands, or along the southwest coast, and they have seen more muskoxen in recent years (Resolute Bay HTA, pers. comm.).

*Collar Deployment*

Twelve muskoxen on Bathurst Island, Cornwallis Island, and western Devon Island were outfitted with satellite collars between June 24 and July 2, 2003. These collars were refurbished after retrieval from caribou on Baffin Island. Transmitters were programmed to transmit a location every 4 days by satellite, with an expected 2-year collar life and drop-off programmed for 3 years following deployment. Collar deployment was by darting and chemical immobilization with metatomidine, ketamine, and Telazol (typically 24 mg metatomidine:360 mg ketamine:45 mg Telazol or 27 mg metatomidine:400 mg ketamine:50 mg Telazol). Antisedan was administered as a reversal (100 mg, although some animals received only a 20 mg dose). Collars were fitted with breakaway mechanisms to ensure release at the conclusion of the study. Unfortunately, the actual fates of the collared muskoxen were usually not known if collars could not be retrieved at the end of the study – the activity would go to zero and the transmitter would become stationary, but without field investigation, we are unable to tell whether that was due to the animal’s death or the collar dropping off.

Locations of collared animals were determined based on Doppler frequency shifts detected by polar-orbiting satellites via Service Argos Inc. (Fancy et al. 1988). Argos collects, processes, and transmits data from polar-orbiting Tiros-N satellites and a network of tracking stations that transfer satellite data to processing centers and users. Argos locations are associated with an accuracy class as follows (Argos 1994):

Class 3: Error <150 m
Class 2: Error <350 m
Class 1: Error <1000 m
Class 0: Error >1000 m
Class A: Poorer than Class 0
Class B: Poorer than Class A
Class Z: Unvalidated location

Location error can be due to PTT (platform transmitter terminal) oscillator instability, changes in PTT elevation (i.e. animal movements), insufficient number of transmissions reaching the satellite (i.e. in some habitat types or terrain), errors in satellite orbital data, computational algorithms, or mapping methods (Harris et al. 1990). For the purposes of spatial analyses, we considered only Class 3 locations (position error <150 m). Error classes may indicate a best case scenario and do not always accurately reflect the situation for a deployed PTT (Argos 1994). After collars dropped, the location clusters around the dropped collars, even considering only Class 3 locations, were generally 800-1500 m in diameter. After collars drop, they may occasionally be moved considerable distances by wolves and foxes, which has occurred with the same kind of collar on caribou on Baffin Island.

*Displacements*
The PTT transmission schedule of one location every 4 days provides us with an index of movement, but it will underestimate the total distance covered by the muskoxen (Figure 2). Only the locations that were on schedule (i.e. 4 days apart) are considered here. Displacements taken after a longer time interval are at a different resolution and will not be comparable to 4-day displacements. Similarly, when several consecutive locations were transmitted within several hours, only the first class 3 location was considered. Only class 3 locations were used for calculating displacements.

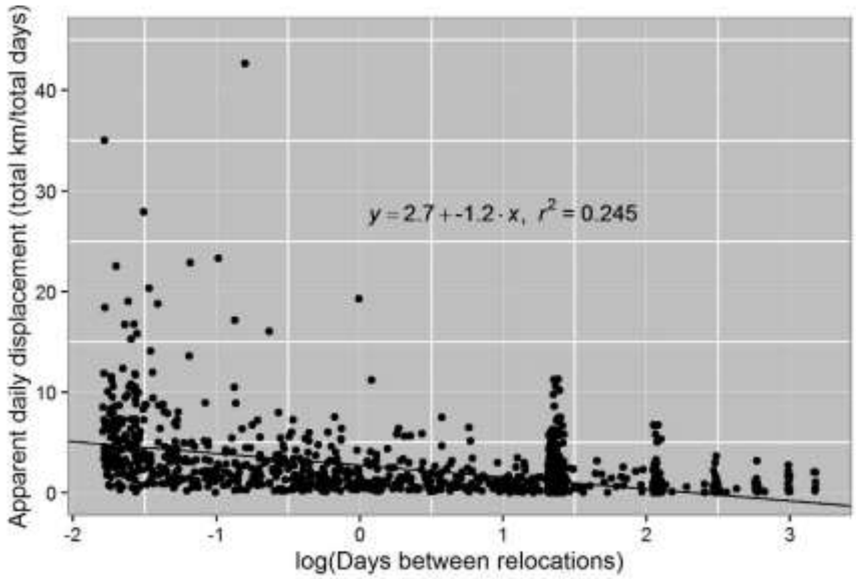

Figure 2. Plot of the time between locations and the log of the apparent daily displacement (i.e. the distance between successive points divided by the number of days). The longer the time between locations, the smaller the apparent daily displacement (F=725.1, df=2235, p<0.001).

*Home Ranges*

Home range size is expected to increase as more relocations are incorporated, up to some threshold number of locations. Gautestad and Mysterud (1995) suggested a minimum of 100-200 locations be used to calculate a home range, and Millspaugh et al. (2006) suggested at least 100 locations. Although most muskoxen (excepting 7729 in 2003-04 and 7740 in 2005-06) had locations in 11-12 months for each year a home range was calculated, breaking years into seasons reduced the number of locations available. Since most muskoxen in most seasons would not have enough locations to provide a reasonable home range estimate, we only calculated home ranges by year, not by season.

Minimum convex polygon (MCP) home ranges were determined using *genmcp* in the Geospatial Modelling Environment (Beyer 2012). MCPs are a simple, intuitive way to represent and compare home ranges. They are particularly useful for comparing to historic home ranges, calculated before quantity and quality of data allowed the development of other home range estimators. However, MCPs do not provide any indication of intensity of use within a home range. To address this shortfall, we also calculated kernel density estimator (KDE) home ranges using *kde* and *isopleth* in the Geospatial Modelling Environment (Beyer 2012) with a smoothed cross validation (SCV) bandwidth calculator to determine the smoothing parameter *h*.

*Habitat Selection*

The land cover layer used to define habitat was derived from 1999-2002 Landsat imagery (Olthof et al. 2008), available under an open government license from Natural Resources Canada (http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/free-data-geogratis/11042). It is available at 30 m resolution by 1:250,000 National Topographic Survey (NTS) map tile, with 15 land cover classes (Figure 3, Table **1**). Elevation at telemetry points and random points was extracted from a digital elevation model based on National Topographic Survey 1:50,000 map sheets for the study area.

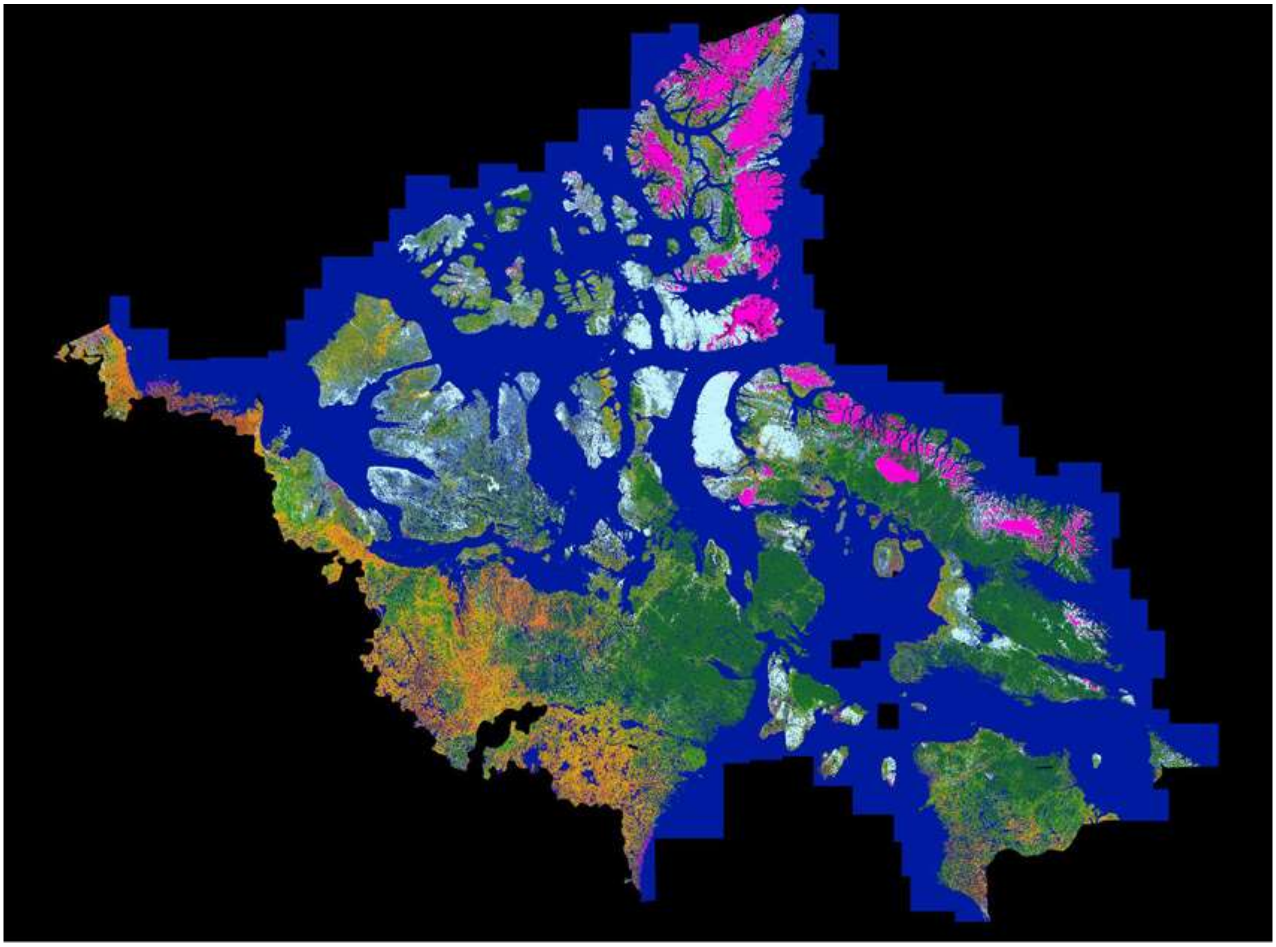

Figure 3. Overview of the 15-class northern land cover product, as a mosaic of 1:250,000 NTS map tiles (300 m resolution product shown), developed from Landsat imagery 1999-2002. Available online through Natural Resources Canada.

Table 1. Land cover classes in the circa-2000 northern land cover product (Olthof et al. 2008).

| | Land Cover Class | Description |
|---|---|---|
| I. Graminoid | 1. Tussock graminoid tundra | Moist tussock tundra with <25% dwarf shrub <40 cm tall, moss, and may include lichen |
| | 2. Wet sedge | Wet sedge including cottongrass, saturated for a significant part of the growing season; may include moss and <10% dwarf shrub <40 cm tall |
| | 3. Moist to dry non-tussock graminoid/dwarf shrub tundra | 50-70% vegetated cover of graminoids, dwarf erect <40 cm tall and prostrate shrubs, trace amounts moss and lichen |
| | 4. Dry graminoid prostrate dwarf shrub tundra | Upland/well-drained non-tussock graminoid tundra with low to prostrate dwarf shrub, 70-100% cover |
| II. Shrub (>25% cover) | 5. Low shrub | Moist sites, erect <40 cm tall shrub forming >25% of vegetated cover, mainly dwarf birch (*Betula*)/willow (*Salix*). Remaining cover of graminoids, lichen, prostrate shrubs, and bare soil |
| | 6. Tall shrub | Moist to wet sites, erect tall shrub >40 cm forming >25% vegetated cover, mainly dwarf birch (*Betula*)/willow (*Salix*)/alder (*Alnus*). Remaining cover of graminoids, lichen, <10% prostrate shrubs, and bare soil |
| | 7. Prostrate dwarf shrub | Dry sites, >50% vegetated prostrate dwarf shrubs, graminoids, <10% lichen/moss. Dryas/heath, usually on bedrock/till |
| III. Sparse vegetation (2-10% cover) | 8. Sparsely vegetated bedrock | Barren surfaces with 2-10% graminoids/dwarf prostrate shrubs on acidic, igneous, mostly unconsolidated bedrock. |
| | 9. Sparsely vegetated till/colluvium | Barren surfaces with 2-10% graminoid/prostrate dwarf shrub vegetation on non-acidic/calcareous bedrock/colluvium. Vegetation generally consists of graminoids and prostrate dwarf shrubs (*Dryas-Salix* Tundra / Barrens on Bioclimatic Zone 1; Purple *Saxifrage*-Herb Tundra / Barrens on Bioclimatic Zone 2; Edlund and Alt, 1989). |
| | 10. Bare soil with cryptogram crust, frost boils | Unconsolidated barren surfaces having experiences significant cryoturbation with 2-10% graminoids and cryptograms |
| IV. Wetlands | 11. Wetlands | Vegetated areas where water table intersects surface for all/part of the year. Generally decreasing biomass with increasing latitude from sedge/moss/low shrub at central Hudson Bay, moss/dwarf shrub at south-central Baffin Island, to moss further north (Walker et al. 2002) |
| V. Non-vegetated (<2% cover) | 12. Barren | <2% vegetation on nonacidic/calcareous parent material |
| | 13. Ice/snow | Glaciers, ice fields; permanently covered by ice/snow. |
| | 14. Shadow | Topographic shadow |
| | 15. Water | Liquid standing water |

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A total of 610 muskox telemetry locations did not have land cover classes assigned and were removed from the habitat analysis, leaving a total of 8,313 used locations with an assigned error less than 150 m. The locations were analysed in ArcMap 10.0 (ESRI, Redlands, CA).

Resource selection functions (RSFs) are sensitive to how available resources are defined as well as which resources are used (Manly et al. 2002). Muskoxen are not territorial (Banfield 1974; for example 7734 and 7743), and had largely overlapping home ranges. We assumed that any location within all the MCPs of the muskoxen on one island could have been theoretically available to other muskoxen on that island sometime during three-year study period. Consequently, using the Geospatial Modelling Environment (Beyer 2012) 20,000 random points were generated within the 2003-2006 MCPs, yielding18,096 land cover classes that were retained for analysis. Classes 5 and 6 (low and tall shrub) were not present in the study area. We calculated RSFs using points collected year-round, points in the snow-free summer period (June 15 – September 15) and points in winter/spring (September 16 – June 14). The years referred to in this report are June 1 to May 31 of the next year.

We used logistic regression, since the used-available design relies on a binary response variable (1= used, i.e. a telemetry location, and 0=available, a random point within the home ranges on the island) with package *glm* in R 2.15.3 (R Core Team 2013). We ran several RSF models using land cover and elevation variables for each collared individual and for island groups, ranked the models using AIC and did not apply model averaging.

**Results**

*Collar Deployment*

Eleven muskoxen were collared, four on Bathurst Island, two on Cornwallis Island, and five on Devon Island (Table 2). A twelfth animal was collared on June 28, 2003, but the collar stopped moving by July 18, 2003. It is not known if this animal died at that time. If it did, capture myopathy, predation, disease or human causes may have been responsible; alternatively, faulty collar drop-offs or attachment screws could have caused the collar to drop prematurely. Other muskoxen were darted and not collared: one was darted on June 24 with no apparent effect; one on June 25 was too old and in too poor of condition to collar (northeast of Bracebridge Inlet on Bathurst Island, ear-tagged as 31/18 in the left/right ears); one on June 25 subsequently died as a result of capture operations (east of Erskine Inlet on Bathurst Island, ear-tagged as 25/17 in the left/right ears); and another on July 1 that also died during the capture attempt (tagged as 07/32 in left/right ears). Based on minimum counts of muskoxen on Bathurst Island in 2001 (82 muskoxen, Jenkins et al. 2011) and on Cornwallis Island (18 adult muskoxen and no calves, GN unpubl. data) and western Devon Island (85 adult muskoxen and 10 calves, GN unpubl. data) in 2002, the collared animals represented a small proportion of the adult muskoxen on each island. Considering that a minimum count represents fewer animals than the actual population size, the proportion of collared muskoxen represents less than 11% on Cornwallis Island, less than 6% on (western) Devon Island, and less than 5% on Bathurst Island.

The predicted transmission life of the PTTs was 730 days, based on battery capacity, transmission power use and frequency, and latent non-transmission power use. One PTT was active for only 145 days, another two PTTs lasted 717 and 790 days, and the remaining 8 PTTs recorded locations for 1012-1154 days. Of the 11 collars deployed, 7 remained active on muskoxen so that the study period could be extended to three years. The percent of class 3 locations processed by Service Argos varied by PTT from 5.2 to 28.8% (

Table **4**, Figure 6).

Table 2. Capture and collar deployment for 11 muskoxen on Bathurst, Cornwallis, and Devon islands.

| | Ear Tag Number (Left, Right) | Capture Date | PTT End Date | Days | Capture Location |
|---|---|---|---|---|---|
| 7711 | 11/1700, 15/0938 | 26-Jun-03 | 17-May-06 | 1056 | Bracebridge Inlet, Bathurst Island |
| 7716 | 22/1691, 23/1690 | 24-Jun-03 | 15-May-06 | 1056 | Variscan River, Bathurst Island |
| 7717 | 37/1688, 10/1689 | 25-Jun-03 | 22-Aug-06 | 1154 | May Inlet, Bathurst Island |
| 7720 | 16/1693, 5/1692 | 26-Jun-03 | 24-Aug-05 | 790 | Young Inlet, Bathurst Island |
| 7724 | 35/1699, 3/1698 | 27-Jun-03 | 12-Jun-06 | 1081 | Port Refuge, Devon Island |
| 7729 | 1/0946, 42/0947 | 28-Jun-03 | 09-May-04 | 316 | Pioneer Bay, Devon Island |
| 7734 | 49/0939, 8/0940 | 28-Jun-03 | 05-Apr-06 | 1012 | Dragleybeck River, Devon Island |
| 7735 | 30/1407, 14/0030 | 30-Jun-03 | 22-Nov-03 | 145 | Maxwell Bay, Devon Island |
| 7737 | 36/0950, 12/0949 | 02-Jul-03 | 18-Jun-05 | 717 | Rookery Creek, Cornwallis Island |
| 7740 | 6/0941, 48/0942 | 28-Jun-03 | 18-Jul-03 | 20 | Eidsbotn West Fiord, Devon Island |
| 7742 | 09/1694, 50/1695 | 02-Jul-03 | 20-May-06 | 1053 | Abbott River, Cornwallis Island |
| 7743 | 42/1742, 38/1738 | 02-Jul-03 | 16-May-06 | 1049 | Macormick Bay, Devon Island |

Table 3. Measurements for adult female muskoxen captured in summer 2003 on Bathurst, Cornwallis, and Devon islands.

| | Bos Gap (cm) | Horn Spread (cm) | Head Length (cm) | Total Body Length (cm) | Forefoot Length (cm) | Hindfoot Length (cm) | Neck Circumference (cm) |
|---|---|---|---|---|---|---|---|
| 7711 | 1.95 | 46.5 | 43 | 219 | 21 | 29 | 61 |
| 7716 | 3.7 | 47.5 | 48 | 225.5 | 22 | 29.5 | |
| 7717 | 8.0 | 46.5 | 45.0 | 234.5 | | | |
| 7720 | 3.87 | 46 | 43.0 | 215.5 | 22 | 29 | 376.5 |
| 7724 | 3.65 | 38.5 | 44 | 225.5 | 22.5 | 27.5 | 68 |
| 7729 | 3.41 | 46 | 46 | 220 | 21 | 26.5 | 78.5 |
| 7734 | 1.36 | 47.5 | 43 | 215 | 22 | 29 | 73 |
| 7735 | 3.0 | 48.5 | 44.5 | 218 | 22 | 29 | 81 |
| 7737 | 4.28 | 28.5 | 42 | 228 | 21.5 | 28 | 72 |
| 7740 | 2.00 | 50 | 45 | 214 | 24 | 28 | |
| 7742 | 2.42 | 41 | 43 | 216 | 20 | 27.5 | 68 |
| 7743 | 0.87 | 42 | 42 | 224.5 | 20 | 26.5 | |
| 25/17 | 2.46 | 39.1 | 43.0 | 235 | 21 | 28 | 71 |
| 31/18 | 2.57 | 42.4 | 42.0 | 225 | 20.5 | 28 | |
| 07/32 | 3.7 | 51 | 43 | 227 | 22.5 | 27 | 75 |

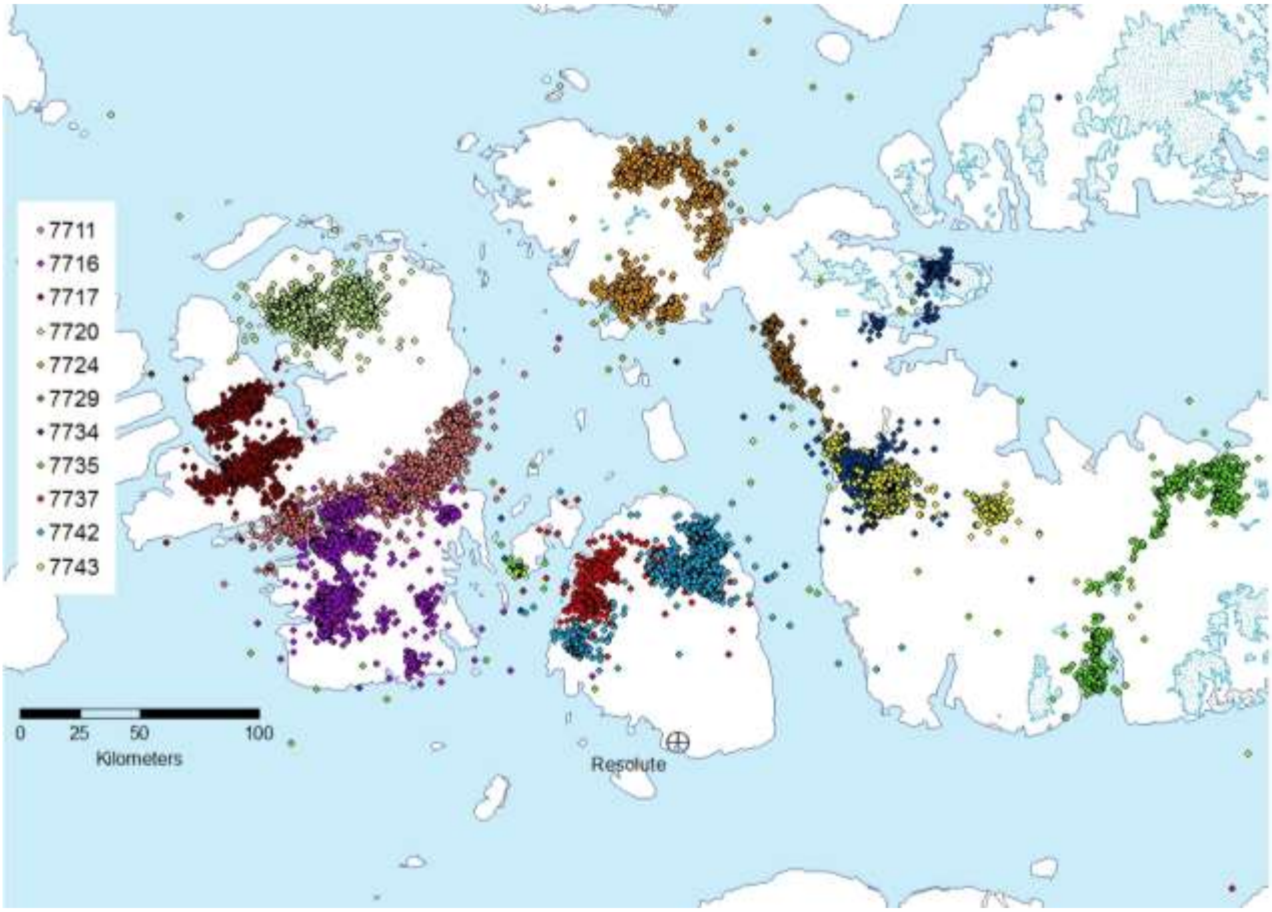

Figure 4. Class 3, 2, and 1 Argos locations (<1000 m associated error) for 11 satellite-collared muskoxen, 2003-2006, some of which clearly have error greater than 1000 m (locations recorded near Baffin Island's Brodeur Peninsula, Lougheed Island, and on south Ellesmere Island).

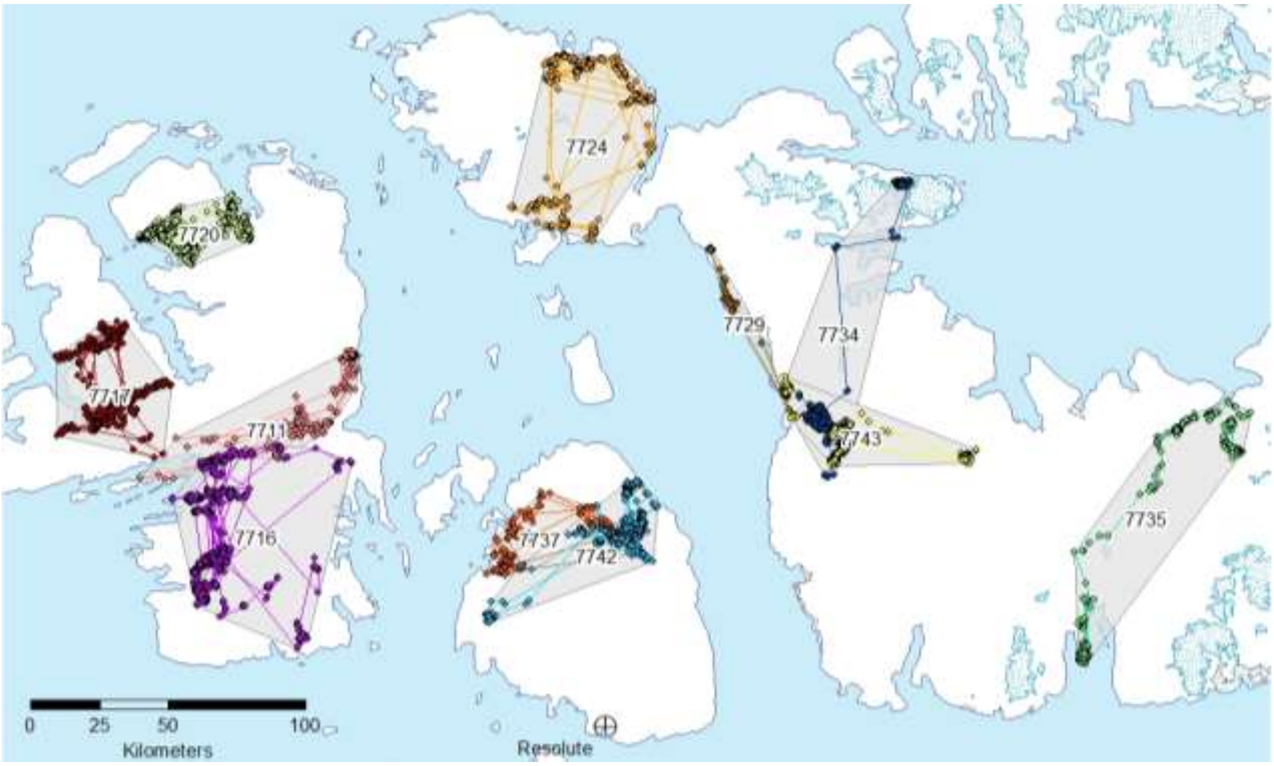

Figure 5. Class 3 Argos locations (<150 m associated error) for 11 satellite-collared muskoxen, 2003-2006. Grey polygons represent minimum convex polygon home ranges for each individual for the study period.

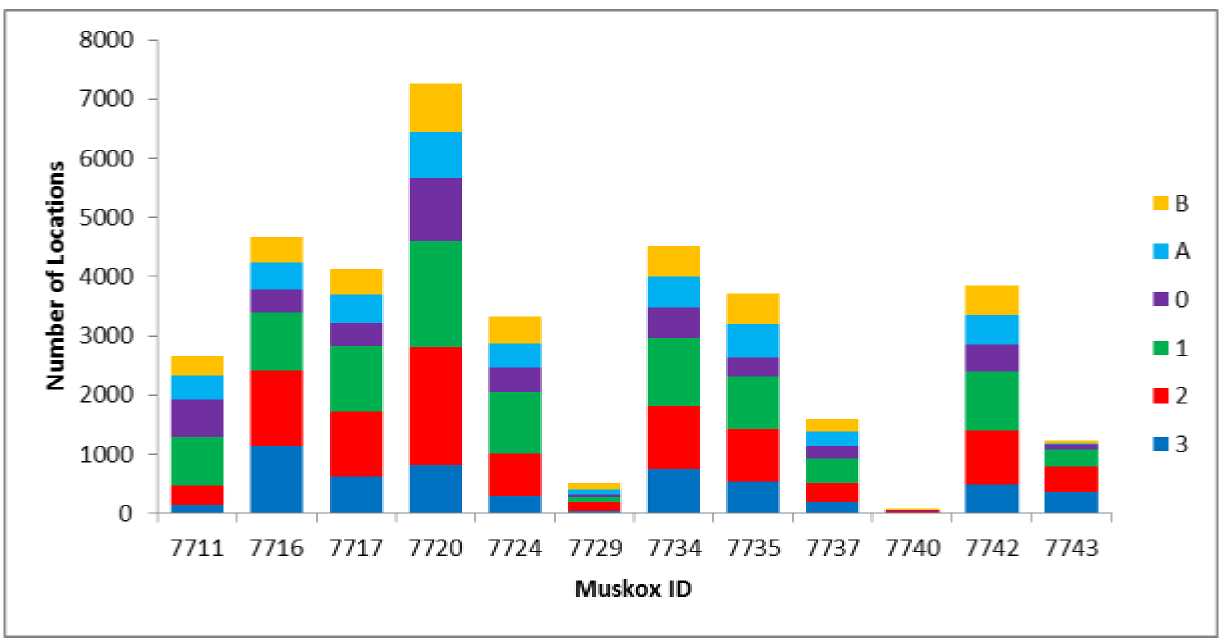

Figure 6. Total Argos locations for 12 collared muskoxen for the study period 2003-2006 (collar deployments range in duration) by location class: Class 3 (<150 m error), Class 2 (<350 m error), Class 1 (<1000 m error), Class 0 (>1000 m error), Class A (>1000 m error and less confidence than Class 0), and Class B (less confidence than Class A).

Table 4. Satellite fix success of collars on 12 muskoxen, including 7740, which was a 20-day collar deployment.

| | Class 3, <150 m | Class 2, <350 m | Class 1, <1000 m | Class 0, >1000 m | Class A | Class B | Total Locations |
|---|---|---|---|---|---|---|---|
| 7711 | 137 (5.2%) | 331 (12.5%) | 815 (30.8%) | 647 (24.4%) | 393 (14.8%) | 325 (12.3%) | 2648 (1056 days) |
| 7716 | 1144 (24.5%) | 1272 (27.2%) | 980 (21.0%) | 387 (8.3%) | 457 (9.8%) | 432 (9.2%) | 4672 (1056 days) |
| 7717 | 623 (15.1%) | 1104 (26.8%) | 1094 (26.6%) | 404 (9.8%) | 460 (11.2%) | 435 (10.6%) | 4120 (1154 days) |
| 7720 | 809 (11.1%) | 2008 (27.6%) | 1791 (24.7%) | 1064 (14.6%) | 765 (10.5%) | 827 (11.4%) | 7264 (790 days) |
| 7724 | 298 (8.9%) | 711 (21.3%) | 1037 (31.1%) | 423 (12.7%) | 405 (12.2%) | 459 (13.8%) | 3333 (1081 days) |
| 7729 | 37 (7.1%) | 155 (29.8%) | 93 (17.9) | 35 (6.7%) | 94 (18.1%) | 106 (20.4%) | 520 (316 days) |
| 7734 | 742 (16.4%) | 1067 (23.6%) | 1155 (25.6%) | 515 (11.4%) | 526 (11.7%) | 509 (11.3%) | 4514 (1012 days) |
| 7735 | 545 (14.7%) | 883 (23.8%) | 891 (24.0%) | 323 (8.7%) | 560 (15.1%) | 505 (13.6%) | 3707 (145 days) |
| 7737 | 189 (11.9%) | 333 (20.9%) | 412 (25.9%) | 214 (13.4%) | 237 (14.9%) | 208 (13.1%) | 1593 (717 days) |
| 7740 | 16 (22.5%) | 15 (21.1%) | 12 (16.9%) | 8 (11.3%) | 12 (16.9%) | 8 (11.3%) | 71 (20 days) |
| 7742 | 497 (12.9%) | 899 (23.3%) | 1008 (26.1%) | 453 (11.7%) | 496 (12.9%) | 504 (13.1%) | 3857 (1053 days) |
| 7743 | 356 (28.8%) | 442 (35.8%) | 280 (22.7%) | 77 (6.2%) | 39 (3.2%) | 42 (3.4%) | 1236 (1049 days) |

*Muskox 7711*

Muskox 7711 was captured on June 26, 2003, in western Polar Bear Pass, about 5 km from Bracebridge Inlet, in a group of 9 adult/subadult muskoxen and 2 calves. She moved to a lowland area in Polar Bear Pass about 12 km west of Goodsir Inlet from July to January 2004. At the end of January, she moved to the south side of the pass, continuing west to Bracebridge Inlet by March. On April 17, she was on a large unnamed island in Bracebridge Inlet, where she remained until at least June 12. She was relocated on Bathurst Island on June 20. She spent July to November in central Polar Bear Pass, and December to January 2005 near Bracebridge Inlet. She moved back to central Polar Bear Pass in February and remained there until the end of April. By May 14, she was just north of Goodsir Inlet on the east coast of Bathurst Island. She spent May until January 2006 just north of Rapid Point, along a 14-km stretch of coastal lowlands (about 7 km wide) east of the Scoresby Hills. She went south to Goodsir Inlet from February 2 until March 14, then returned north to the Rapid Point area by May 17. Locations from June to December 2006 fall within 800 m of each other where the collar is presumed to have dropped.

Muskox 7711 spent the summer in east-central Polar Bear Pass in 2003, 2004, and 2005. Locations recorded for summer 2006 are from a small area and the collar was likely stationary. January, February, and March were spent closer to Bracebridge Inlet in Polar Bear Pass in 2004 and 2005, but on the east coast of the island near Rapid Point in 2006. September 2003 and 2004 was spent in east-central Polar Bear Pass, and September 2005 was spent north of Rapid Point. Her movements were primarily constrained to the Polar Bear Pass area, although they stretched from Bracebridge Inlet in the west to Goodsir Inlet in the east, and 25 km north along the coast. Muskox 7711's locations and home range are shown in Figure 7, Figure 8, Figure 9, and Figure 10.

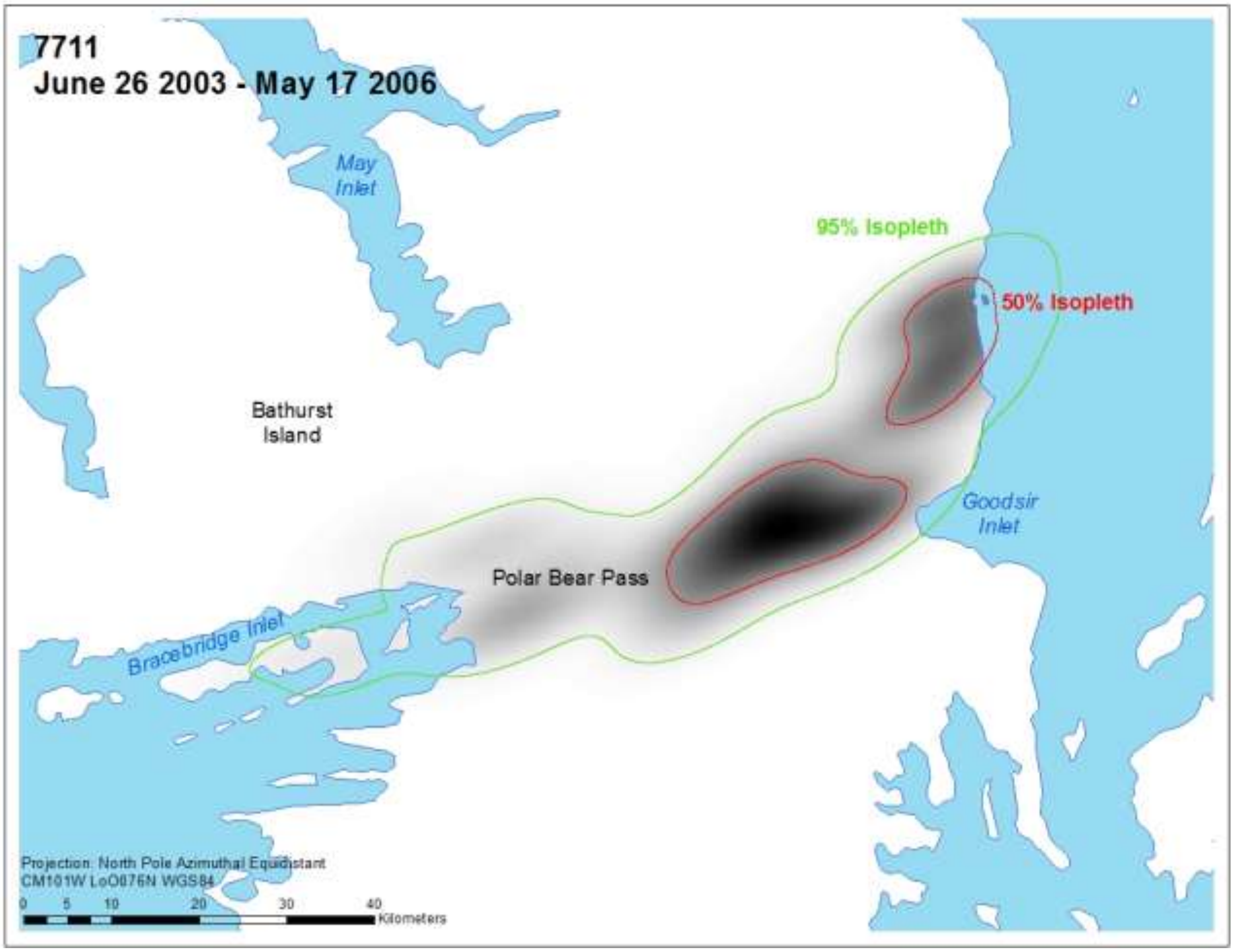


Figure 7. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7711. Bandwidth (variance x, variance y, xy covariance): 28354605.8582769, 12092025.6805042, 12652225.0684675 (SCV; N=137).

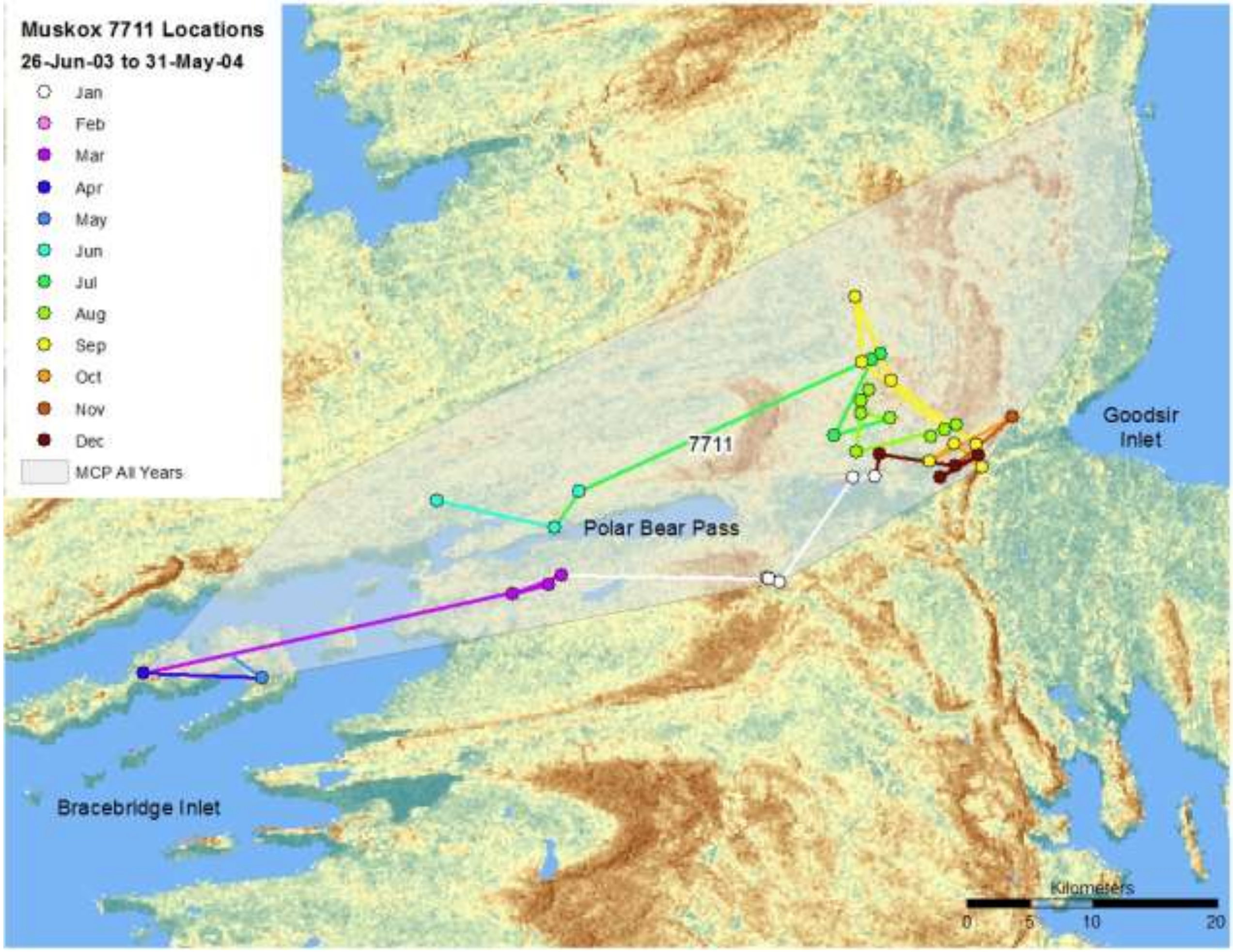


Figure 8. Locations of Muskox 7711 in 2003-04 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

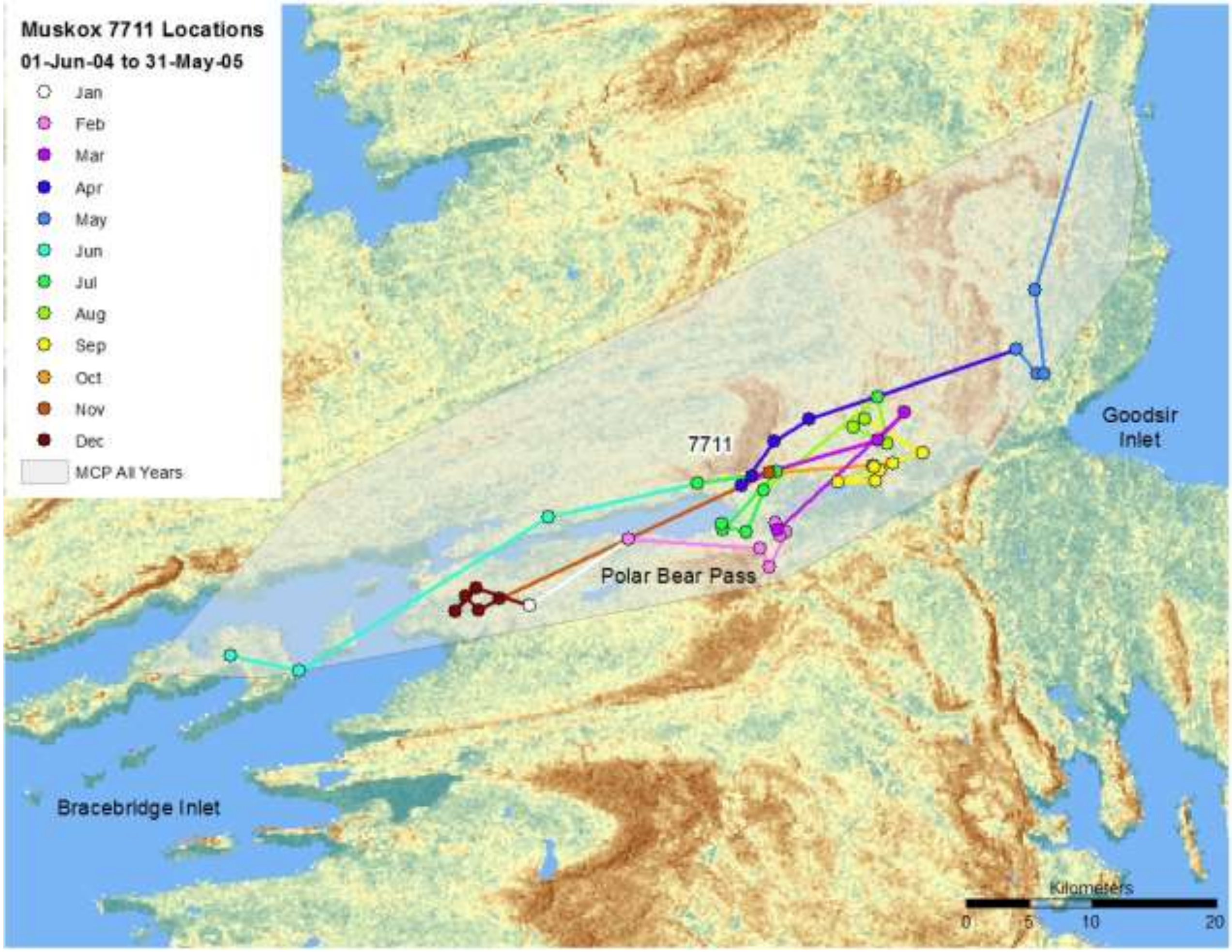

Figure 9. Locations of Muskox 7711 in 2004-05 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

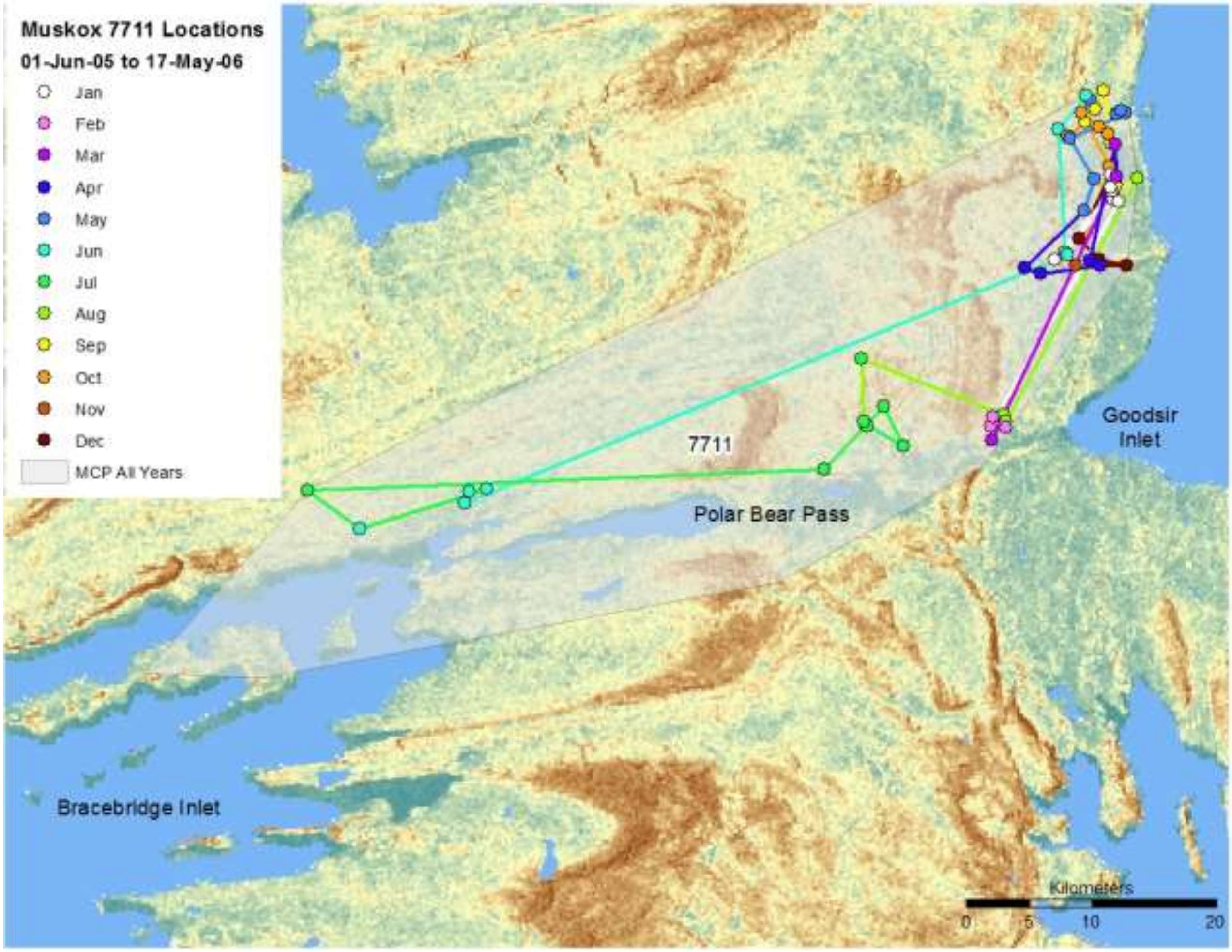


Figure 10. Locations of Muskox 7711 in 2005-06 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

*Muskox 7716*

Muskox 7716 was captured on June 24, 2003, at Bracebridge Inlet south of Polar Bear Pass near Crying Fox Creek. She was skinny, without a calf. She remained within about 15 km until the end of July, and moved about 25 km south to Misty River for August. From August 27 to September 20 she wandered some of the higher terrain north of Alison Inlet, but returned to Misty River October 6. December 1 she was further north, about 15 km east of her capture location, and remained there until December 21, when she moved northeast. She spent January 2004 in lowlands about 10 km north of Bateman Bay. By February 7, she had moved southwest to Misty River. She moved north to the Variscan River March 18-22, then moved southeast and spent March 26-April 11 about 10 km inland from the Gregory Peninsula. She moved south again to Dyke Acland Bay on the south coast of Bathurst Island for April 19 to May 17. May 21 she was back at Misty River, with a brief detour north June 2-6. By June 14-18 she was moving gradually north from the Misty River area to Crying Fox Creek by June 22. She moved west towards Bracebridge Inlet June 26, then north to Polar Bear Pass from June 30 until July 4. She moved south towards the Variscan River July 8, spent July 16-24 at Misty River, moving back north on July 28, then north again to the area east of Crying Fox Creek by August 1. From August 9-13 she moved south to Misty River where she spent September and October. She moved about 8 km south in November, but back to Misty River by November 25. She moved north December 3 and by December 7 was east of Crying Fox Creek, where she remained until January 12, 2005, when she moved to Polar Bear Pass. With the exception of March 25 to April 2 when she was in central Polar Bear Pass, she spent January to May in the western part of the pass. On May 24, she moved south to Crying Fox Creek, occupying a 15-km long east-west strip along the creek valley. She moved south again July 17, arriving at Misty River on July 31 and continuing gradually south of the river, remaining there until November 20. She moved north of Misty River for December until moving to the Variscan River area on January 3, 2006, and Crying Fox Creek on January 7. She moved south through the Variscan River area February 24-28, and to Misty River from March 4 until May 15, when the locations cluster within 700 m, where the collar was stationary until the end of the year. Hunters from Resolute Bay found Muskox 7716's blue 1690 ear tag on the land in 2014 and returned it to the Wildlife Office.

Muskox 7716 spent most of her time in 4 lowland areas – western Polar Bear Pass, east of Crying Fox Creek, and north and south of Misty River. She spent September-October 2003, 2004, and 2005 south around Misty River. November-December was spent north of Variscan River. All 4 areas would be visited in the summer months. Her movements were generally restricted to these relatively discrete areas, occasionally wandering over a much larger area (September 2003, January 2004, April 2004). An MCP home range will give an inflated estimate of space use for this individual, since it includes these long sporadic travels without representing where the majority of 7716's location fell, in the four discrete lowland areas. Muskox 7716's locations and home range are shown in Figure 11, Figure 12, Figure 13, and Figure 14.

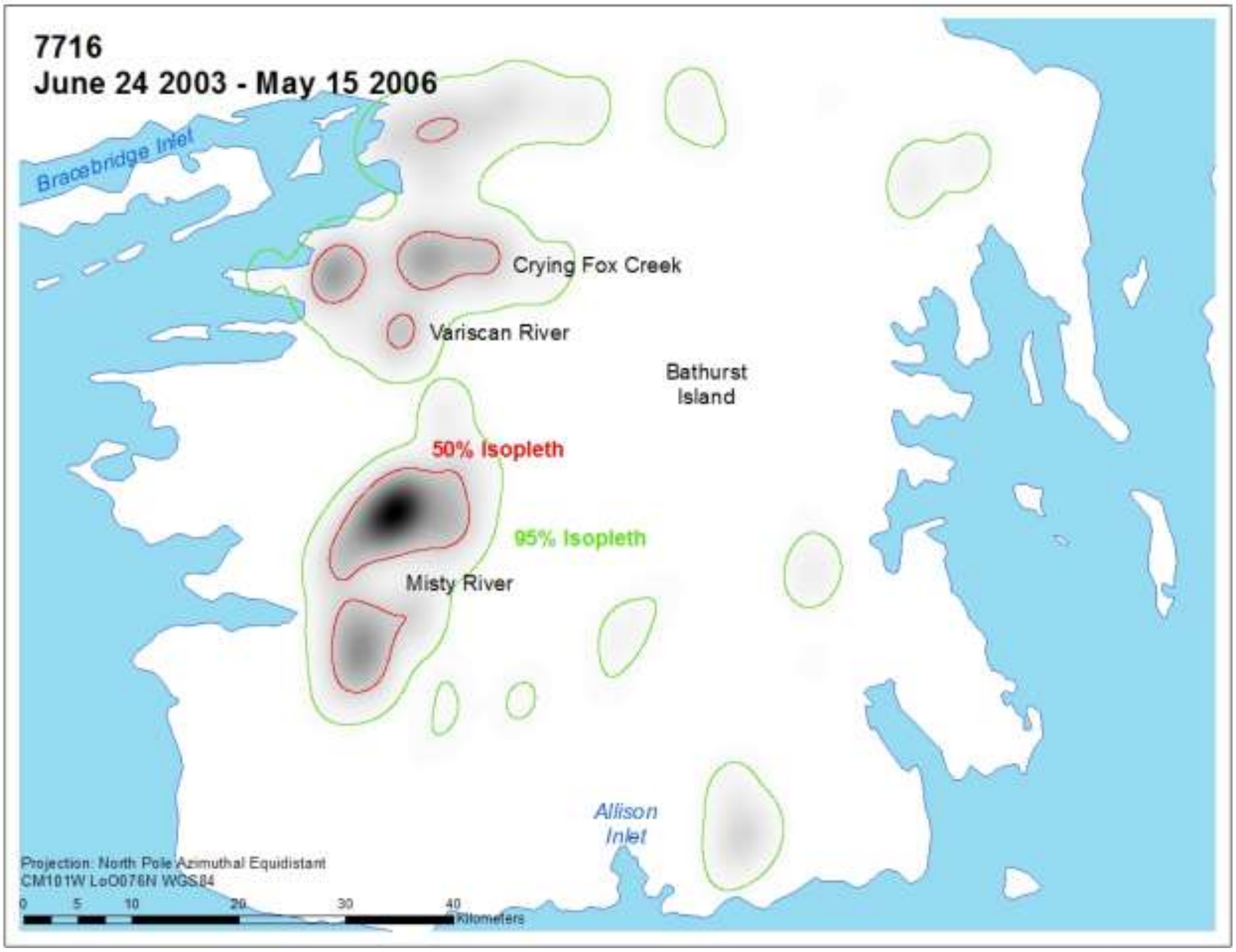


Figure 11. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7716. Bandwidth (variance x, variance y, xy covariance): 2439474.11253954, 3909967.14392347, 619169.684628177 (SCV; N=1139).

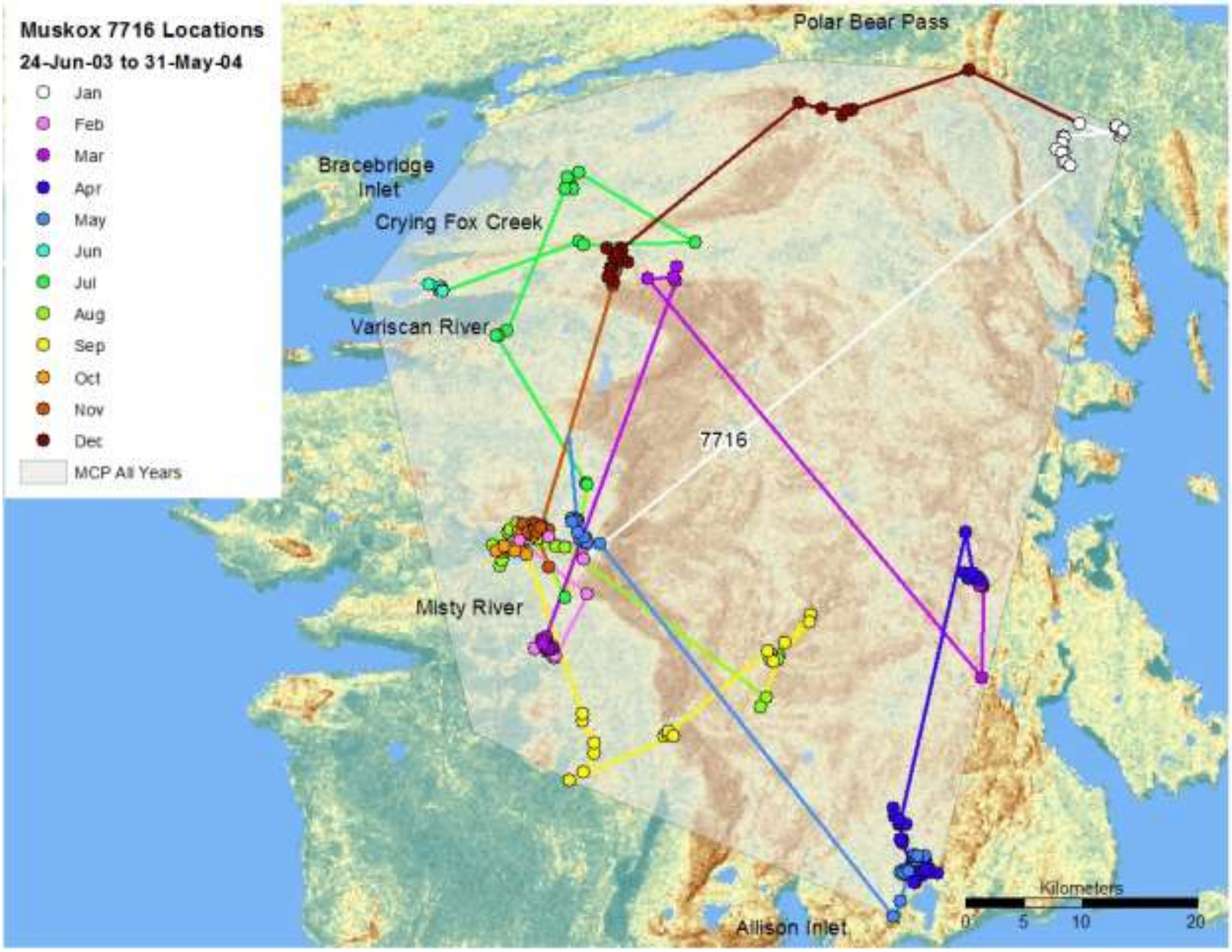


Figure 12. Locations of Muskox 7716 in 2003-04 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

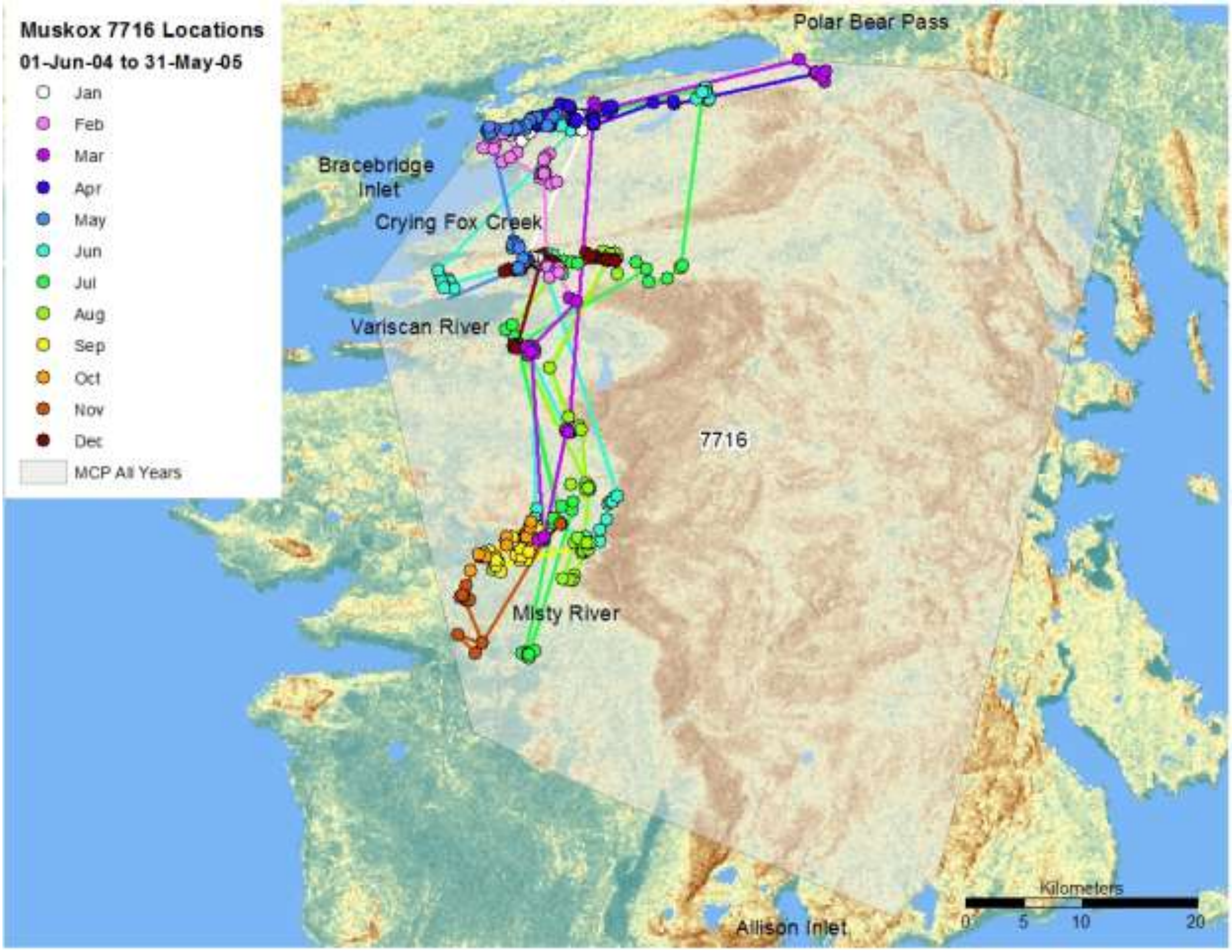


Figure 13. Locations of Muskox 7716 in 2004-05 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

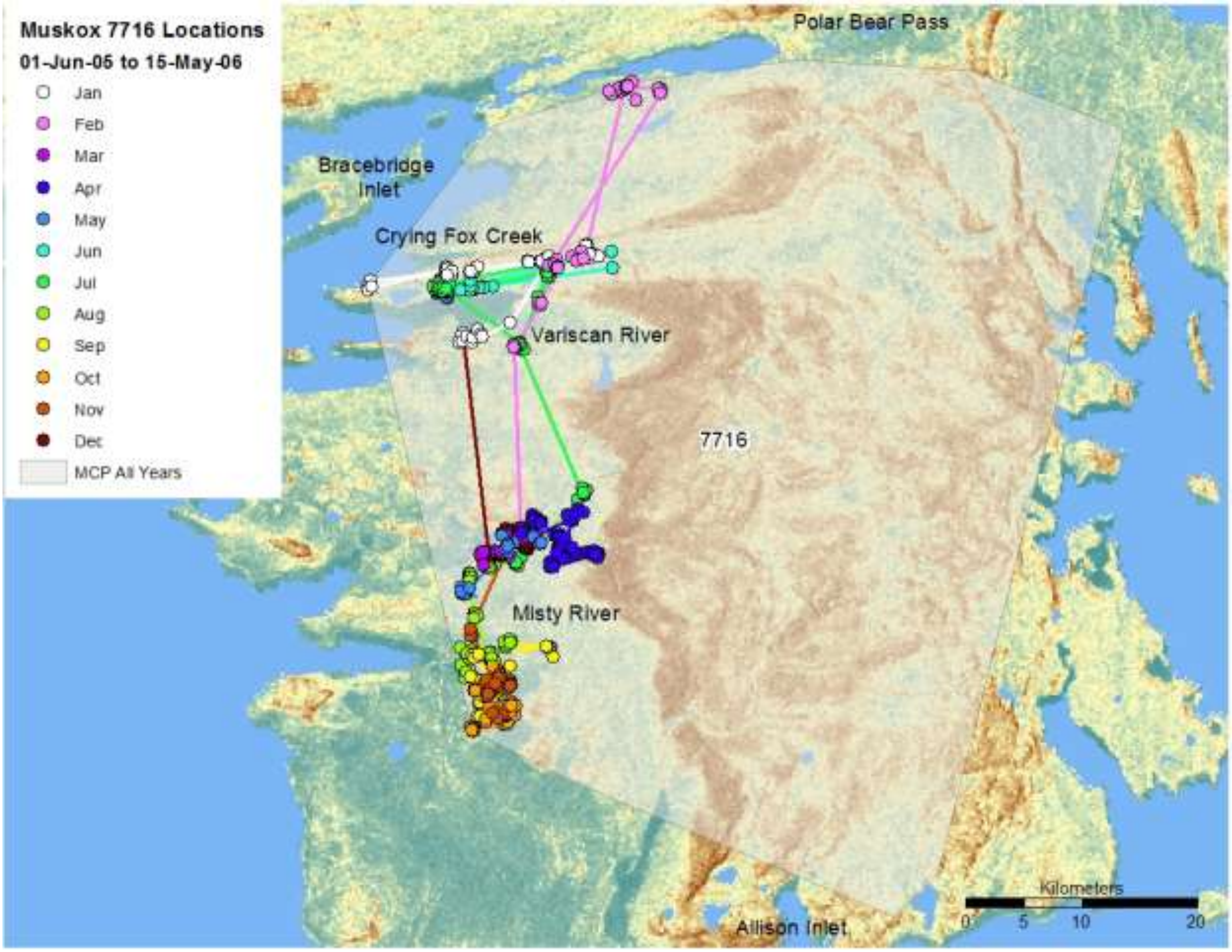


Figure 14. Locations of Muskox 7716 in 2005-06 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

*Muskox 7717*

Muskox 7717 was captured as a skinny, middle-aged cow on June 25, 2003, on northern Bathurst Island between Erskine and May Inlets in a group of 11 adult/subadult muskoxen and 5 calves (she did not have a calf). She remained in a 12-km long area until September 10. Her next relocation, October 12, was 20 km south, in the neighbouring valley. She remained in a 20-km stretch of that valley until February 19, 2004. By February 23 she was at the south end of Erskine Inlet. She remained on the southwest coast of Erskine Inlet until at least March 6, then moved further south by March 30 along the Bracebridge River. She returned to the valley north of the Bracebridge River, although she made a brief sojourn to the north coast of Bracebridge Inlet from May 9-17, and remained in the western part of the valley until August 25. She moved to the eastern side of the valley, toward May Inlet, and used the entire valley through September, October, and November. By December, she localized near Erskine Inlet where she remained until January 7, 2004. She moved to the neighboring valley to the north, where she was located January 23. She remained in the 17-km stretch of the valley nearest Erskine Inlet until April 4, when she moved east toward May Inlet. In the first week of June she moved back to the western part of the valley. She used the entire length of the valley in July and August. She moved south September 11 to the other valley, and was located there September 16. She spent the rest of September and October at the eastern end of the valley, near May Inlet, and moved to the western part at Erskine Inlet for November, gradually moving east in January and February 2006. She moved to the northern valley briefly from March 18-April 4, but returned to the southern valley on April 7. She moved west to the south end of Erskine Inlet for May 5-15, with a final location slightly east on May 17, at a cluster where the collar dropped. Although some locations were almost 3 km apart, most locations in the cluster were within 800 m.

Muskox 7717 almost exclusively used a series of low-lying east-west valleys, running between Erskine and May Inlets, in a fairly similar way over the 3 year collar deployment. She spent the fall/early winter at the eastern end of a valley stretching from Erskine Inlet in the west to Dundee Bight on May Inlet in the east, in 2003, 2004, and 2005. She spent November to January at the western end of the same valley in all 3 years as well. She returned in 2004 and 2005 to spend the spring and summer in the valley where she was collared in 2003, although her collar was stationary before she may have repeated the movement to that valley in 2006. Muskox 7717's locations and home range are shown in Figure 15, Figure 16, Figure 17, and Figure 18.

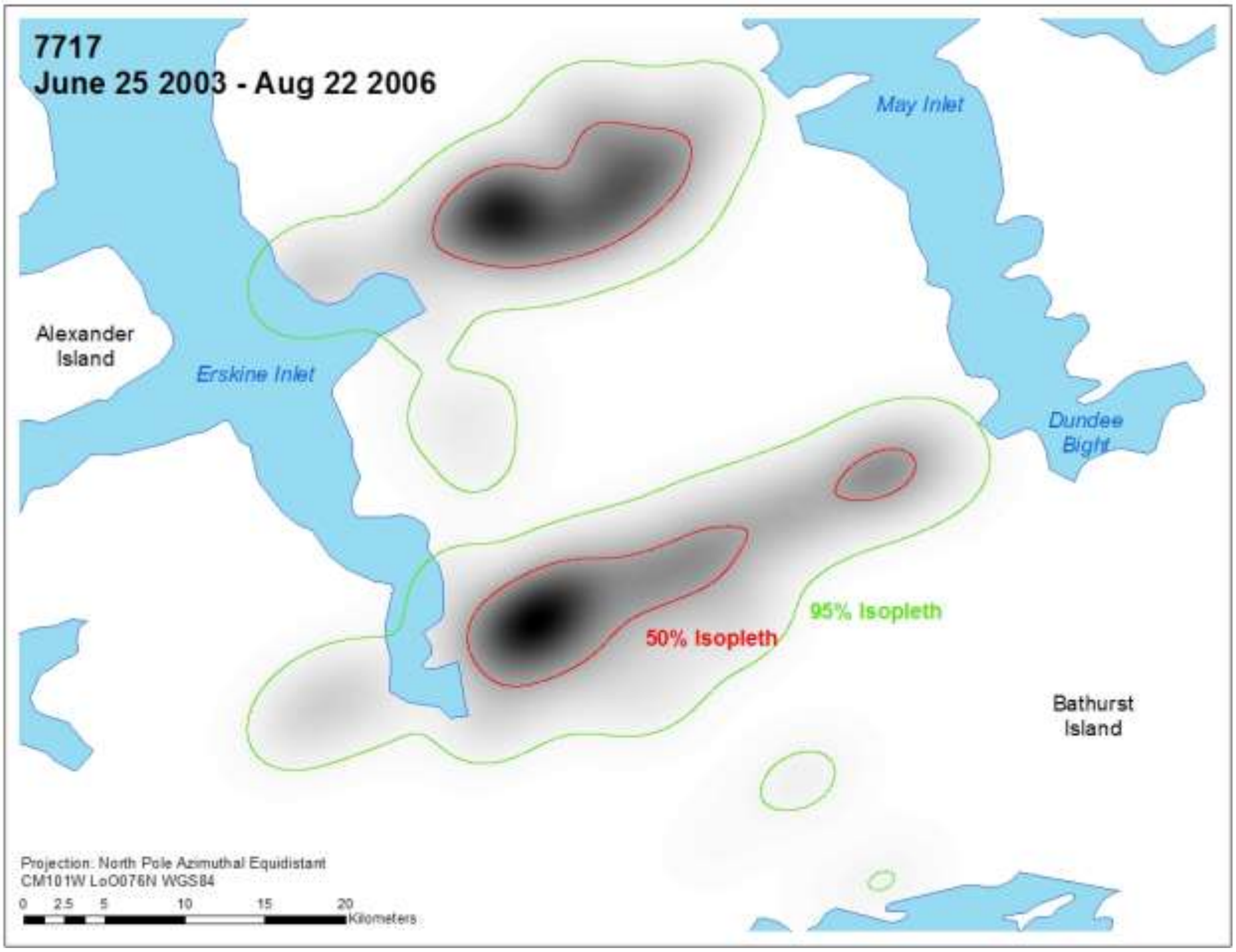


Figure 15. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7717. Bandwidth (variance x, variance y, xy covariance): 4397270.69351898, 3737192.95386684, 797282.718496332 (SCV; N=528).

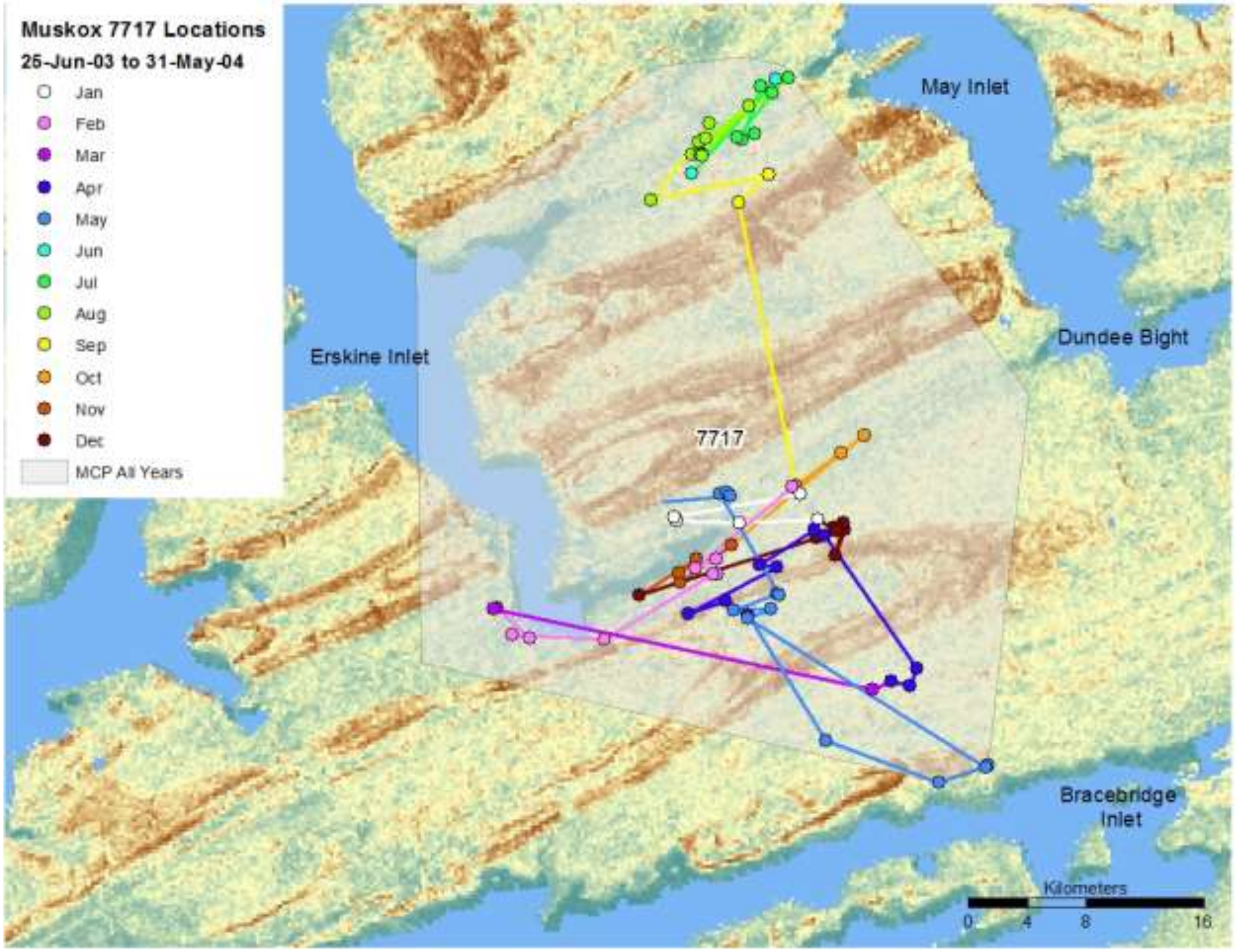

Figure 16. Locations of Muskox 7717 in 2003-04 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

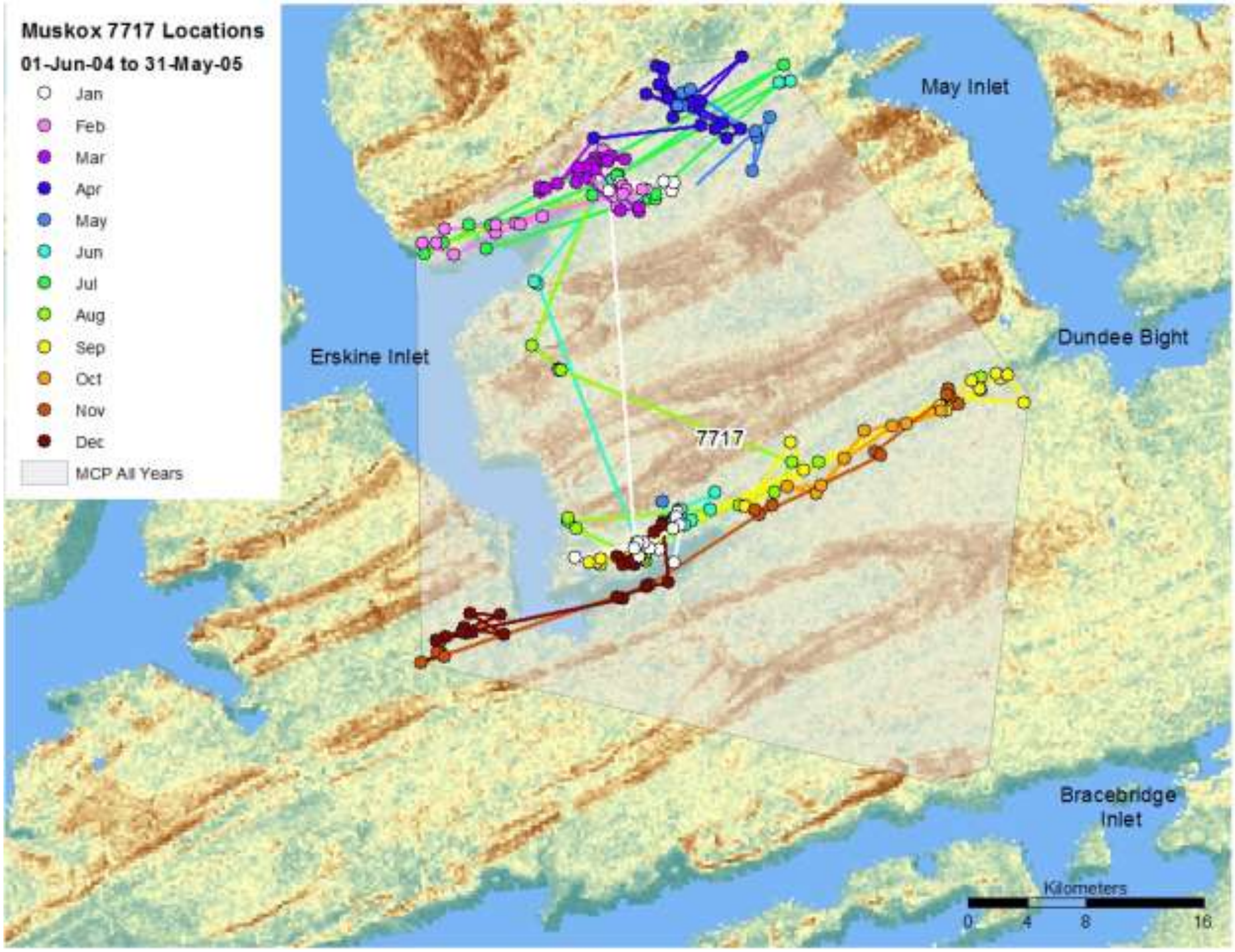

Figure 17. Locations of Muskox 7717 in 2004-05 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

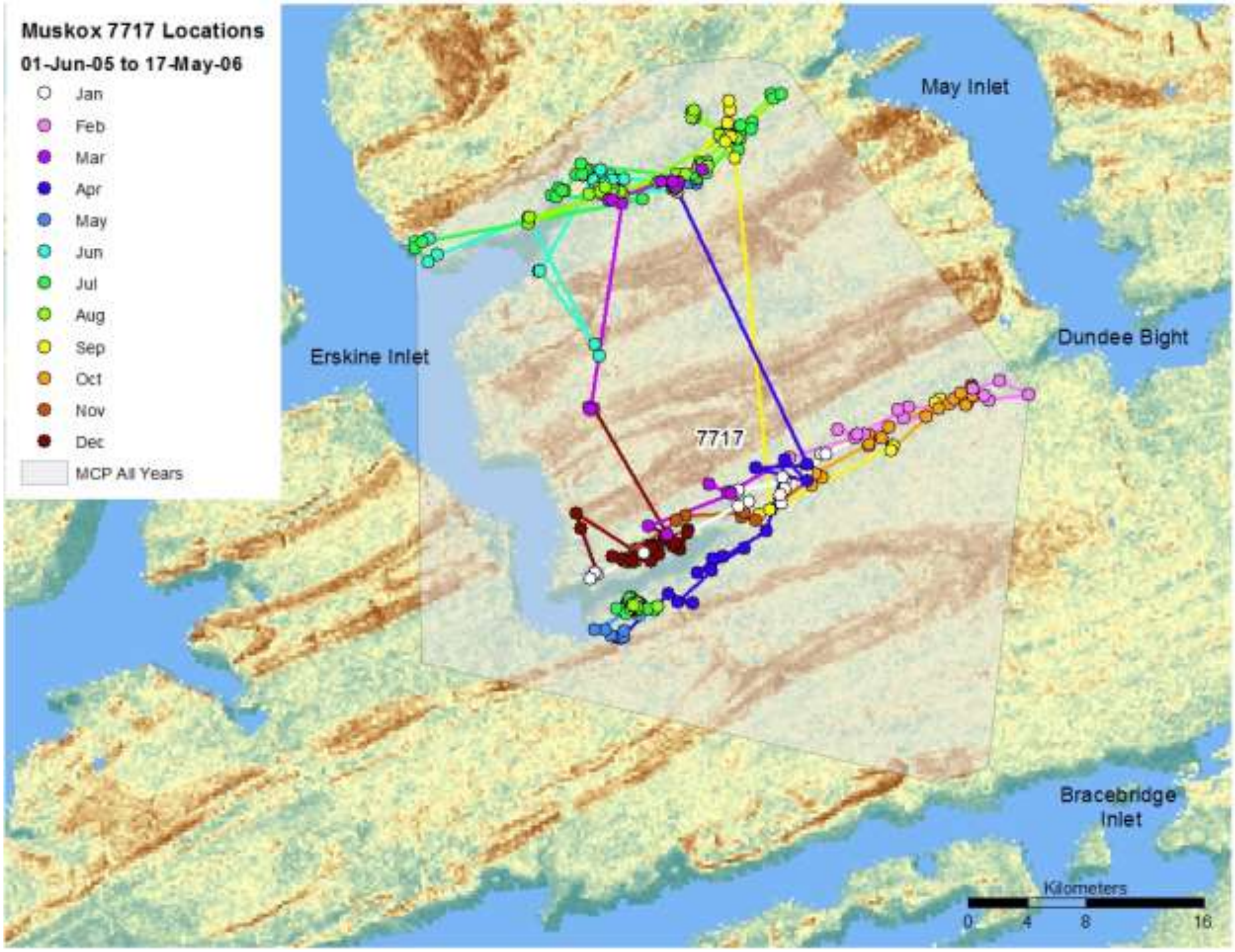

Figure 18. Locations of Muskox 7717 in 2005-06 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

*Muskox 7720*

Muskox 7720 was captured in a group of 13 adult/subadult muskoxen on June 26, 2003, at southern Purcell Bay on Bathurst Island. She remained there until July 12 and was relocated about 12 km north along Purcell Bay on July 27 after spending at least until July 16 at Young Inlet. She reversed this movement on September 4 and 5, moving east to Young Inlet at Emma Point and south to the Humphries Hill area. She moved west to Purcell Bay and likely followed the shoreline north, spending October 16-24 on the north shore of Purcell Bay before returning south by November 3. She moved east again December 8 and spent the rest of the month at Young Inlet. She spent January 2004 at the south end of Young Inlet, moving north February 4-17, to Purcell Bay February 20-23, and reaching the lowlands at the north shore of Purcell Bay by February 28. She left the northern lowlands April 13 and was at the eastern Purcell Bay lowlands April 18. She moved east to Young Inlet at Emma Point May 3, returning May 28 and remaining at east Purcell Bay until June 9. On June 13 she was travelling north and on June 28 she was in the northern Purcell Bay lowlands again. Muskox 7720's PTT only transmitted locations for 3 days in July 2004. On July 14 she was at northern Purcell Bay, and on July 18 and July 22, she was along eastern Purcell Bay. She was back to northern Purcell Bay August 3. August 20 she appeared to be moving south, and was at the eastern Purcell Bay lowlands August 25-September 2, before moving to Young Inlet for September 9. She remained around Young Inlet until December 23, when she moved west from Emma Point to the north shore of Purcell Bay. She spent January until July 13 within 15 km of northern Purcell Bay. On July 13 she moved south to the eastern Purcell Bay lowlands, moving north again on August 7. At the time of her last location, August 22, she appeared to be moving, with no location cluster to indicate a mortality or dropped collar, so it is likely that the collar malfunctioned and the PTT stopped sending locations before drop-off.

Muskox 7720 used 4 relatively discrete lowland areas between Young Inlet and May Inlet at Purcell Bay – the north and east shores of Purcell Bay, and the south and west shores of Young Inlet south of Emma Point. During the summer (2003-2005), she moved primarily between the north and east Purcell Bay lowlands. She spent September at Purcell Bay in 2003, at the west and south Young Inlet lowlands in 2004. In 2003 and 2004 she spent early winter at Young Inlet, then moved later in the season to northern Purcell Bay. Muskox 7720's locations and home range are shown in Figure 19, Figure 20, Figure 21, and Figure 22.

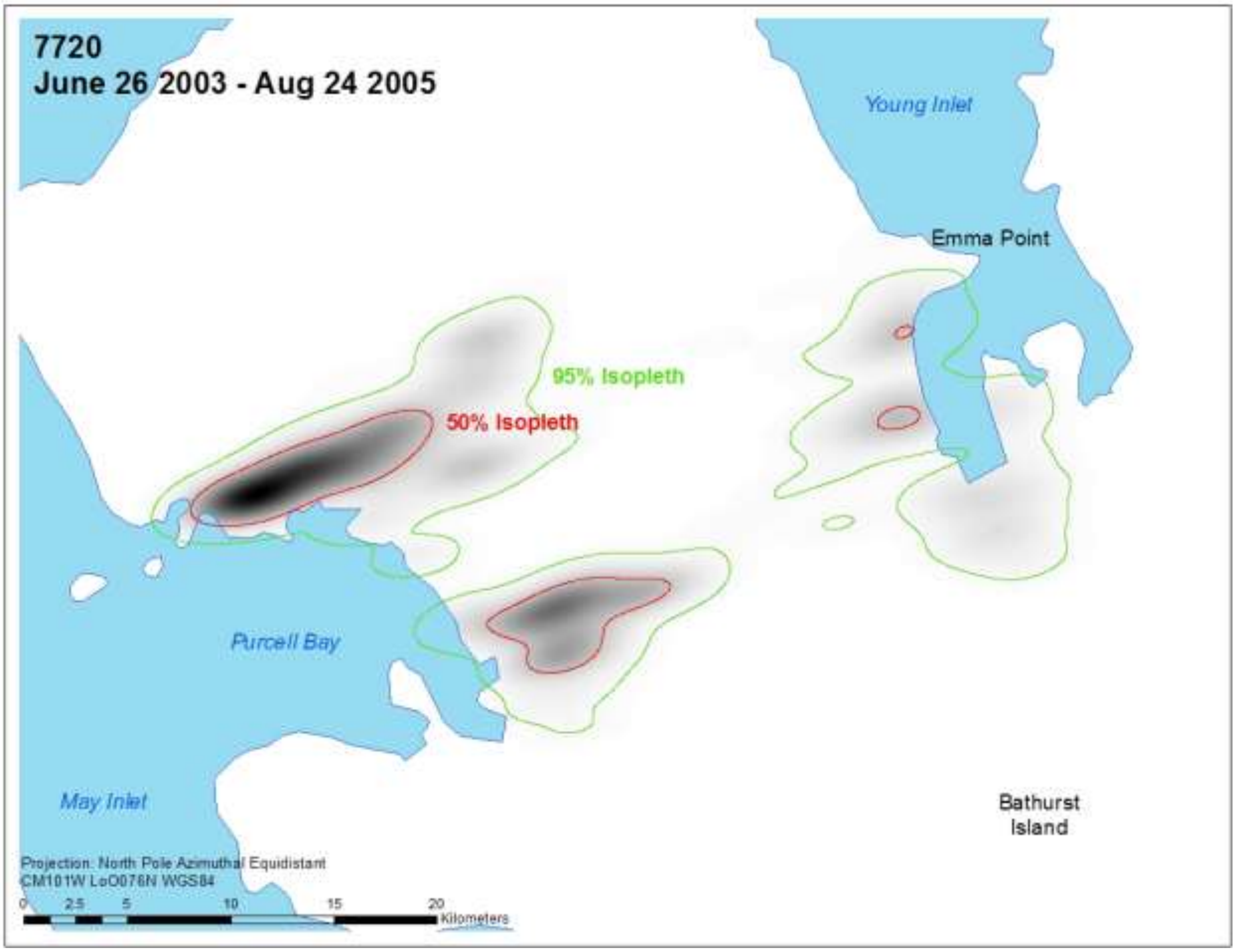


Figure 19. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7720. Bandwidth (variance x, variance y, xy covariance): 2215549.66878574, 420784.245682144, 436783.909056074 (SCV; N=1064).

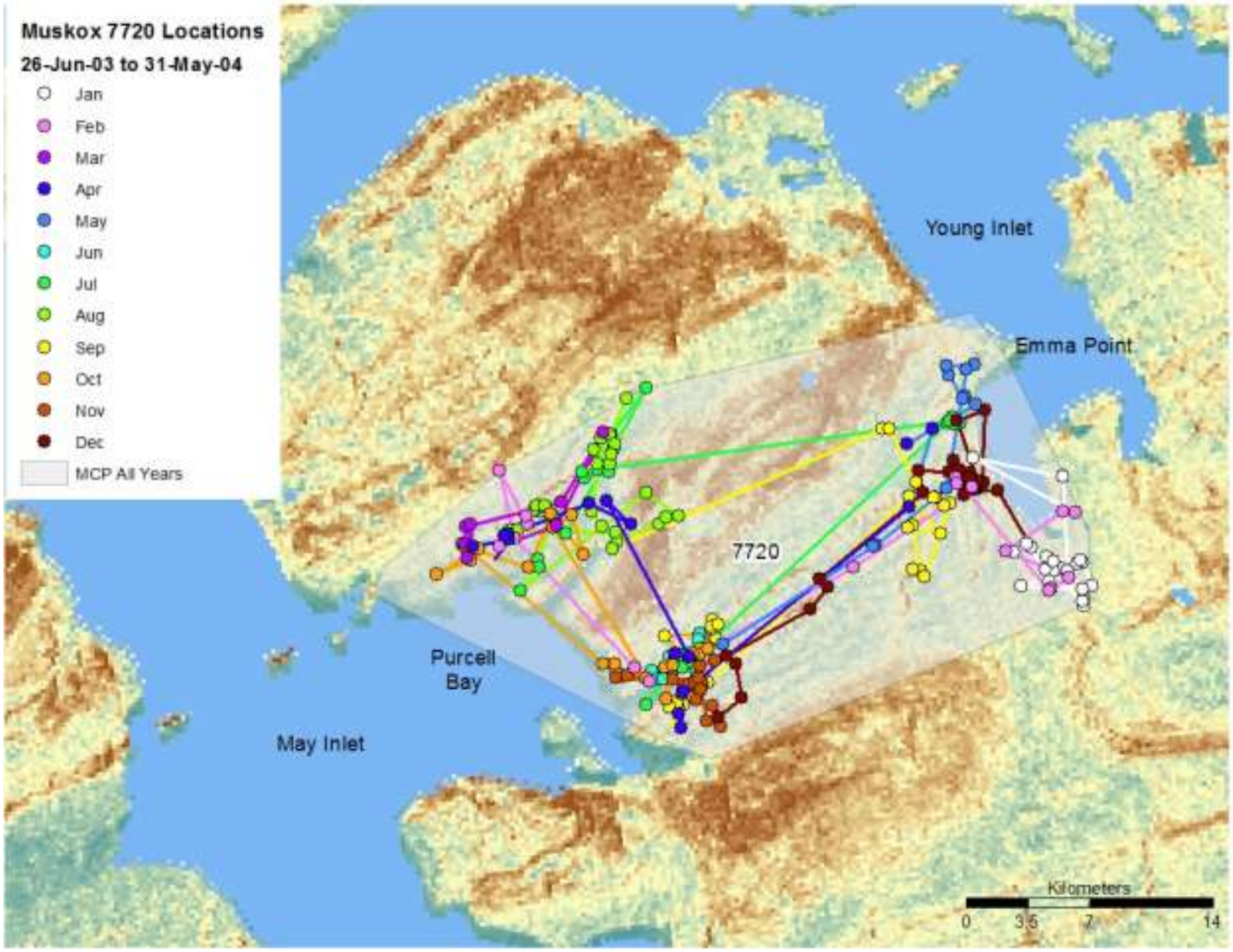

Figure 20. Locations of Muskox 7720 in 2003-04 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

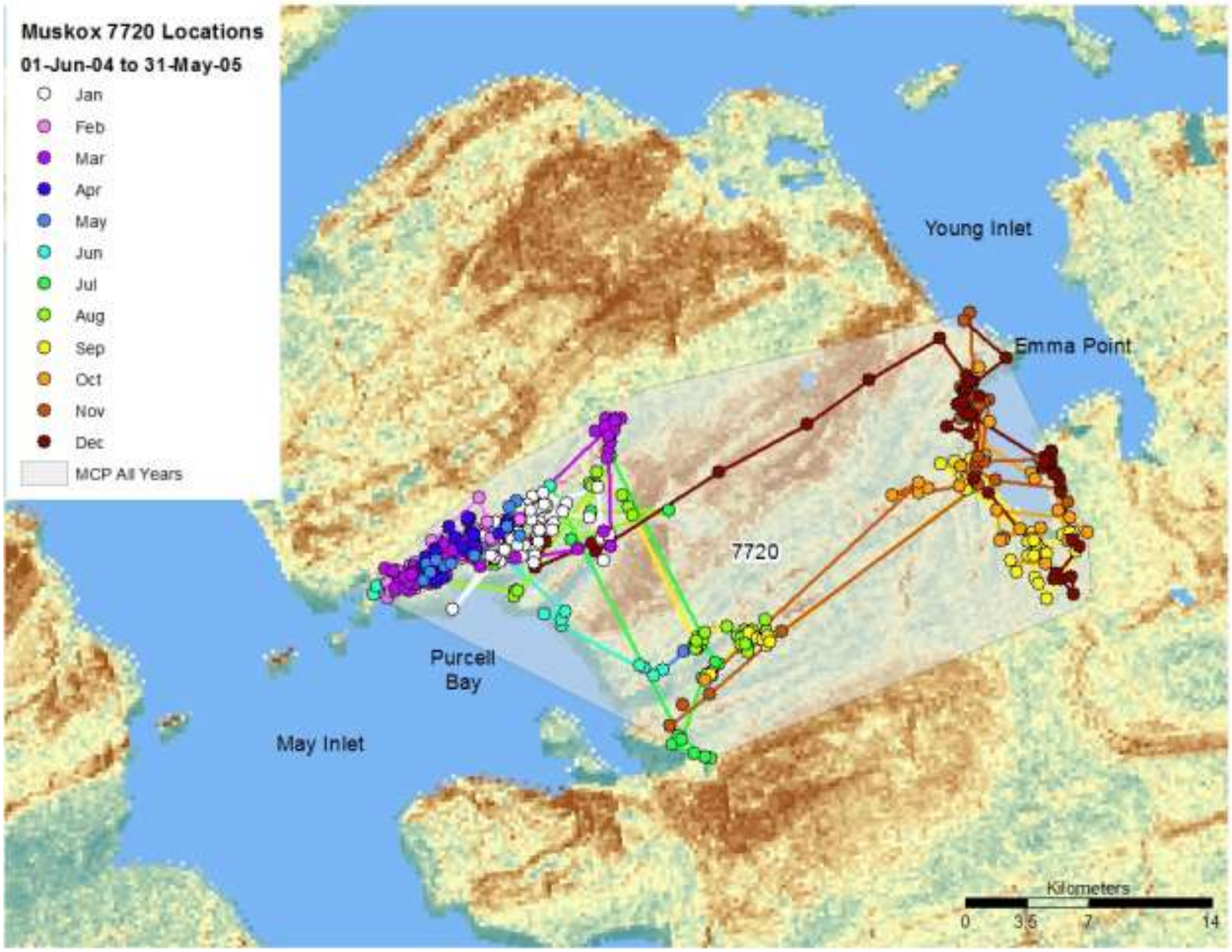

Figure 21. Locations of Muskox 7720 in 2004-05 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

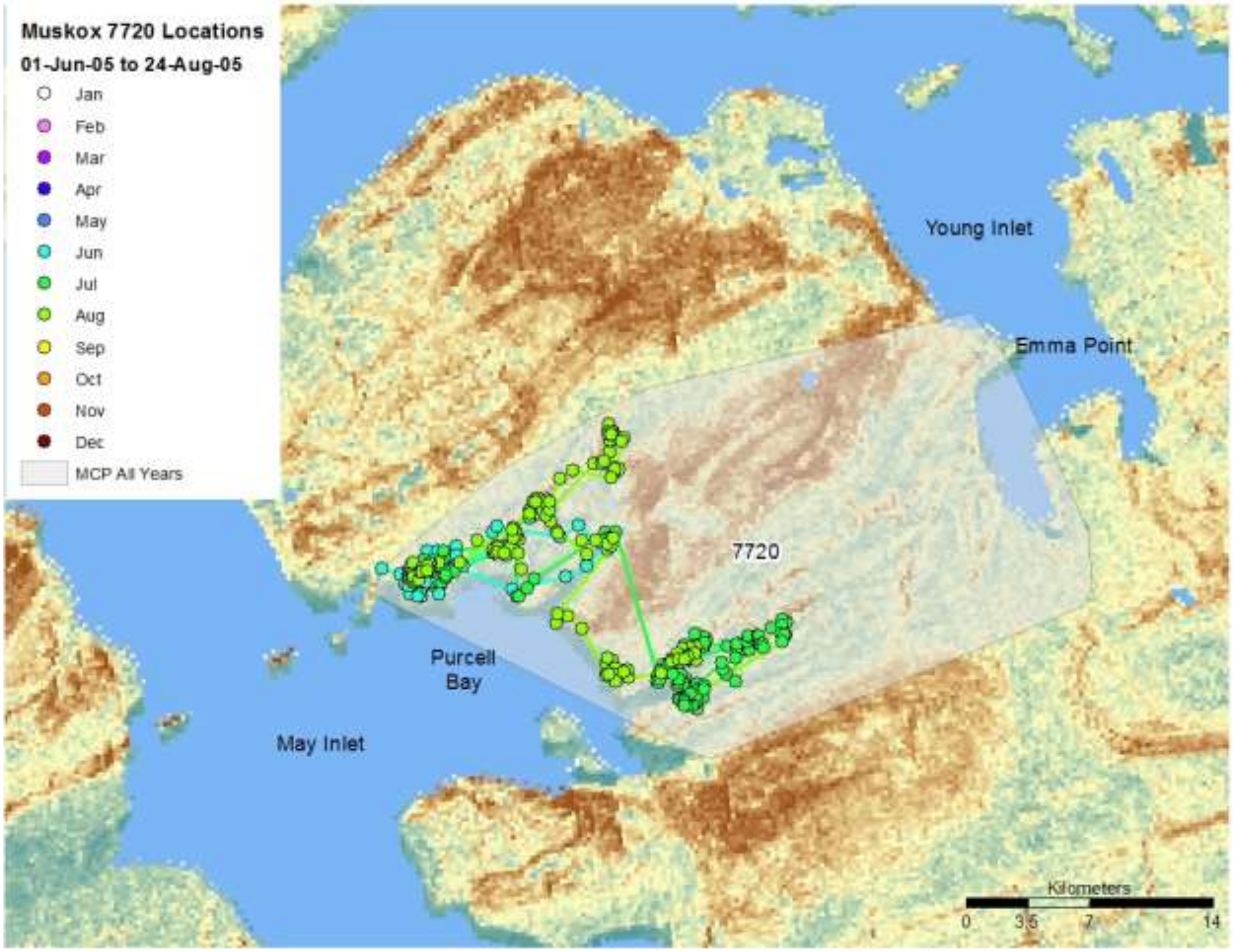

Figure 22. Locations of Muskox 7720 in 2005 on Bathurst Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 300 m, in brown. MCP home range over all years shown in grey.

*Muskox 7724*

Muskox 7724 was captured on June 27, 2003, near Inglis Sound on Devon Island, with one other adult and 1 yearling muskox. She was skinny at the time of capture. She remained in the area until August 11, when she moved east to Arthur Fiord. She moved north up the fiord to the Tucker River inland from Wilmer Bay from September 19-28, and arrived October 2 along the Ensorcellement River, where she remained for fall and early winter. In January 2004, she moved back to Tucker River until March 30, when she returned to Ensorcellement River on April 3. She remained there until November 5. On November 13 she was at Arthur Fiord and on November 17 she was at Inglis Sound near Stewart Point. She remained in the area until March 8, 2005. She spent March 21 to May 3 at Ensorcellement River. Her May 12 location, inland from Arthur Fiord and Barrow Harbour suggests she may have followed a river to the Ensorcellement headwaters rather than following the coastline. She was inland from Inglis Bay in the west to Cape Simpkinson in the east until July 23. On August 8, she was at the Ensorcellement River. From August 15-20 she was at Cape Disraeli and the Tucker River, returning north of Mount Parker on September 8 to the Ensorcellement River. On October 27 she moved east along the coast to Cape Disraeli. She remained there until moving on December 26 south to a river west of Cape Simpkinson, where she remained until February 4. She continued north along Inglis Sound into the interior on March 4, and Tucker River on March 12. She continued north along the coastal lowlands by Mount Parker towards the Ensorcellement River, where her last location was recorded in a cluster of points within 900 m on June 12.

Muskox 7724 used river valleys and coastal lowlands. She spent summer 2003 at Inglis Sound, and summer 2004 and 2005 at Ensorcellement River. She spent fall at Ensorcellement River in all three years. She spent early winter in different locations each year, 2003 along the Ensorcellement River, 2004 at Inglis Sound, and 2005 at Cape Disraeli. She spent the late winter along the south shore of Devon Island in 2005 and 2006, although in 2004 she was at Tucker River. She appears to have used at least 2 routes and a combination of coastline and inland corridors to connect these activity centers. Muskox 7724's locations and home range are shown in Figure 23, Figure 24, Figure 25, and Figure 26.

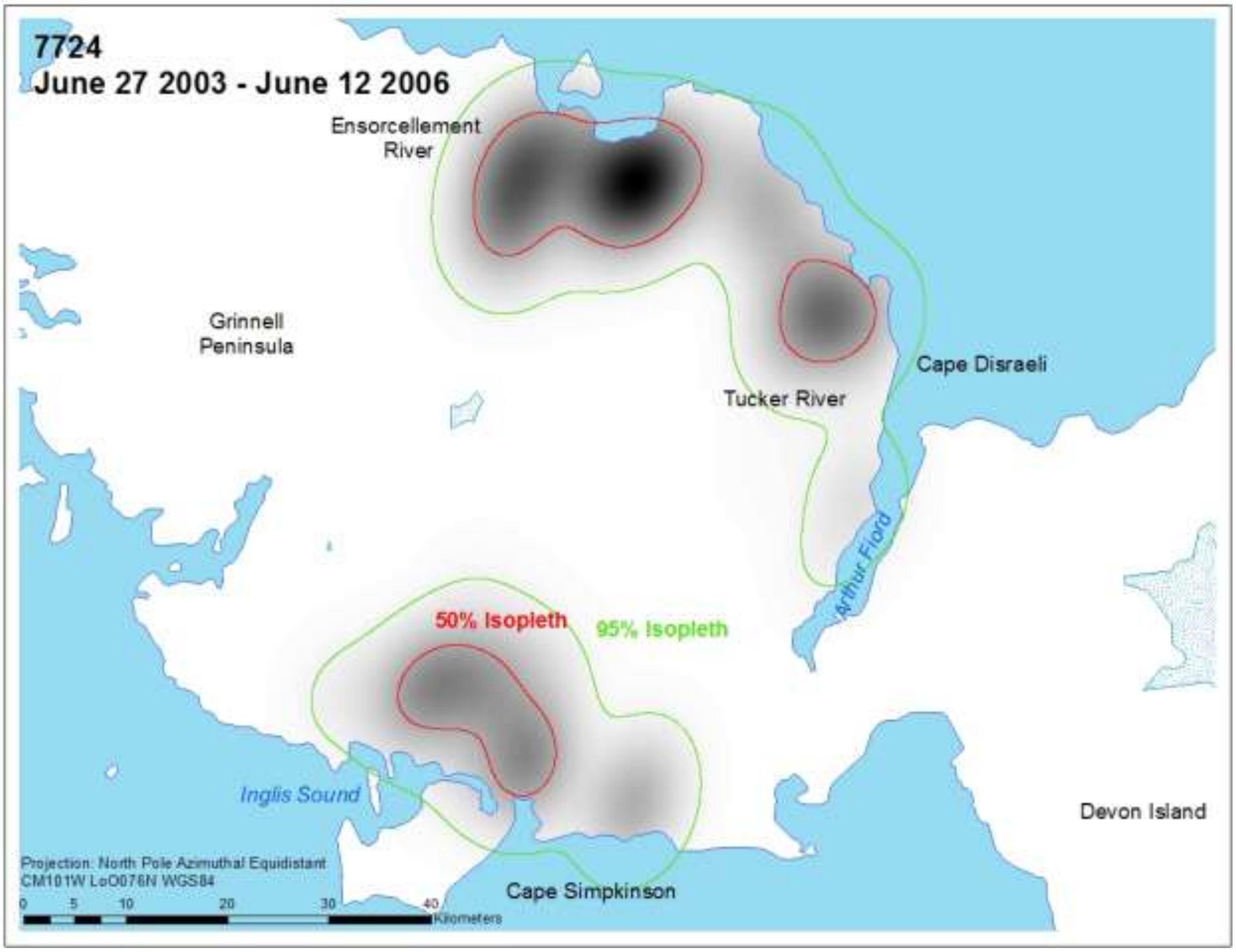


Figure 23. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7724. Bandwidth (variance x, variance y, xy covariance): 9847867.03144586, 15945639.6023741, 1918762.01300923 (SCV; N=302).

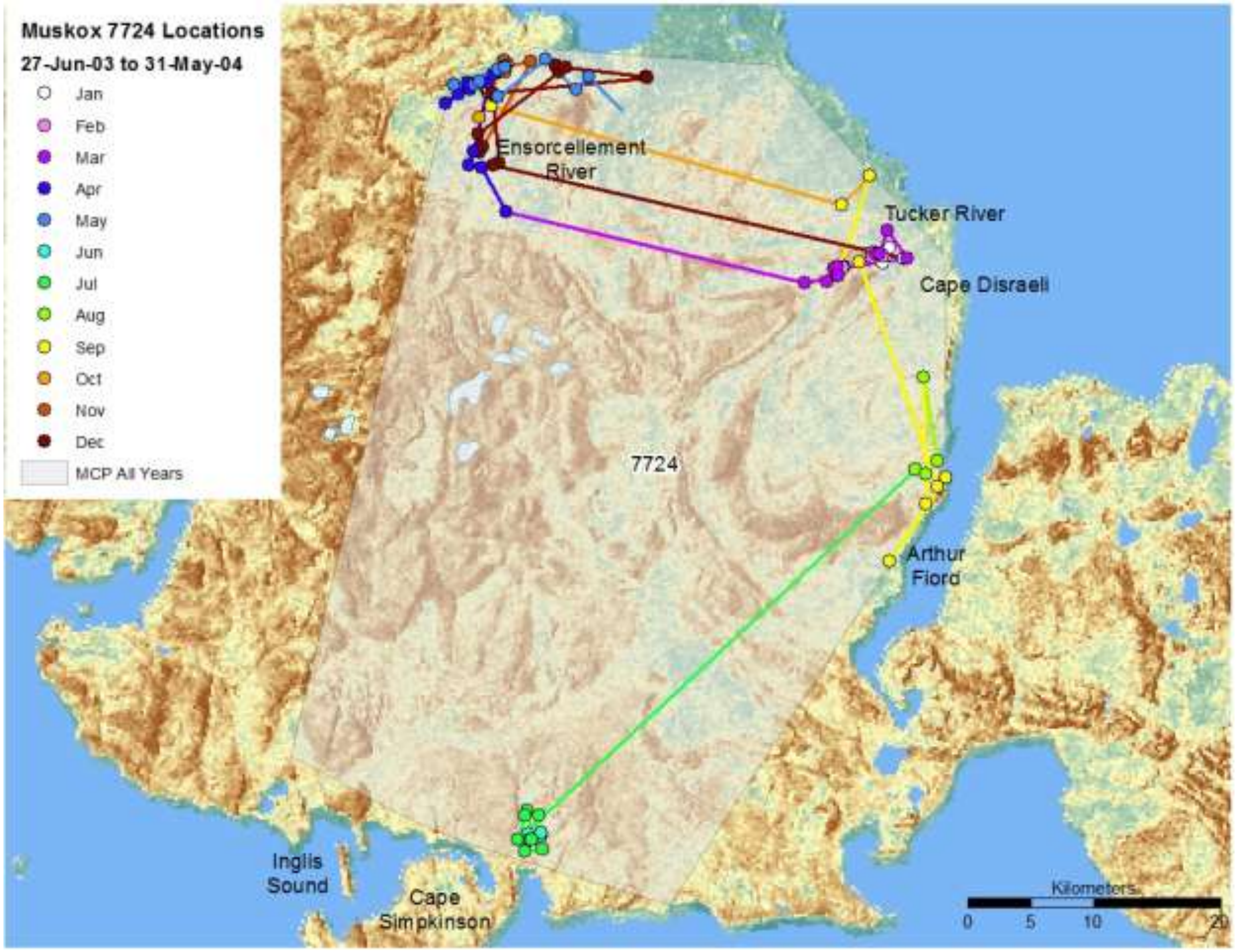


Figure 24. Locations of Muskox 7724 in 2003-04 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. Ice fields and glaciers are stippled blue and white. MCP home range over all years shown in grey.

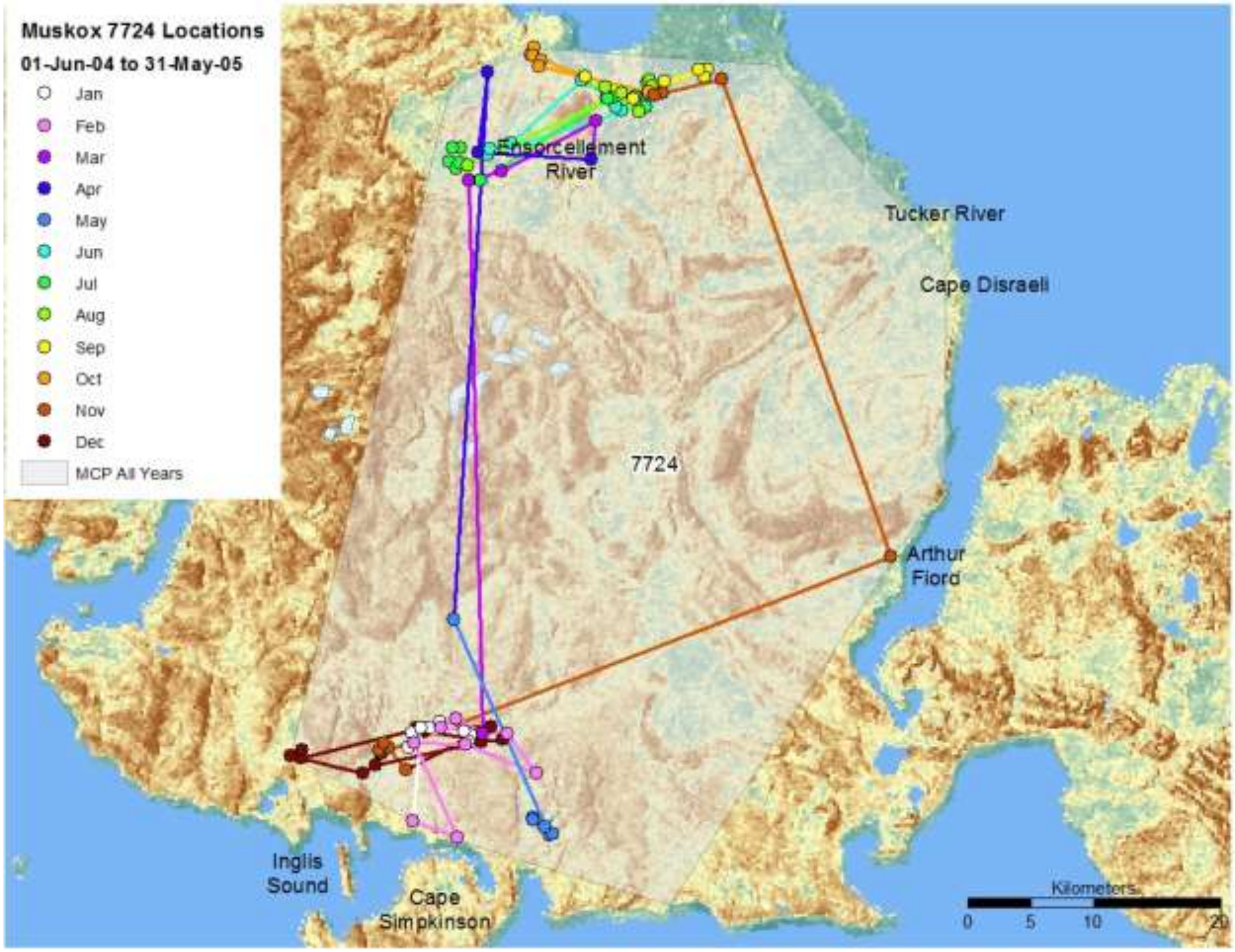


Figure 25. Locations of Muskox 7724 in 2004-05 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. Ice fields and glaciers are stippled blue and white. MCP home range over all years shown in grey.

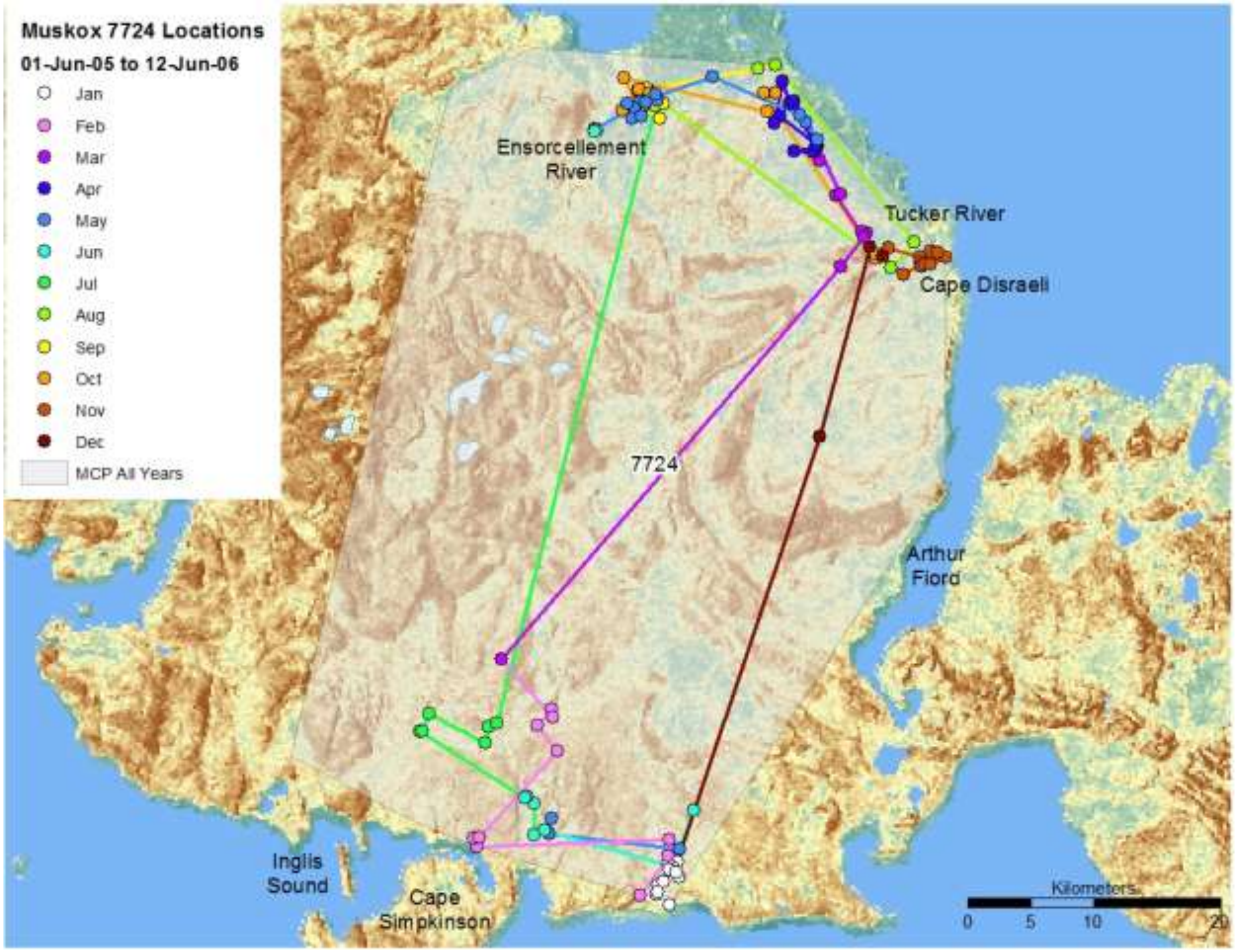


Figure 26. Locations of Muskox 7724 in 2005-06 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. Ice fields and glaciers are stippled blue and white. MCP home range over all years shown in grey.

*Muskox 7729*

Muskox 7729 was collared June 28, 2003, at Baring Bay on Devon Island. She remained along the coast between Point Hogarth in the north and Owen Point in the south until September 8. On October 15, she was located near Dragleybeck Inlet. She returned north to the Owen Point area and 15 km south along the shore and remained there until April 23, 2004, when she moved north to Point Hogarth. Her last location was May 9, 2004, 4 km north of Point Hogarth. Although she was only collared for 10 months, she remained along the coastal lowlands in all seasons (Figure 27, Figure 28).

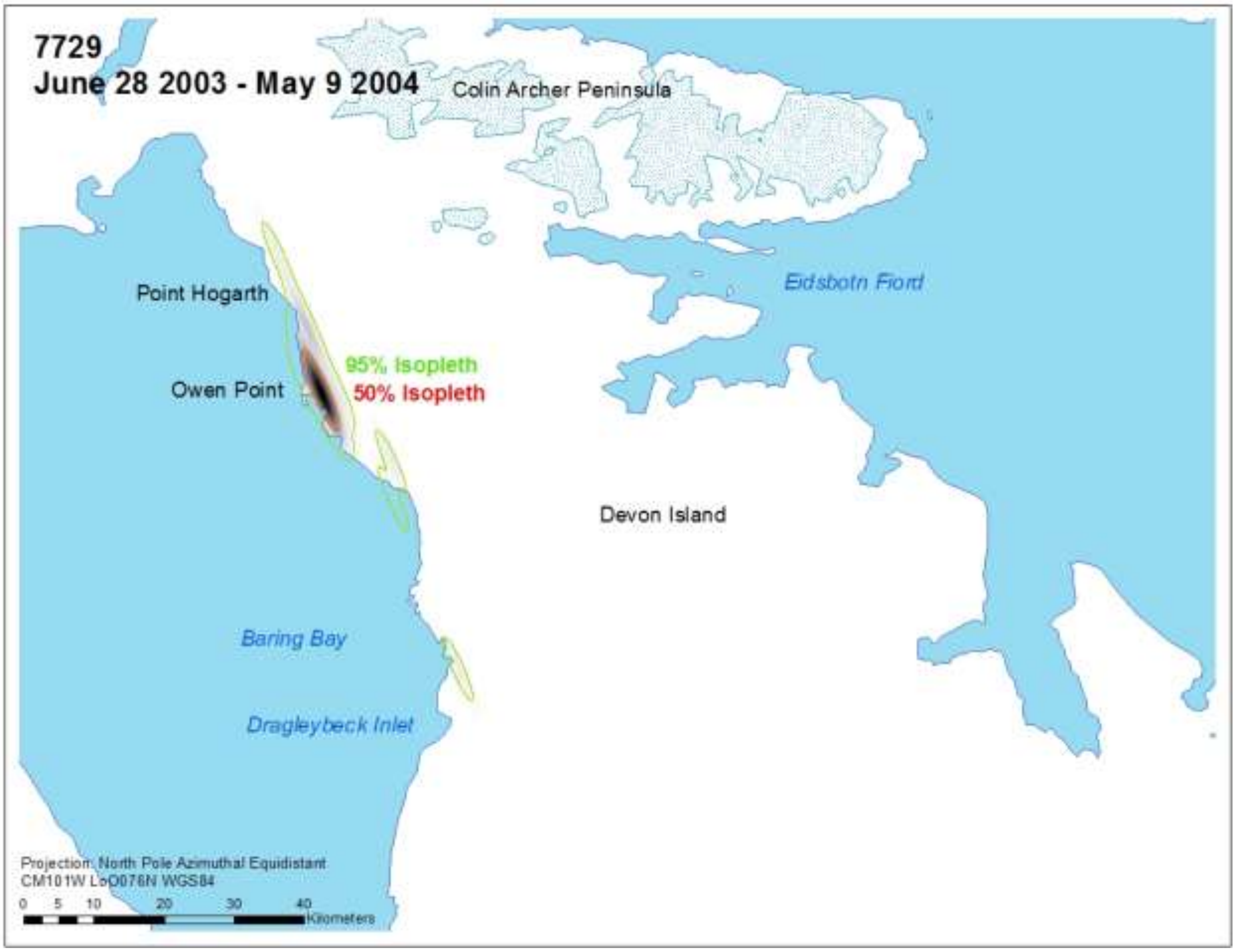


Figure 27. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7729. Bandwidth (variance x, variance y, xy covariance): 2099262.58774062, 9246764.10793008, -4004666.22941573 (SCV; N=36).

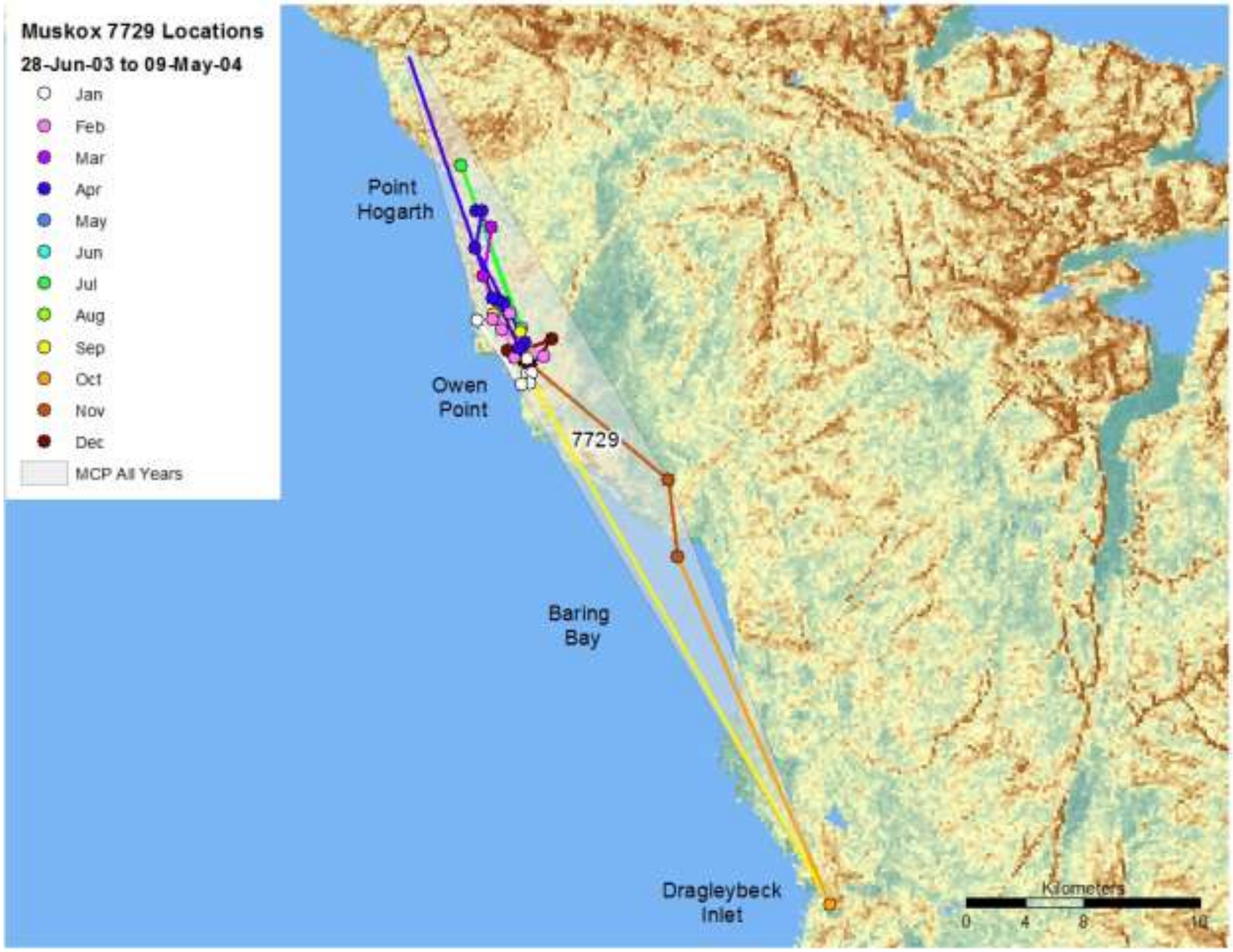


Figure 28. Locations of Muskox 7729 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. MCP home range shown in grey.

*Muskox 7734*

Muskox 7734 was collared about 20 km inland from the Dragleybeck Inlet area of Baring Bay, on Devon Island. She was skinny at the time of capture. She remained along a 15-km stretch of land until October 26. She moved briefly north August 27 to September 4, and moved back to that area on October 30. By November 7 she was at the shore of Dragleybeck Inlet, moving north in December and back south by December 29. She remained in this area, about 15 km inland from Dragleybeck Inlet, until moving 5 km east May 21-25. She remained in that area until July 12, when she moved 5 km west to her previously occupied area. She was back east on August 9 until October 24, moving November 1 back to the western site. She remained there until moving to the eastern site on April 6, 2005. She moved south and then to the western site on July 19, where she remained until August 28. She returned to the western site on December 10 and remained there until March 8, 2006. By March 20, she was on the south shore of Eidsbotn Fiord. She continued north across the Colin Archer Peninsula, apparently crossing icefields, with a final location on April 5. There was a cluster of locations within 1.5 km, around this point, as well as some locations in a similar cluster 1.5 km away (April 17 to May 15). Either satellite error led to this cluster, or the PTT moved (with or without Muskox 7734) during this time period. Previous locations for 7734 did not show the same pattern of close clustering over several days.

In summer 2003, 2004, and 2005, Muskox 7734 spent most of her time in 2 areas, about 15 and 20 km inland from Dragleybeck Inlet, mostly in the eastern area but she did move to the west in midsummer before returning to the eastern site until early winter. She spent winters at the western site, about 15 km from Dragleybeck Inlet. In spring 2006, she overlapped several of these areas with 7743, although 7743 did not go north to Colin Archer Peninsula, moving east instead. The movement may have been out of 7734’s typical home range, since it seems incongruous with her previous short distance movements along Baring Bay. Muskox 7734’s locations and home range are shown in Figure 29, Figure 30, Figure 31, and Figure 32.

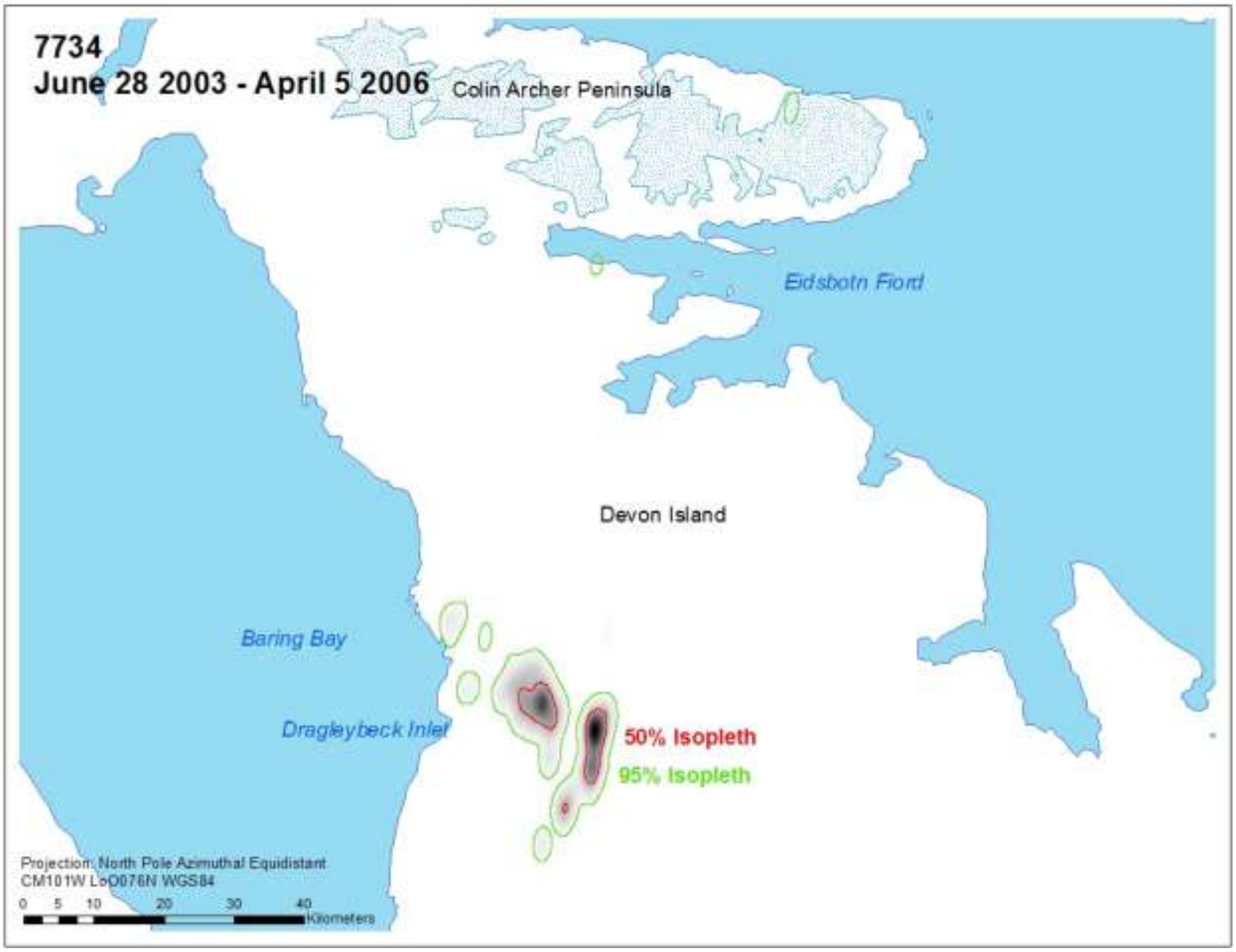


Figure 29. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7734. Bandwidth (variance x, variance y, xy covariance): 519319.857416571, 2252010.07494058, 173091.35136827 (SCV; N=729).

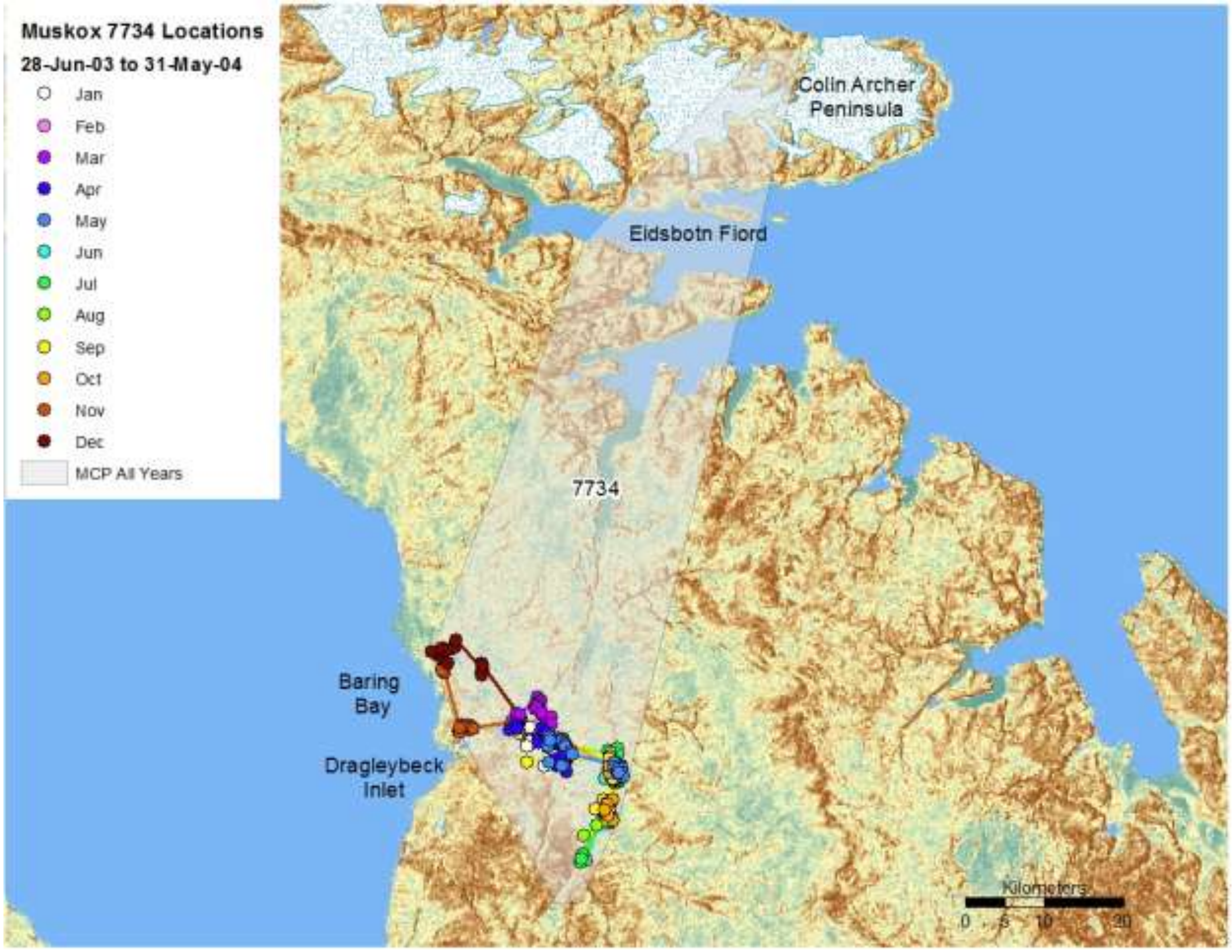


Figure 30. Locations of Muskox 7734 in 2003-04 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. Ice fields and glaciers are stippled blue and white. MCP home range over all years shown in grey.

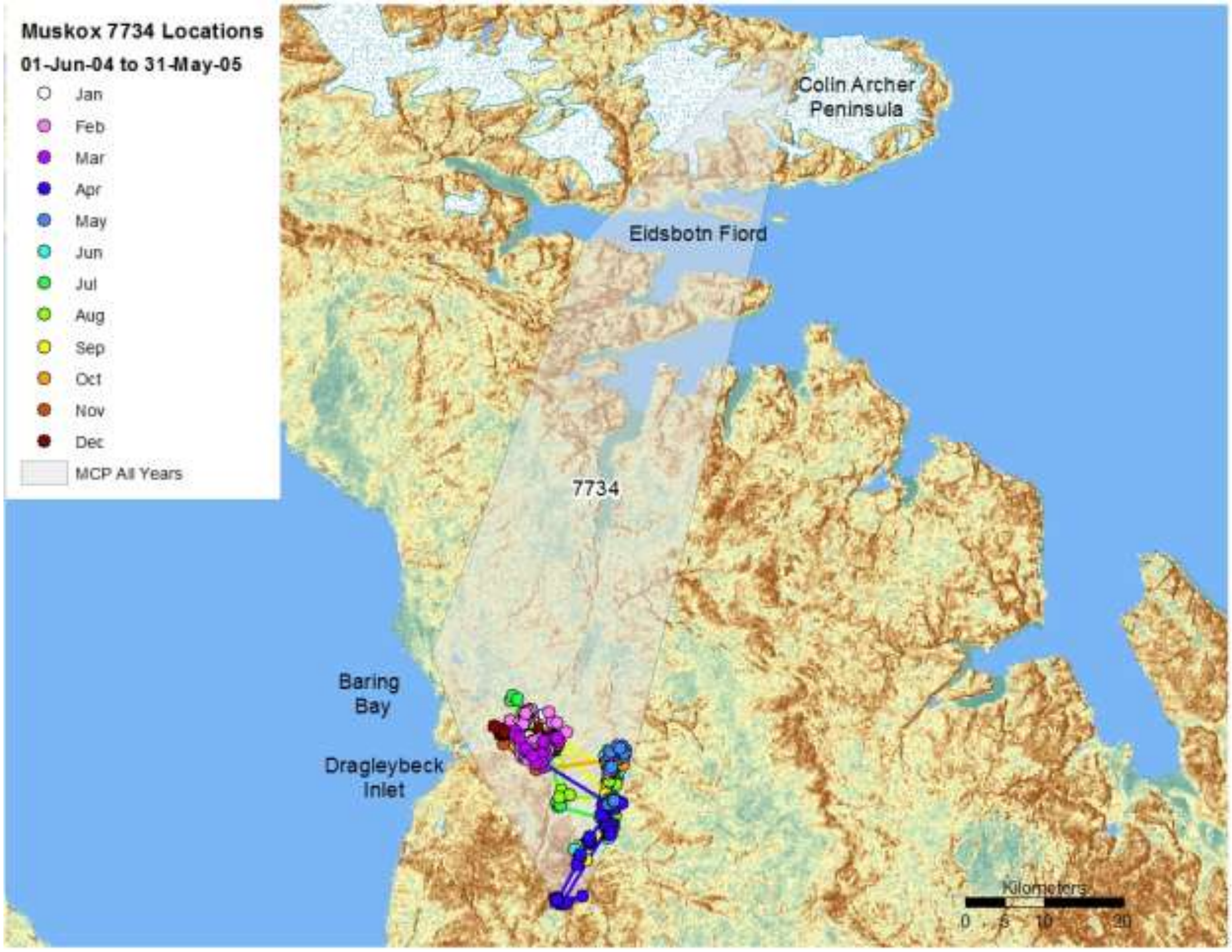


Figure 31. Locations of Muskox 7734 in 2004-05 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. Ice fields and glaciers are stippled blue and white. MCP home range over all years shown in grey.

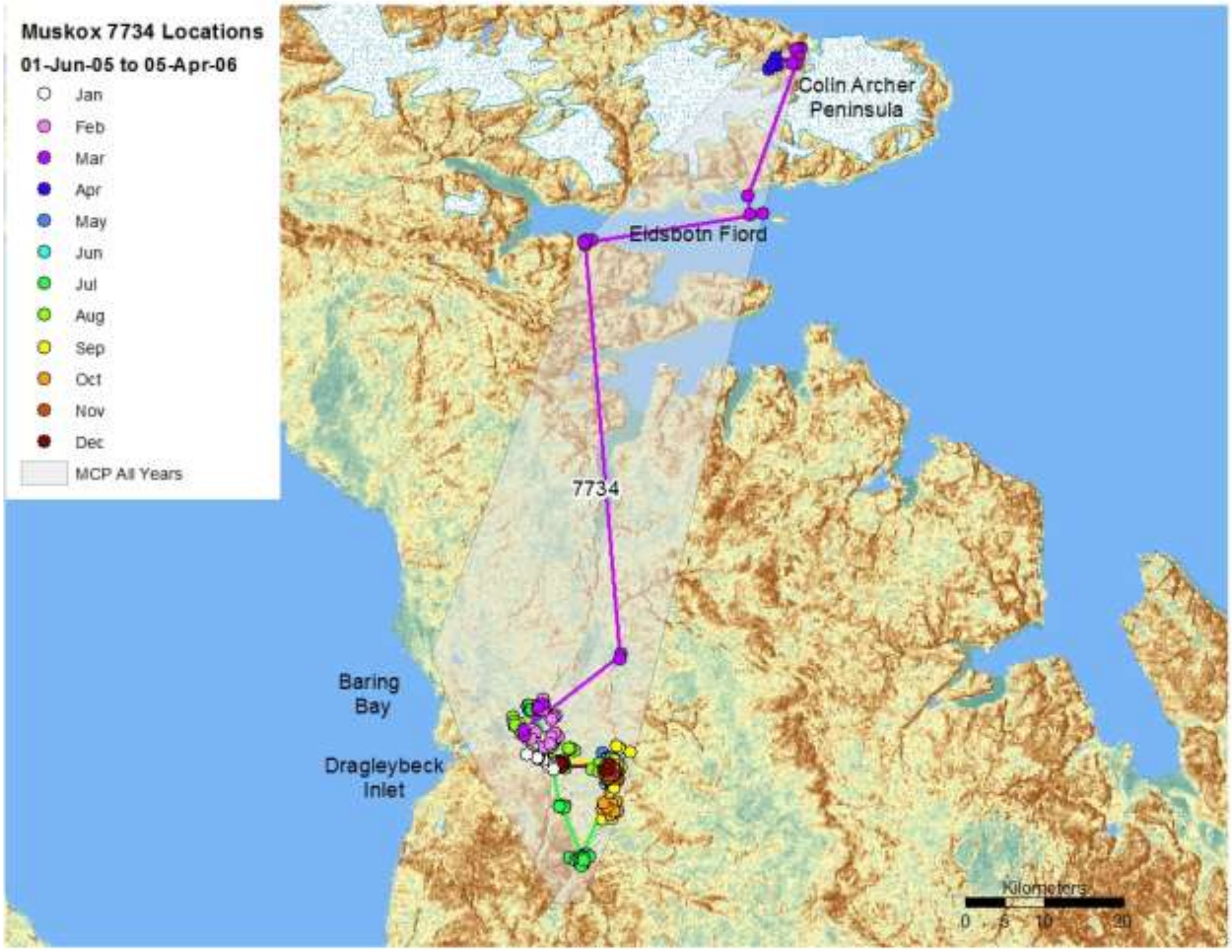


Figure 32. Locations of Muskox 7734 in 2005-06 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. Ice fields and glaciers are stippled blue and white. MCP home range over all years shown in grey.

*Muskox 7735*

A skinny Muskox 7735 was collared June 30, 2003 at Cape Donnet on southern Devon Island, with her calf, another adult, and a subadult. She remained in the area of Cape Donnet north to the end of Ryder Inlet until moving north on August 26. She arrived at Sverdrup Inlet following a river valley from the southwest by mid-October. She moved about 15 km south, along another river valley, until her last location on November 22. There was no clear cluster of locations around this point, suggesting her PTT stopped transmitting. Muskox 7735's locations and home range are shown in

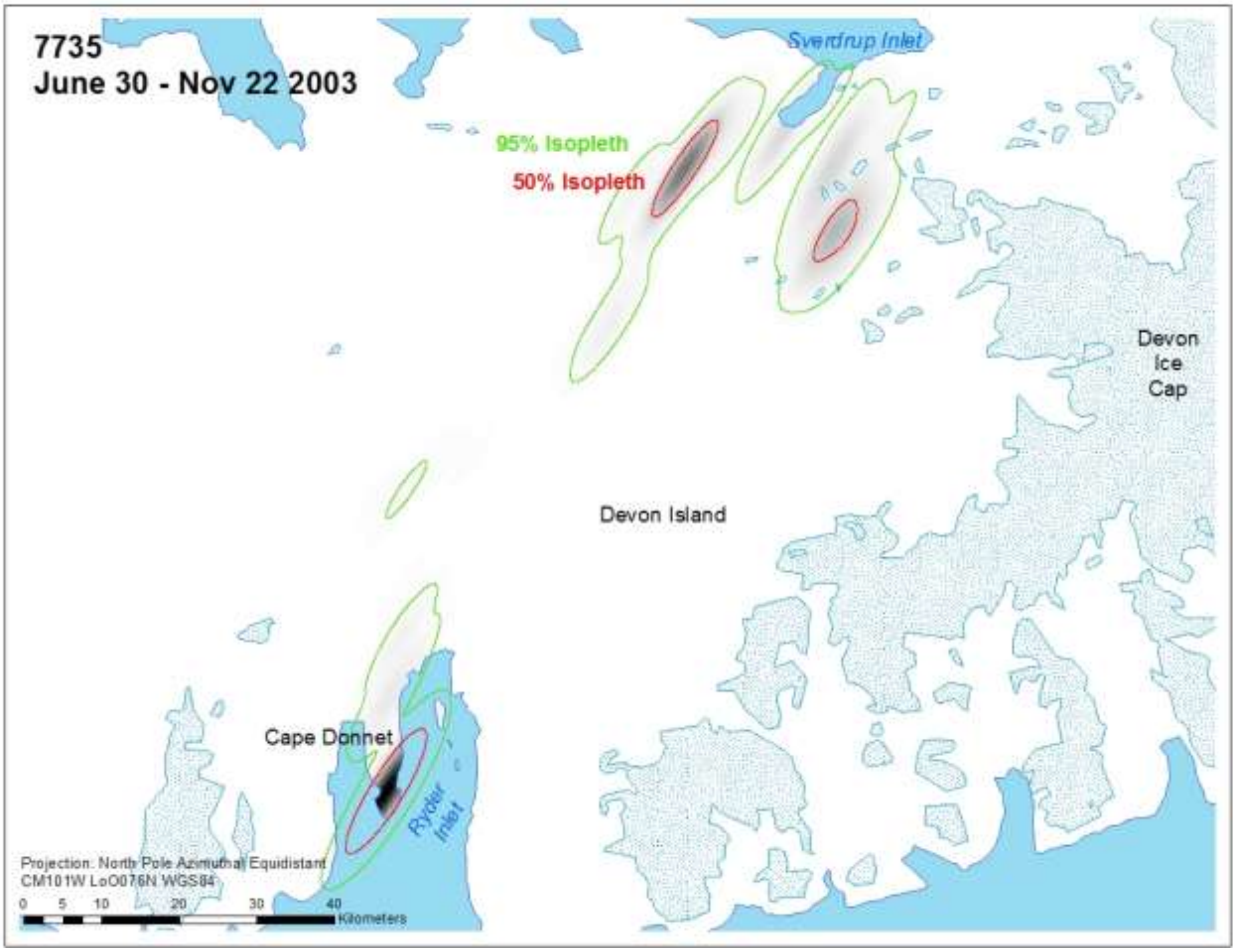


Figure **33** and Figure 34.

Since Muskox 7735 was only collared for 4 months, it is not possible to say whether her home range normally included multiple high productivity areas on the north and south coasts of Devon Island, or whether she was making a long distance movement to access more forage. This does not coincide with any long distance movement by 7734 to the west, and 7729's PTT stopped transmitting in spring 2004, so there was not an obvious widespread event causing movements or mortalities with the other collared Devon Island muskoxen.

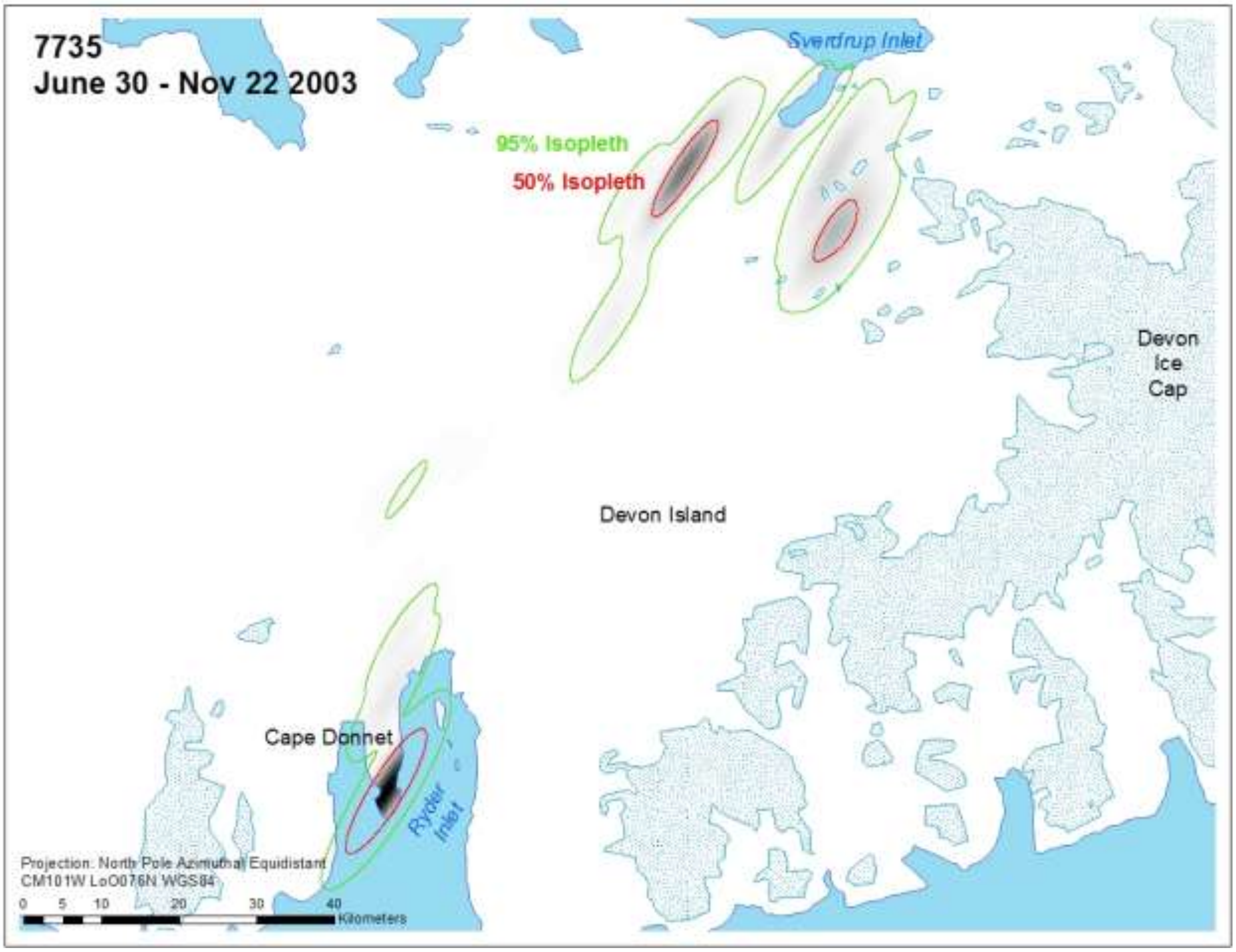


Figure 33. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7735. Bandwidth (variance x, variance y, xy covariance): 7346936.00408111, 16717813.7902949, 10224095.7993297 (SCV; N=533).

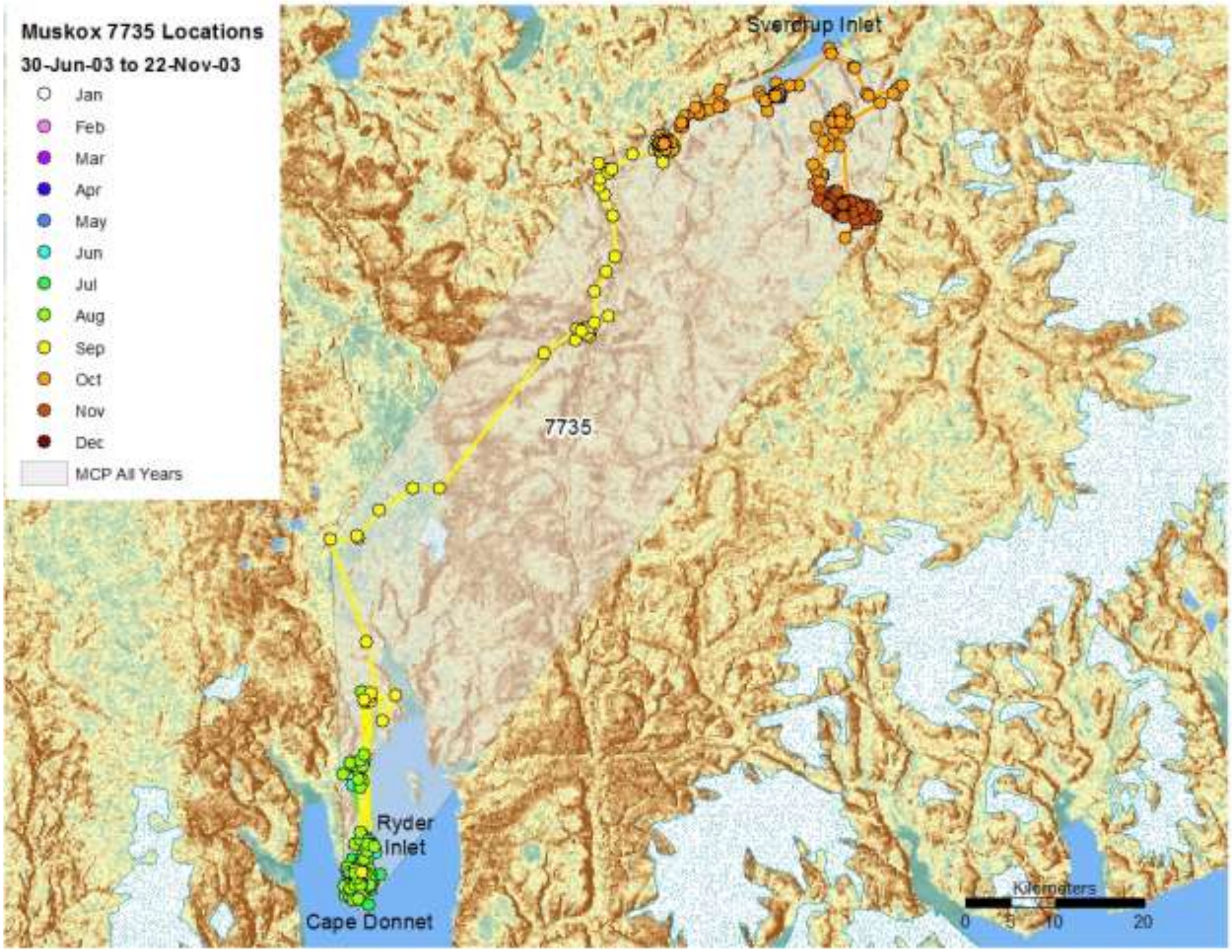


Figure 34. Locations of Muskox 7735 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. Ice fields and glaciers are stippled blue and white. MCP home range shown in grey.

*Muskox 7743*

Muskox 7743 was collared on July 2, 2003, 15 km inland from Dragleybeck Inlet. Although thin when she was captured, she was otherwise large and healthy. She did not have a calf. She remained near her capture location until October 23, moving about 5 km west on October 31. She moved to the north shore of the inlet until January 3, 2004. She remained in the western site east of Dragleybeck Inlet from January 19 until March 7. From March 15 until November 6 she remained in the same area. She spent the rest of November and December 45 km east, near Haughton Dome. She stayed mostly within a 2 $km^2$ area until August 1, when she moved west, arriving about 20 km east of Dragleybeck Inlet on August 5. She remained in that 15-km strip until her last collar location. Her previous restricted movements make it difficult to determine when the PTT because stationary, but it was likely around May 16, 2006.

Muskox 7743's home range overlapped substantially with 7734, but 7743 did not move north to the Colin Archer Peninsula in spring 2006. She moved less frequently out of the area 20 km east of Dragleybeck Inlet, but when she did, it was a long distance to Haughton Dome, where she spent the winter and next summer in a small area before returning. Muskox 7743's locations and home range are shown in Figure 35, Figure 36, Figure 37, and Figure 38.

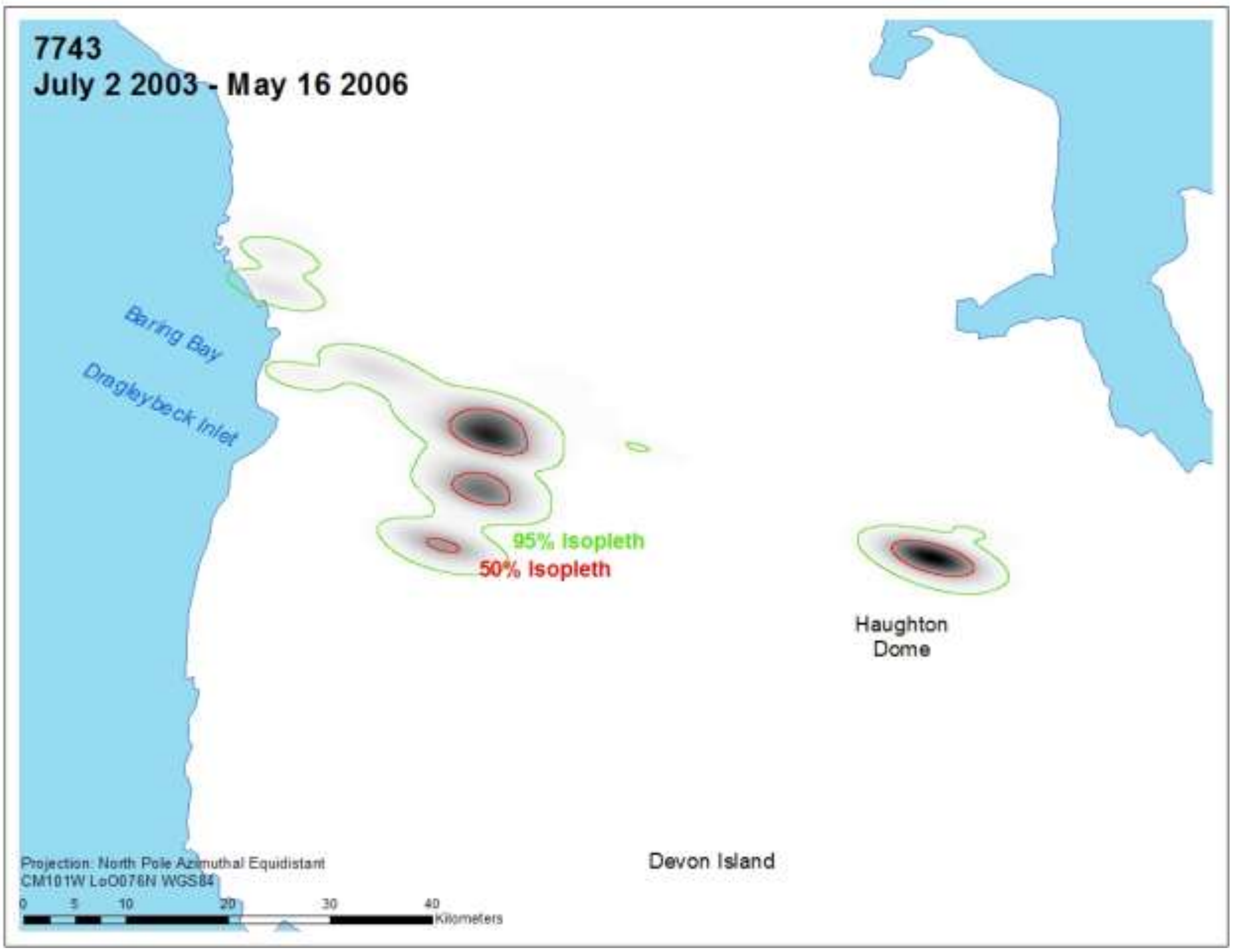


Figure 35. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7743. Bandwidth (variance x, variance y, xy covariance): 6656226.97091622, 990935.857586047, -1660759.61258757 (SCV; N=435).

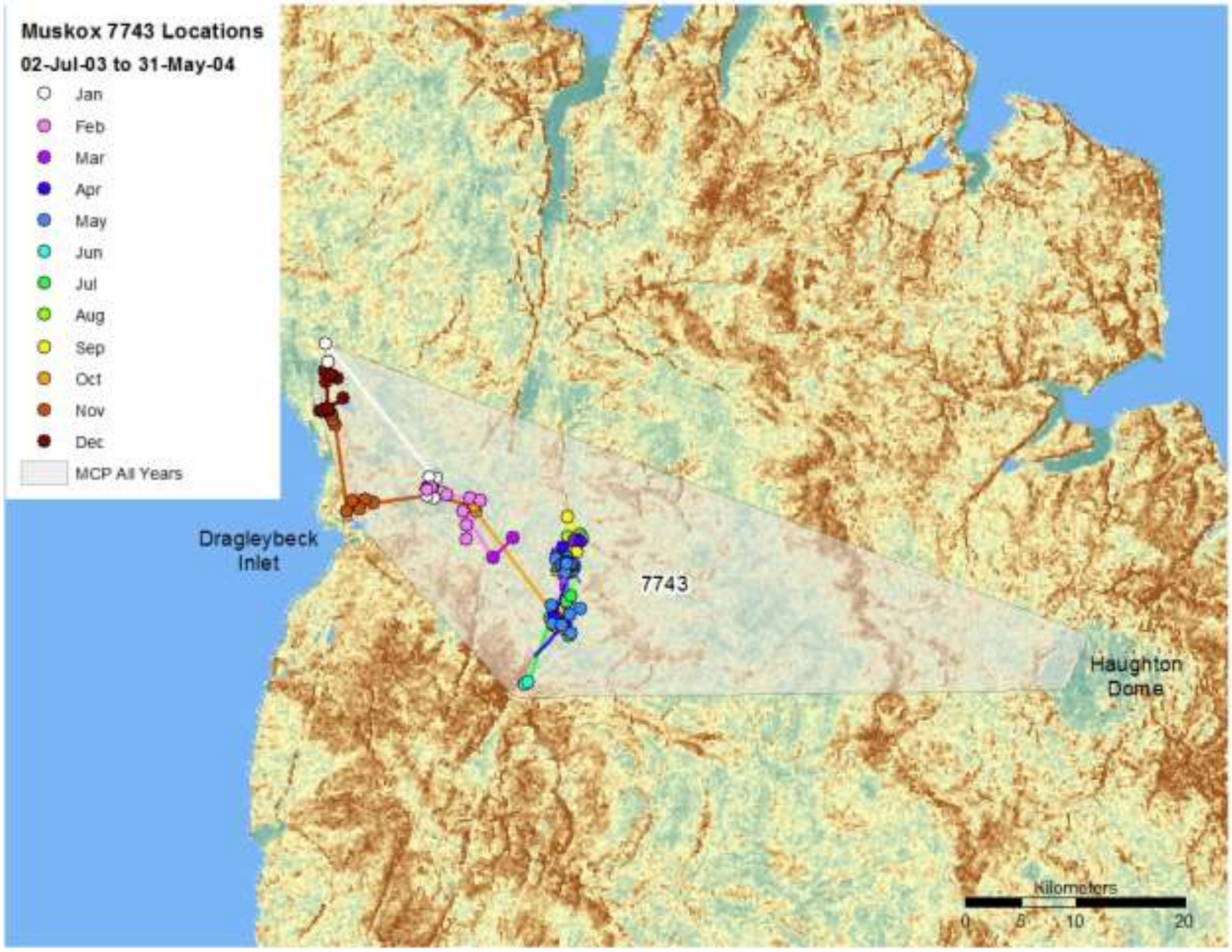


Figure 36. Locations of Muskox 7743 in 2003-04 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. MCP home range over all years shown in grey.

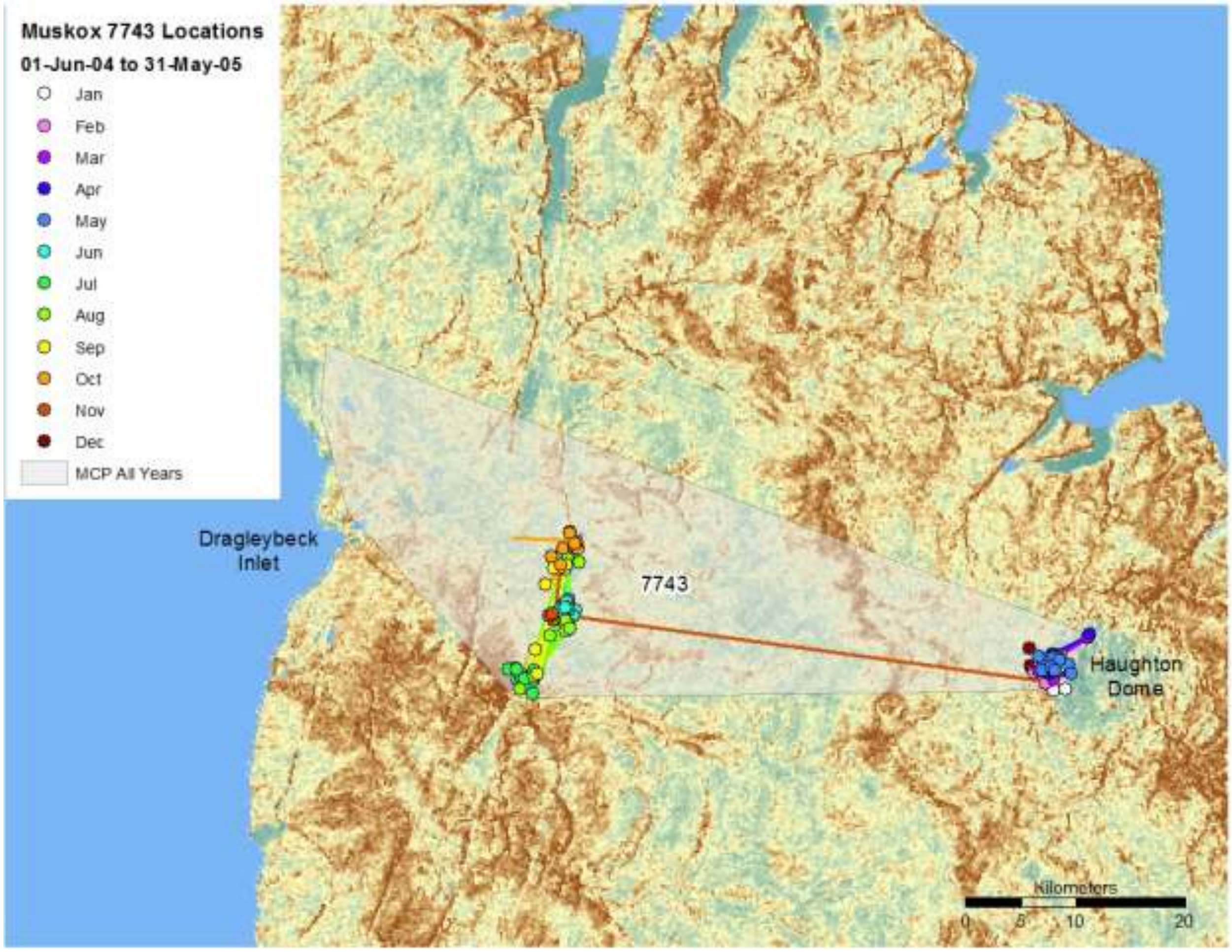


Figure 37. Locations of Muskox 7743 in 2004-05 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. MCP home range over all years shown in grey.

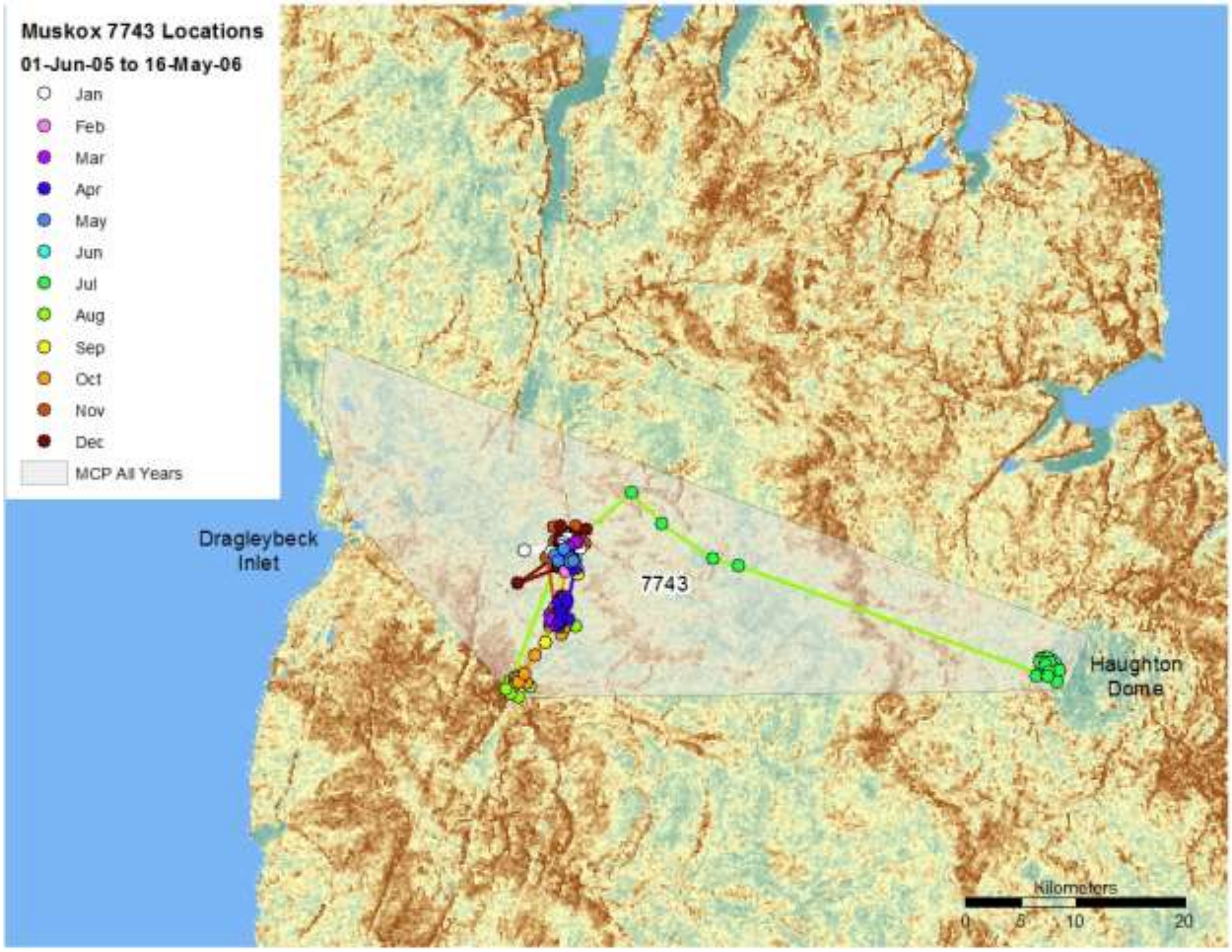


Figure 38. Locations of Muskox 7743 in 2005-06 on Devon Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. MCP home range over all years shown in grey.

*Muskox 7737*

Muskox 7737 was collared on July 2, 2003, inland from the Marshall Peninsula on Cornwallis Island. She moved about 25 km east from her capture location and gradually continued east for another 20 km until July 27, then north and west until September 17, then east again until February 28, 2004. Her next location, on March 31, was about 8 km south and by the next location on April 24 she was on the west coast of Cornwallis Island at Rookery Creek. She continued north along the shoreline until July 21, then east until July 24. She remained there until October 21, with a brief movement west from September 3-15. On November 10 she was on the west coast of Cornwallis Island at Rookery Creek again. She moved north along the coast from January 5, 2005, to March 6. Her PTT was stationary on June 18, 2005, with locations clustered within about 800 m.

Muskox 7737 moved from the northwest coast of Cornwallis Island in summer 2003. She spent the winter in northeast Cornwallis Island. She split summer 2004 and winter 2005 between the 2 areas, and spring 2006 on the west coast
(

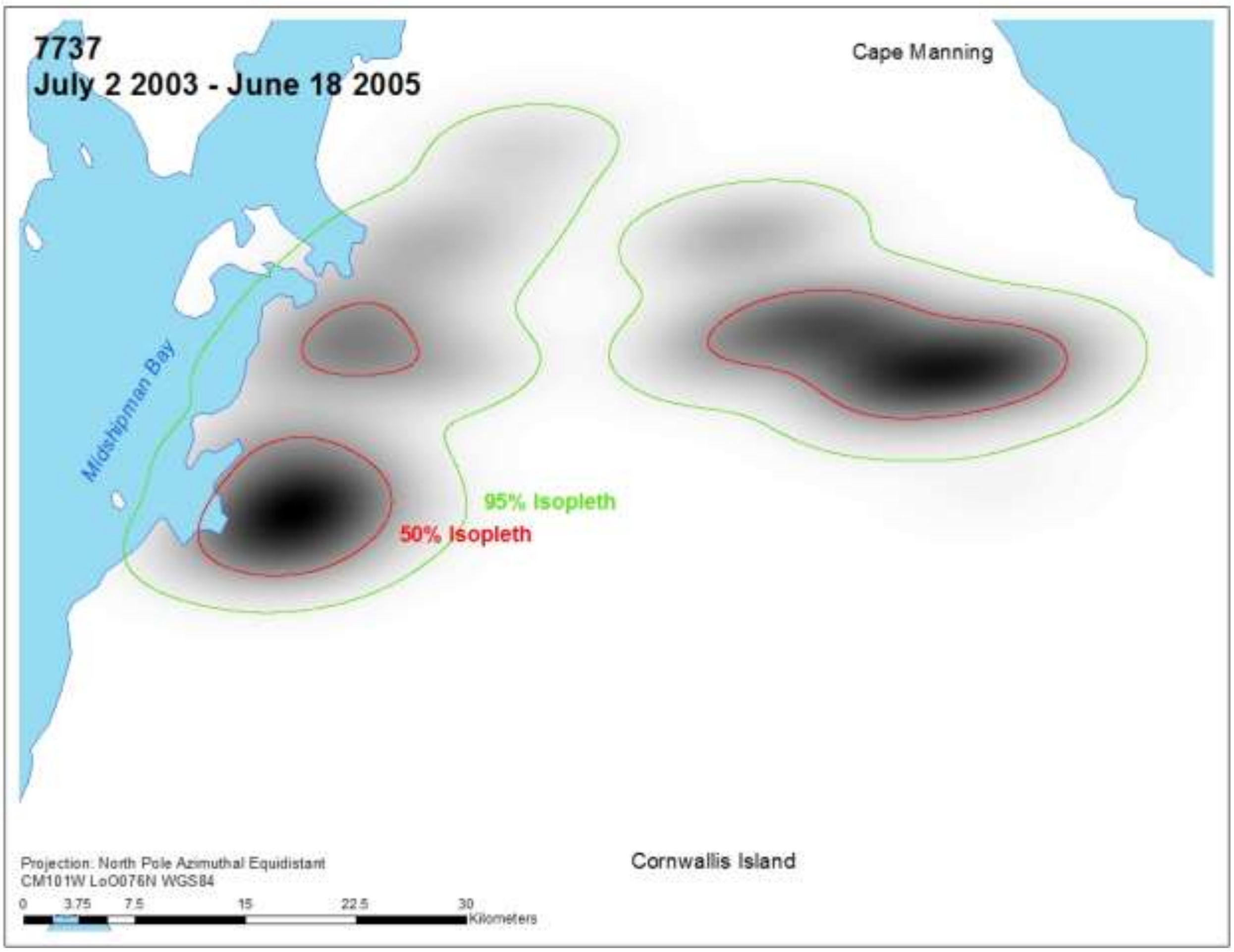


Figure **39**, Figure 40, Figure 41, Figure 42).

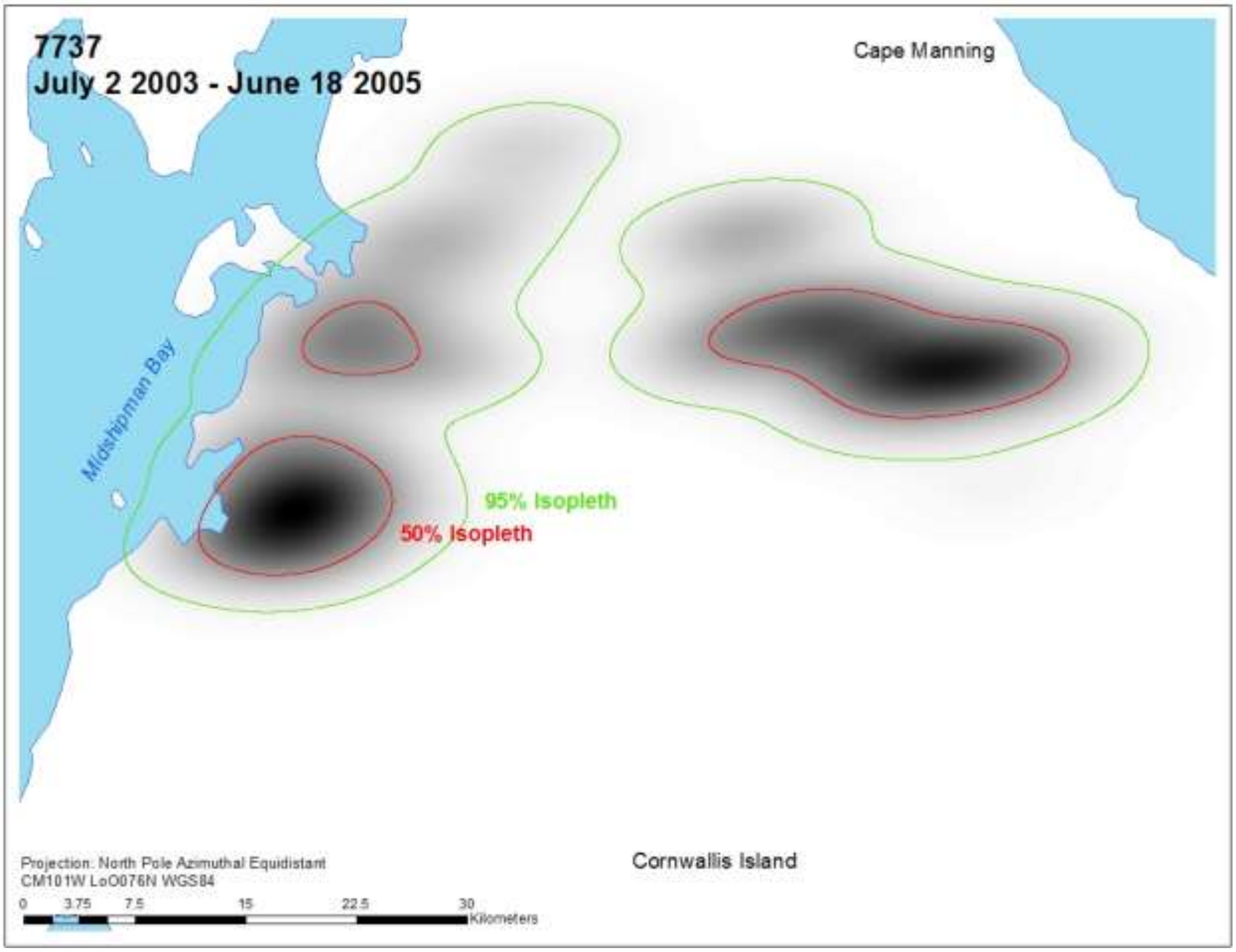


Figure 39. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7737. Bandwidth (variance x, variance y, xy covariance): 16706611.0359773, 3435224.87600488, 1388691.94743433 (SCV; N=189).

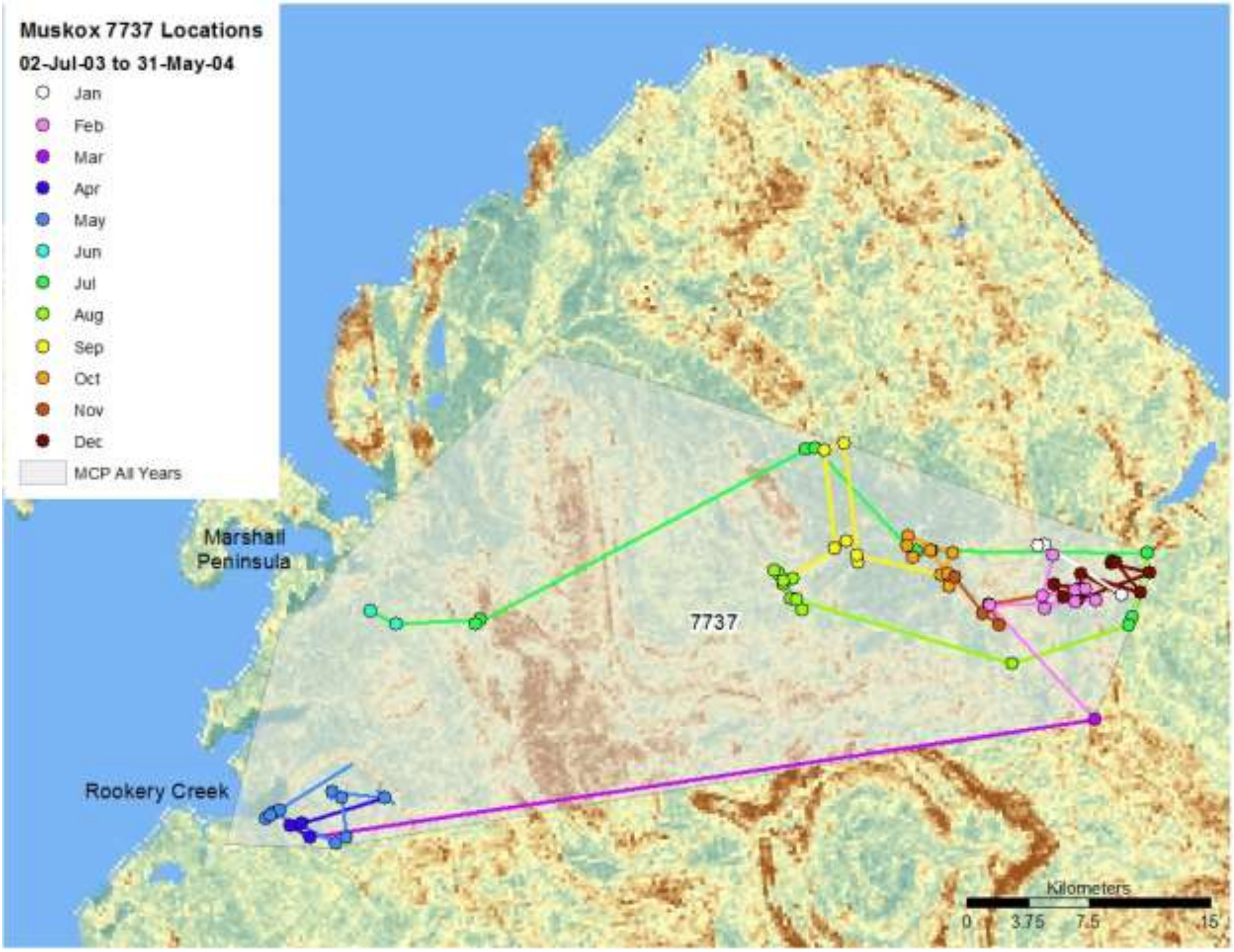


Figure 40. Locations of Muskox 7737 in 2003-04 on Cornwallis Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 250 m, in brown. MCP home range over all years shown in grey.

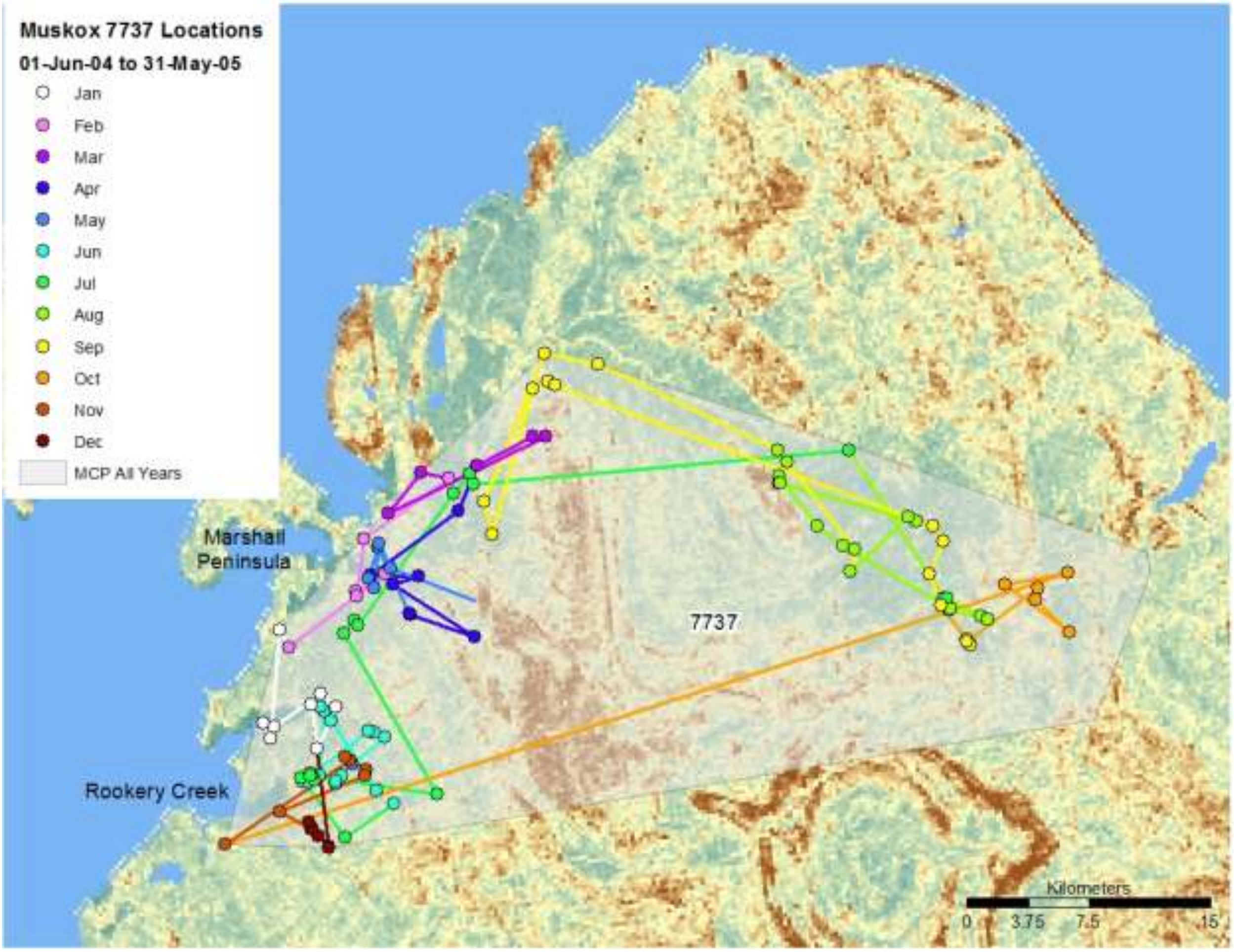


Figure 41. Locations of Muskox 7737 in 2004-05 on Cornwallis Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 250 m, in brown. MCP home range over all years shown in grey.

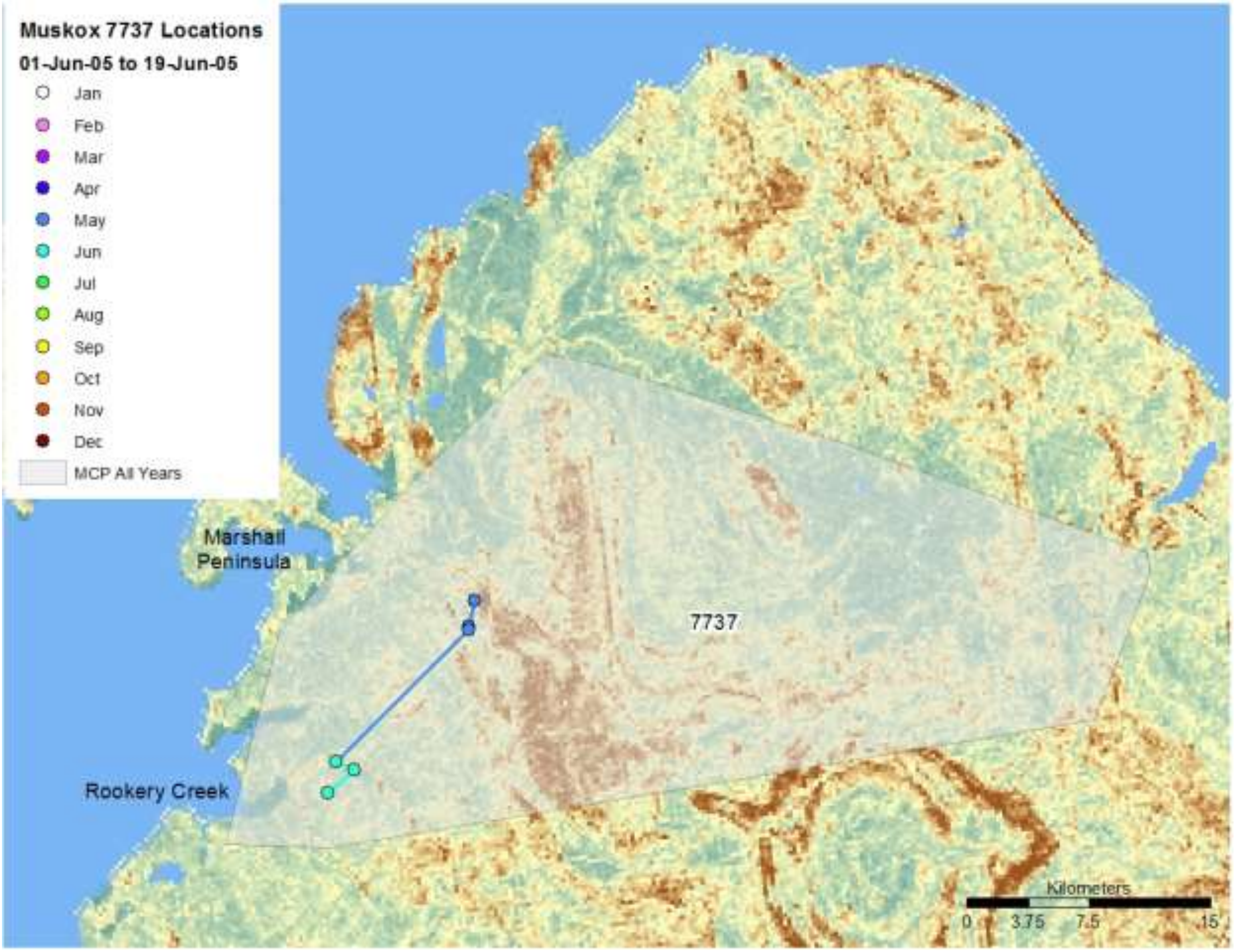


Figure 42. Locations of Muskox 7737 in 2005-06 on Cornwallis Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 250 m, in brown. MCP home range over all years shown in grey.

*Muskox 7742*

Muskox 7742 was collared as a lone female about 9 km inland from Midshipman Bay on Cornwallis Island on July 2, 2003. July 15-19 she moved about 40 km northeast and remained there through the winter and summer and fall 2004, until December 20 when she moved about 8 km north to the Cape Manning area until February 2, 2005. She remained in the northeast until January 4, 2006, when she moved north to Cape Manning again. Her last location was May 20, 2006, in a cluster of locations within 900 m.

Muskox 7742 used areas along the northwest coast of Cornwallis Island and northeast, north to Cape Manning, which she used during winter 2005 and 2006. She was about 10 km south, still on northeast Cornwallis Island, during the other 2 years. She spent summers in both the northwest and northeast areas of Cornwallis Island (Figure 43, Figure 44, Figure 45, Figure 46).

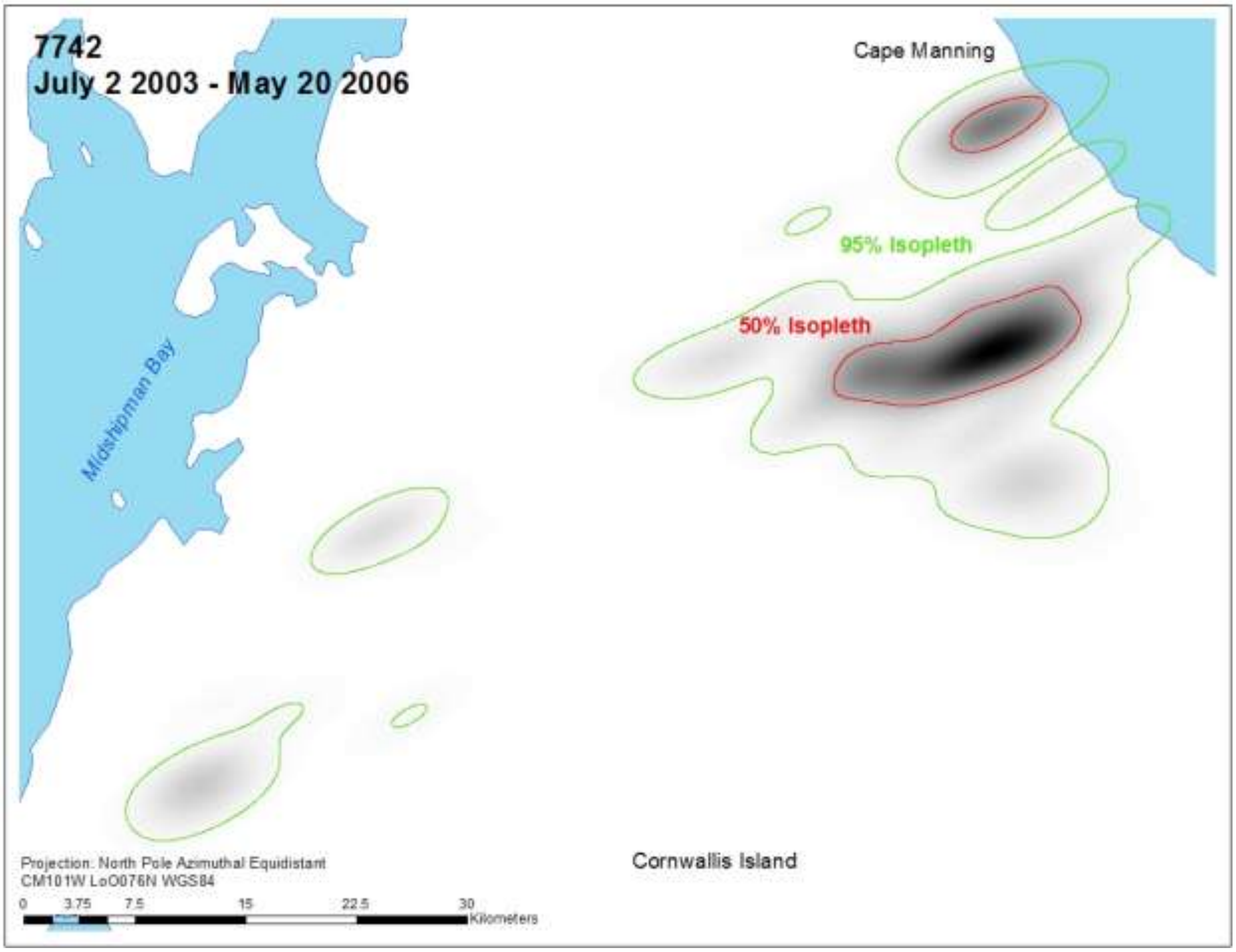


Figure 43. Kernel density estimator home range calculated for the entire collar deployment for Muskox 7742. Bandwidth (variance x, variance y, xy covariance): 5133554.9015436, 1907074.33969247, 2109570.57187549 (SCV; N=496).

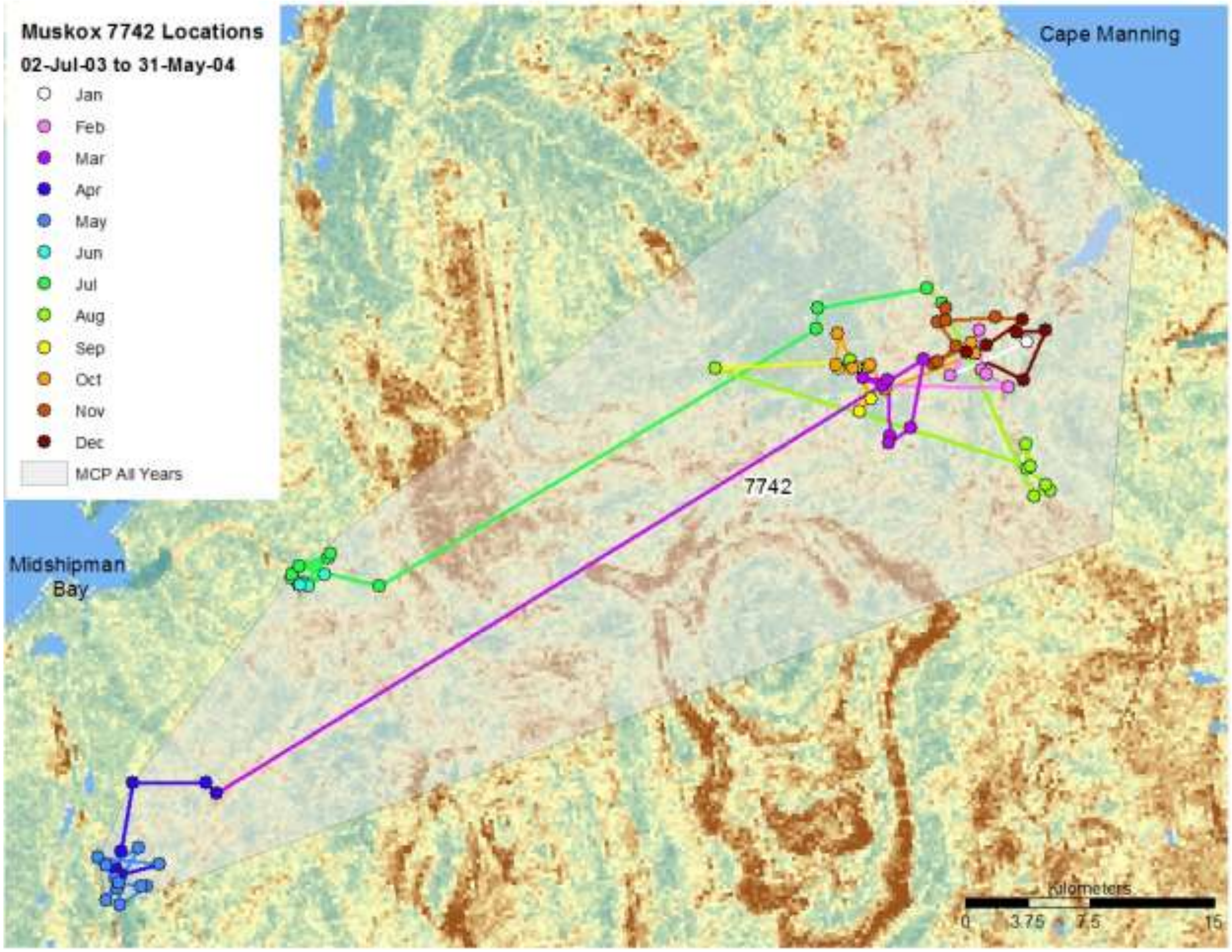

Figure 44. Locations of Muskox 7742 in 2003-04 on Cornwallis Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 250 m, in brown. MCP home range over all years shown in grey.

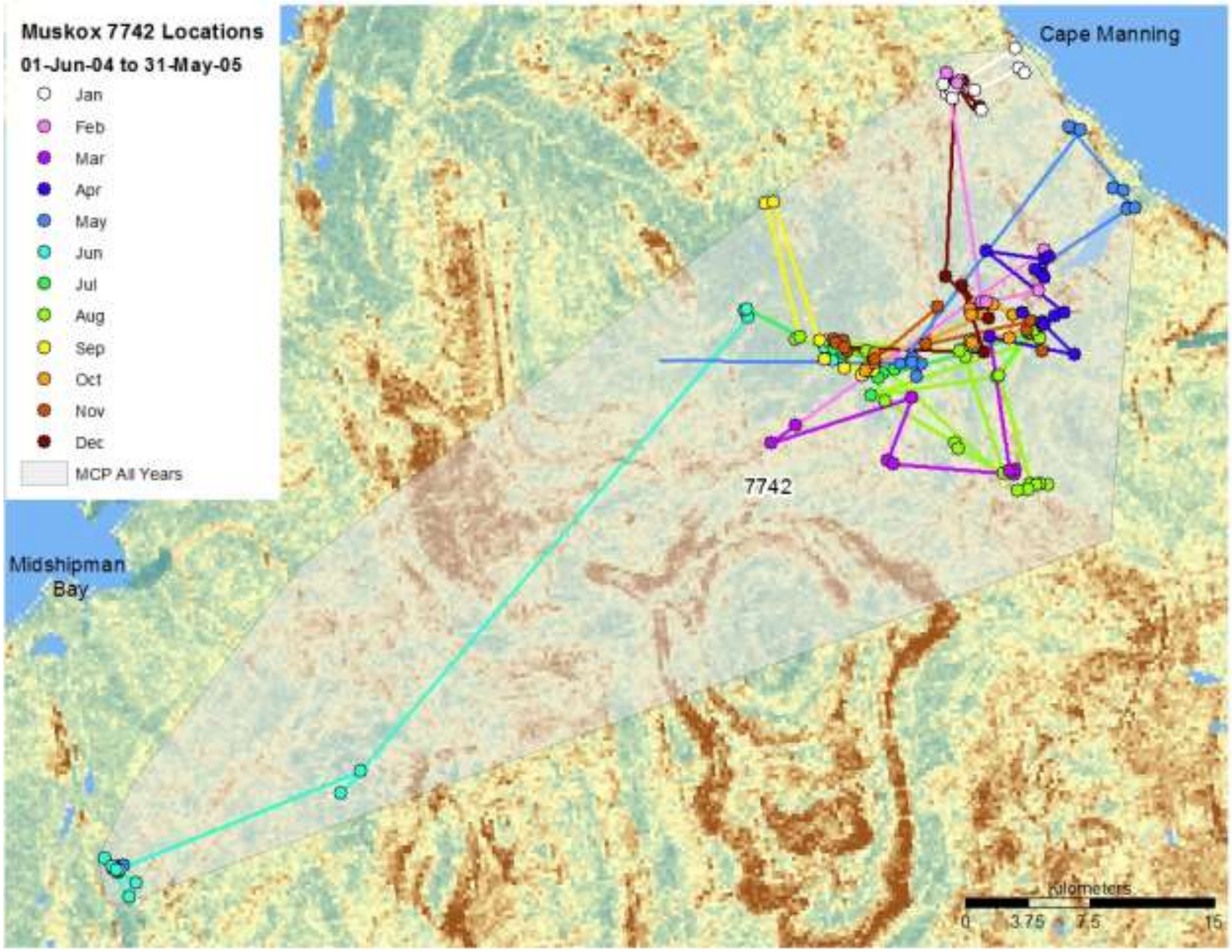


Figure 45. Locations of Muskox 7742 in 2004-05 on Cornwallis Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 250 m, in brown. MCP home range over all years shown in grey.

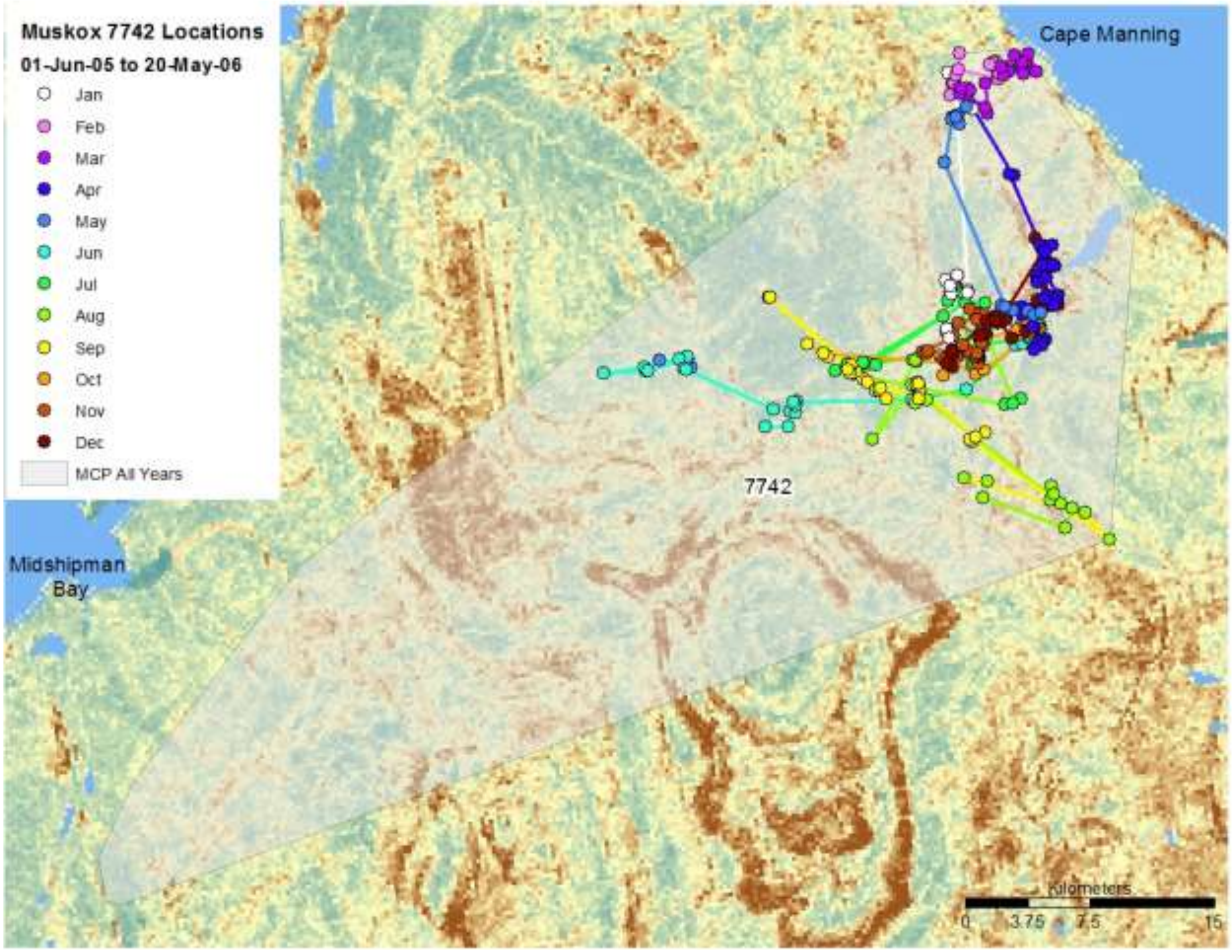


Figure 46. Locations of Muskox 7742 in 2005-06 on Cornwallis Island. Digital elevation model in background with lower elevations in green and higher elevations, to about 250 m, in brown. MCP home range over all years shown in grey.

*Home Range Size*

MCP home ranges of the 11 collared muskoxen, ranging from 233 to 3423 $km^2$ (Figure 46) with an average size of 1649 $km^2$ (SD 884 $km^2$;

Table 6) would be expected to be larger for muskoxen with more locations (Gautested and Mysterud 1995). Using a general linear model, we failed to detect a significant influence of number of locations, number of days collared, or an interaction of collar locations and days, possibly because of the large variability in home range size among individuals and the small samples size. Muskox 7729 was collared for less than 5 months in 2003, and Muskox 7720's PTT went stationary in August 2005, providing less than 3 months of data to calculate a 2005-06 home range. All other animals in all years had locations in at least 11 months of each year for which a home range was calculated, although the number of locations varied. Muskox 7711 had particularly low fix success and all home ranges calculated for 7711 relied on fewer than 100 points. In 2003-04, 7717, 7724, 7737, and 7742 all had 80 or more points but fewer than 100, and 7729 only had 36 points. There were generally not enough class 3 locations to calculate home ranges by season (Table 5). All home ranges are reported, but home ranges calculated based on fewer locations or shorter time spans likely underestimate the actual home range of the individual.

Table 5. Number of class 3 locations transmitted by each collared muskox by season and year. Home ranges were only calculated by year (Jun 1-May 31), noted in bold italic font. Seasonal locations (Summer, Jun 15-Sep 15, and Winter, Sep 16-Jun 14) were used for RSF modelling.

| **Muskox ID** | **Summer 2003** | **Winter 2003-04** | **2003-04** | **Summer 2004** | **Winter 2004-05** | **2004-05** | **Summer 2005** | **Winter 2005-06** | **2005-06** |
|---:|---:|---:|---:|---:|---:|---:|---:|---:|---:|
| 7711 | 17 | 21 | ***38*** | 14 | 30 | ***44*** | 21 | 34 | ***55*** |
| 7716 | 43 | 189 | ***232*** | 125 | 253 | ***378*** | 151 | 378 | ***529*** |
| 7717 | 19 | 63 | ***82*** | 50 | 166 | ***216*** | 84 | 168 | ***325*** |
| 7720 | 79 | 167 | ***246*** | 103 | 377 | ***480*** | 338 | | ***338*** |
| 7724 | 18 | 70 | ***88*** | 29 | 71 | ***100*** | 21 | 89 | ***110*** |
| 7729 | 4 | 32 | ***36*** | | | | | | |
| 7734 | 48 | 163 | ***211*** | 66 | 216 | ***282*** | 117 | 125 | ***242*** |
| 7735 | 275 | 258 | ***533*** | | | | | | |
| 7737 | 23 | 57 | ***80*** | 48 | 60 | ***108*** | | | |
| 7742 | 27 | 59 | ***86*** | 50 | 100 | ***150*** | 86 | 174 | ***260*** |
| 7743 | 14 | 86 | ***100*** | 39 | 97 | ***136*** | 63 | 136 | ***199*** |

Table 6. Minimum convex polygon home range size for 11 satellite-collared muskoxen on Bathurst, Cornwallis, and Devon islands, including only class 3 Argos locations (error <150 m) locations from 2003-2006. Home ranges in bold indicate ranges calculated on less than 11 months of locations; italic represents ranges calculated on fewer than 100 locations. These will likely be relatively smaller than annual home ranges calculated for a greater proportion of the year. The MCP for all years includes all available class 3 locations.

| Muskox ID | Island | 2003-04 MCP ($km^2$) | 2004-05 MCP ($km^2$) | 2005-06 MCP ($km^2$) | All Years MCP ($km^2$) |
|---|---|---|---|---|---|
| 7711 | Bathurst | *835.95* | *525.74* | *965.69* | 1527.87 |
| 7716 | Bathurst | 2927.76 | 963.53 | 815.85 | 3423.20 |
| 7717 | Bathurst | *866.29* | 1061.88 | 878.09 | 1564.20 |
| 7720 | Bathurst | 526.49 | 600.70 | **191.68** | 629.96 |
| 7724 | Devon | *1666.33* | 1912.35 | 1621.74 | 2494.41 |
| 7729 | Devon | *191.86* | | | 232.79 |
| 7734 | Devon | 304.89 | 256.18 | 1598.78 | 2184.99 |
| 7735 | Devon | **2491.69** | | | 2491.69 |
| 7737 | Cornwallis | *803.92* | 880.78 | | 1075.53 |
| 7742 | Cornwallis | *836.52* | 1057.94 | 468.12 | 1384.55 |
| 7743 | Devon | 350.50 | 511.53 | 562.77 | 1131.43 |


Figure 47. Individual home ranges satellite-collared muskoxen for 2003-04, 2004-05, and 2005-06 by year (yellow polygons) and for the study period (grey polygons). Digital elevation model in background with lower elevations in green and higher elevations, to about 500 m, in brown. Ice fields and glaciers are stippled blue and white.

*Inter-island movements*

Two collared muskoxen may have made ice crossings during this study. In 2003, Muskox 7711 moved from the Polar Bear Pass region of Bathurst Island to the large unnamed island in Bracebridge Inlet between location fixes on March 28 and April 17, returning to Bathurst Island between June 12 and June 20. This would coincide with sea ice being present in the inlet. The shortest route crossing the ice would have been 3.2 km to a small island, followed by 1.7 km to the destination island. The second animal, Muskox 7734, may have followed the shoreline of Eidsbotn Fiord (Devon Island) north to the Colin Archer Peninsula between March 20 and March 24, 2006 without crossing ice, or she may have crossed 4.2 km of ice to reach the north shore.

*Displacement*

Four-day displacements are presented in Table 7. Although collars were programmed to collect locations every four days, we included locations that ranged from 3.00 days to 4.98 days apart (we did not adjust to standardize to 4 days). Average straight-line 4-day displacement was 4.0 km/4 days (SD=5.0 km, n=1273) although the maximum 4-day displacements were over 40 km in 4 days (45.0 km by 7716, Mar 22-26, 2004; 43.4 km by 7724, Nov 13-17, 2004; 41.1 km by 7711, Jul 9-13, 2005; 41.0 km by 7716, May 17-21, 2004). For all locations at least 4 hours apart and not more than 24 days apart (mean time interval = 3.9 days, SD = 3.24 days, n= 2237), the average displacement was similar, 3.8 km (SD=5.8 km, n= 2237) (Table 7).

Table 7. Maximum, minimum, and average displacement of collared muskoxen during 4 day periods. Displacement is the estimated straight-line distance between subsequent locations 4 days apart.

| Muskox ID | Max distance between consecutive 4 day locations (km) | Average 4 day Displacement | Number of Locations (4 days apart only) |
|---:|---:|---:|---:|
| 7711 | 41.42 | 4.63 | 41 |
| 7716 | 45.03 | 4.72 | 245 |
| 7717 | 28.25 | 4.70 | 203 |
| 7720 | 20.50 | 4.00 | 67 |
| 7724 | 43.44 | 4.35 | 122 |
| 7729 | 5.34 | 1.92 | 16 |
| 7734 | 22.97 | 3.04 | 205 |
| 7735 | 15.80 | 6.14 | 5 |
| 7737 | 24.86 | 4.95 | 76 |
| 7742 | 37.71 | 3.74 | 155 |
| 7743 | 29.82 | 2.24 | 138 |

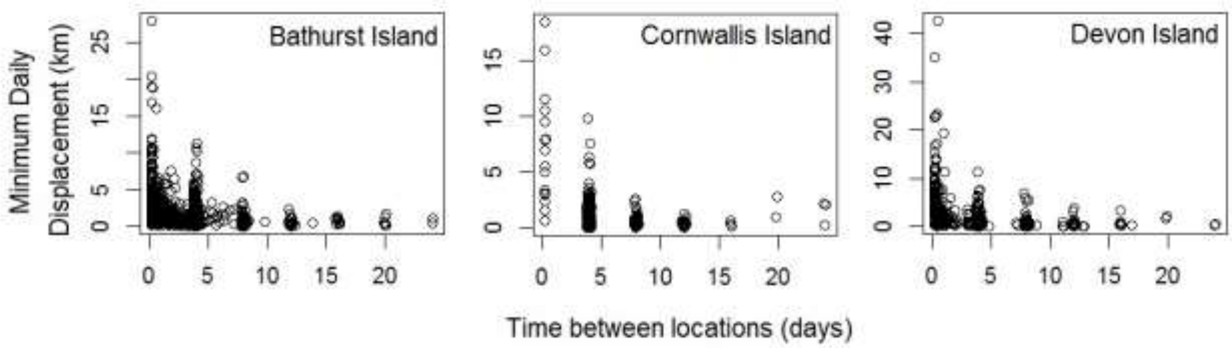


Figure 48. The decrease in apparent daily displacement. The longer the time between 2 points, the smaller the apparent daily displacement, since small scale movements are increasingly missed.

There was no clear seasonal pattern in displacements for the muskoxen collared on each island (see Figure 49 to Figure 57), although the difference in satellite fix success and locations varied. Extensive individual variation seemed to be the norm. In some years, there may have been factors influencing the muskox population across the island – there was a marked decrease in displacements in October to December 2005 on Bathurst Island (also seen in 7742 on Cornwallis Island), although the same pattern did not appear on Devon Island. There was also little synchronicity in displacements for muskoxen, although 7737 and 7742 appeared to show similar patterns of displacements on Cornwallis Island from 2003 to 2005.

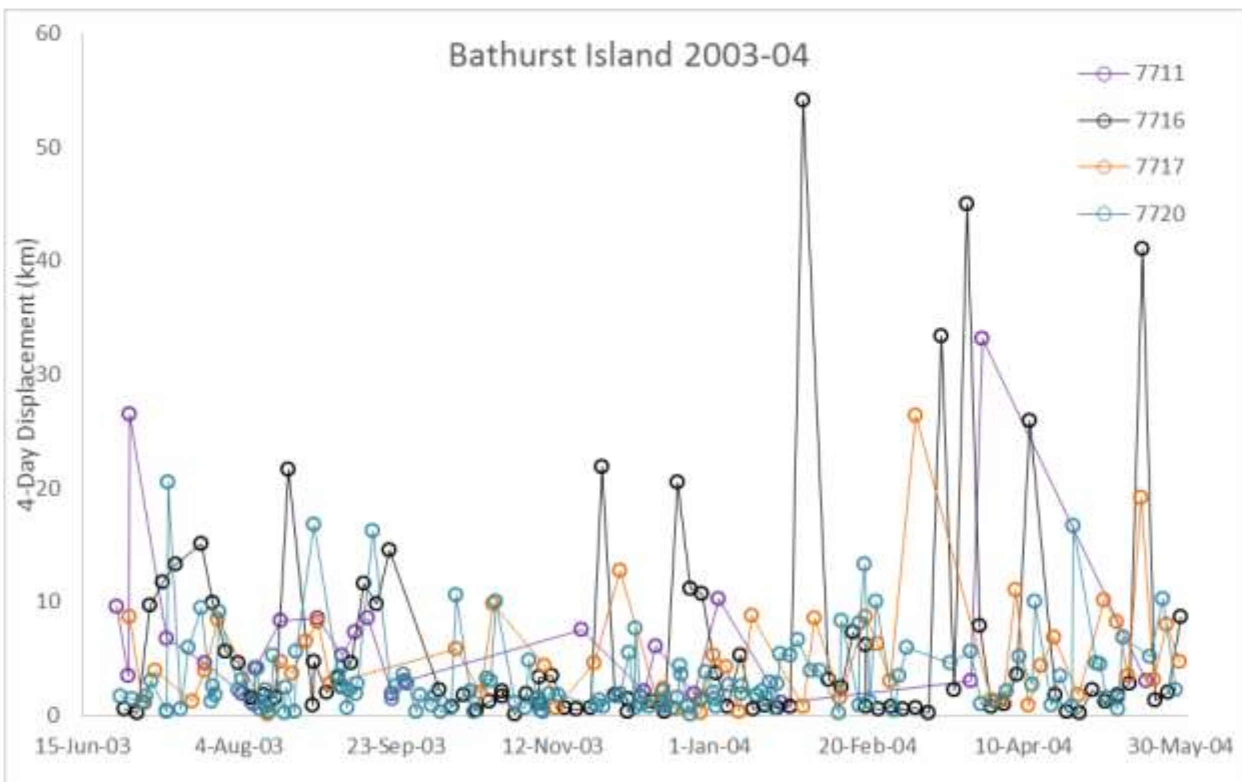


Figure 49. Four-day displacements of muskoxen on Bathurst Island, June 2003-May 2004.

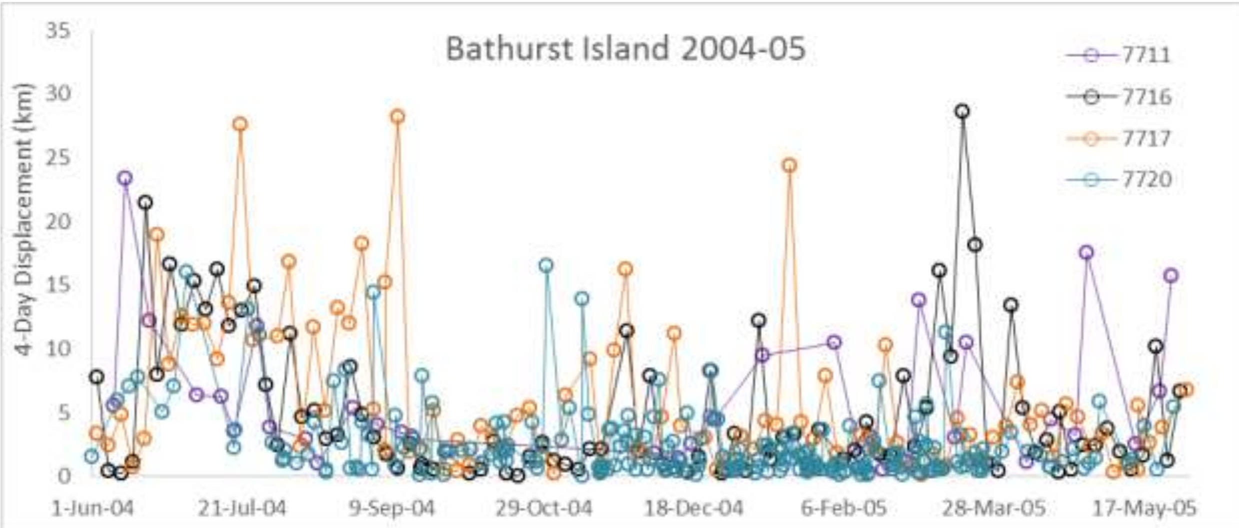


Figure 50. Four-day displacements of muskoxen on Bathurst Island, June 2004-May 2005.

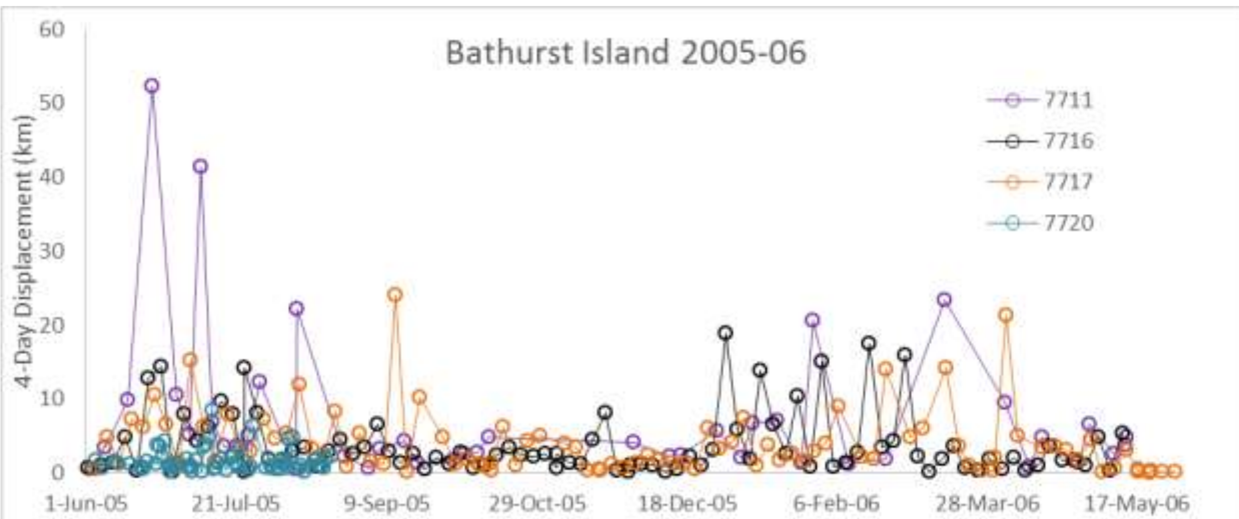


Figure 51. Four-day displacements for muskoxen on Bathurst Island, June 2005-May 2006.

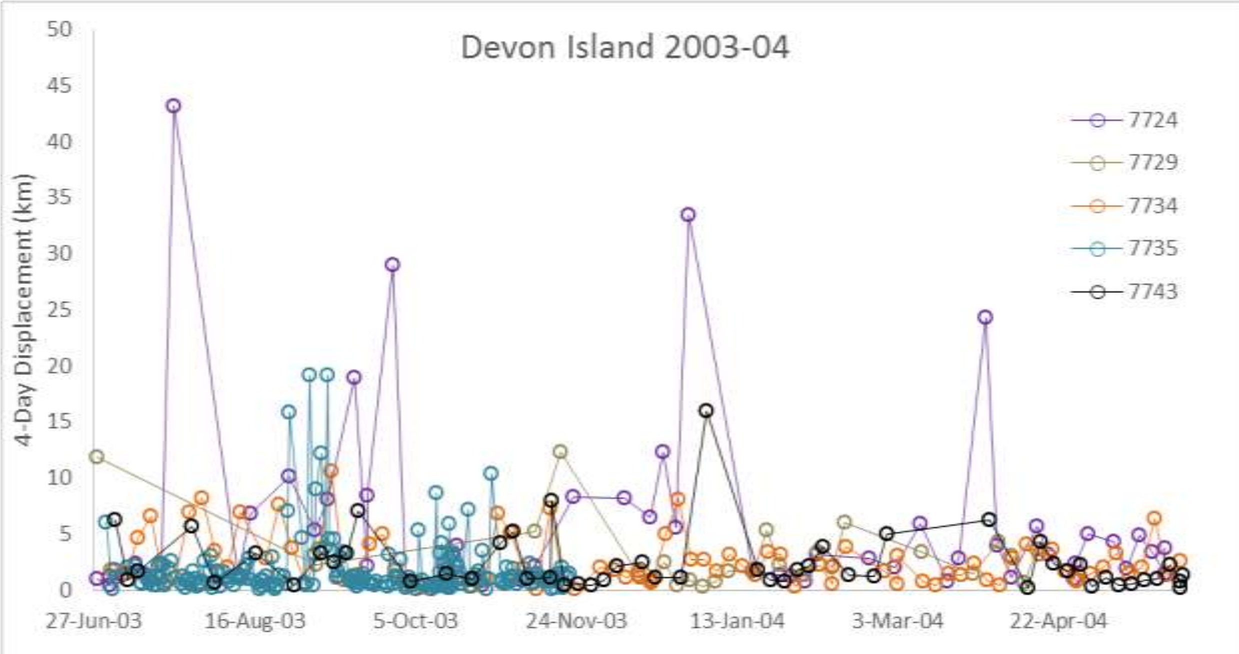


Figure 52. Four-day displacements of muskoxen on Devon Island, June 2003-May 2004.

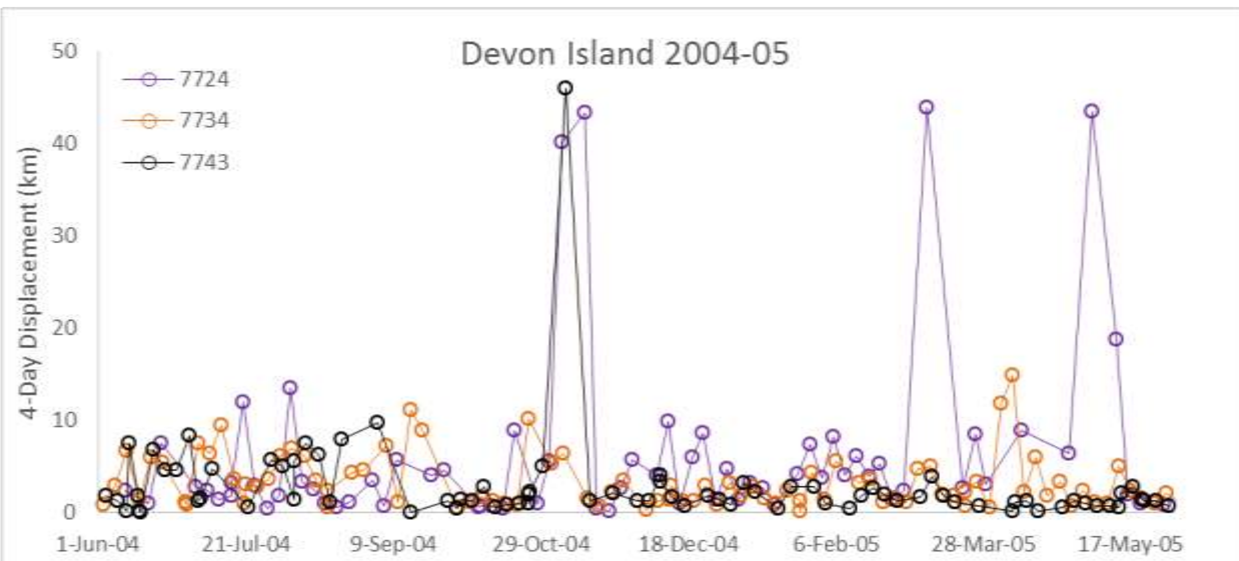


Figure 53. Four-day displacement for muskoxen on Devon Island, June 2004-May 2005.

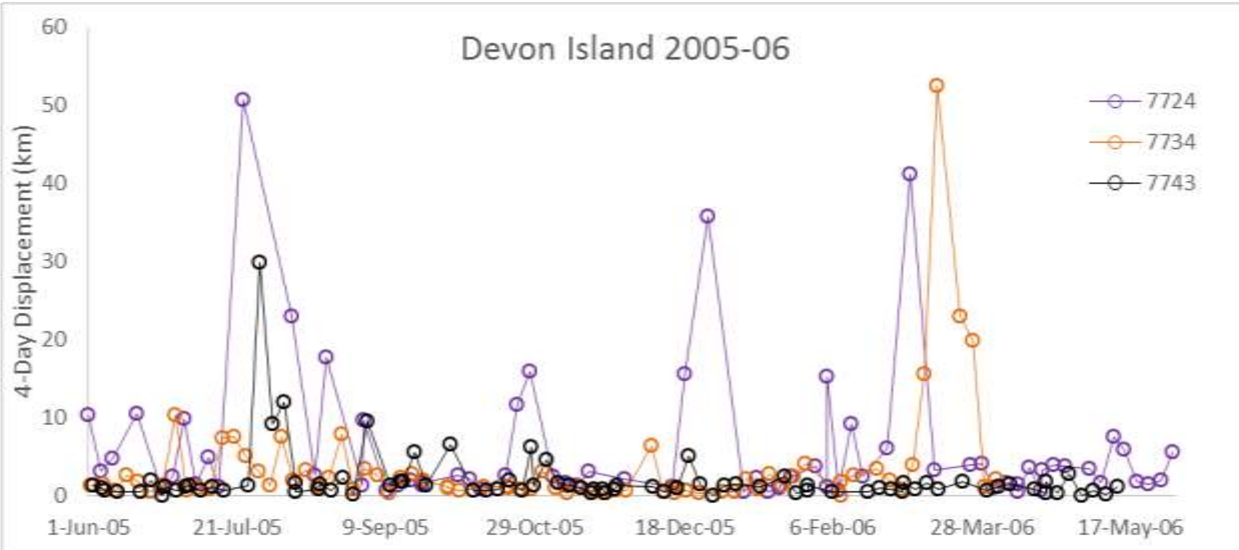

Figure 54. Four-day displacement for muskoxen on Devon Island, June 2005-May 2006.

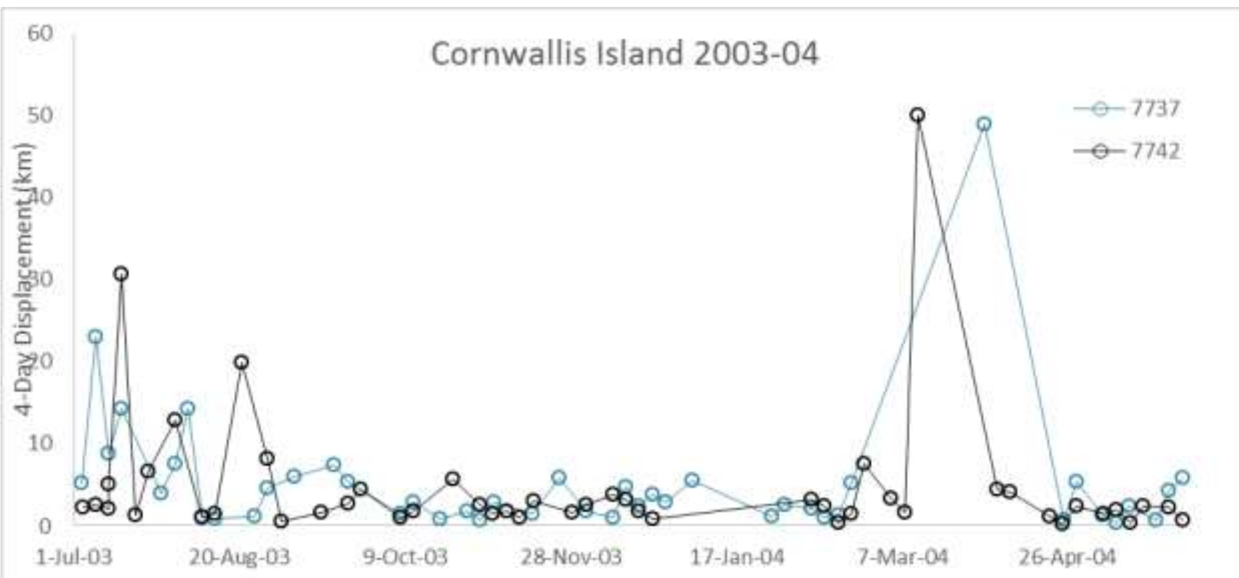

Figure 55. Four-day displacement for muskoxen on Cornwallis Island, May 2003-June 2004.

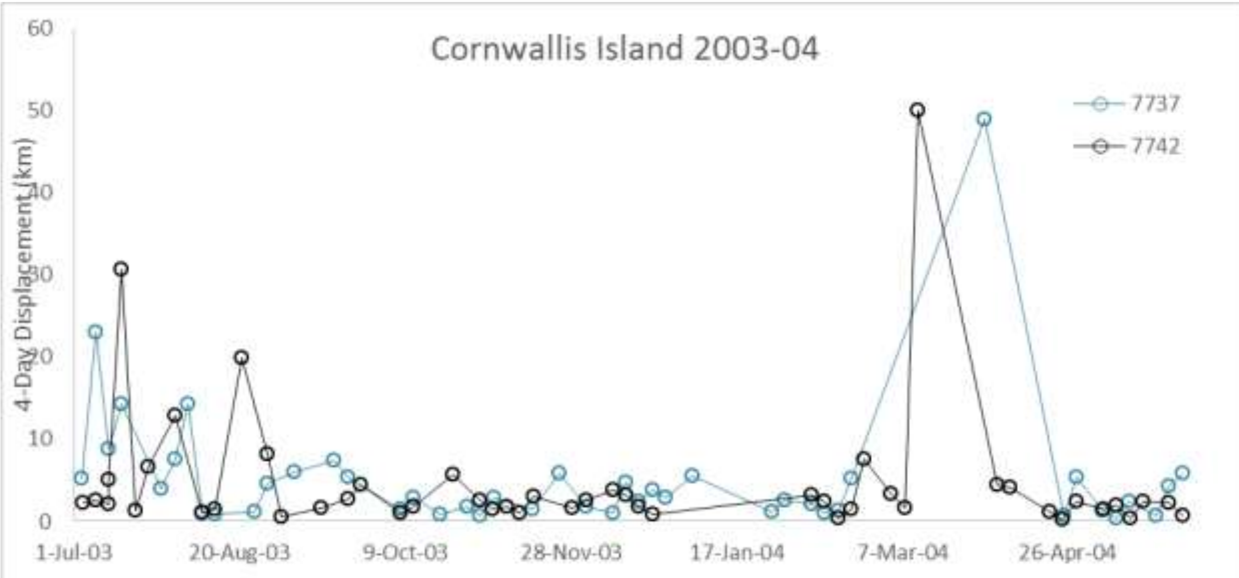

Figure 56. Four-day displacement of muskoxen on Cornwallis Island, June 2004-May 2005.

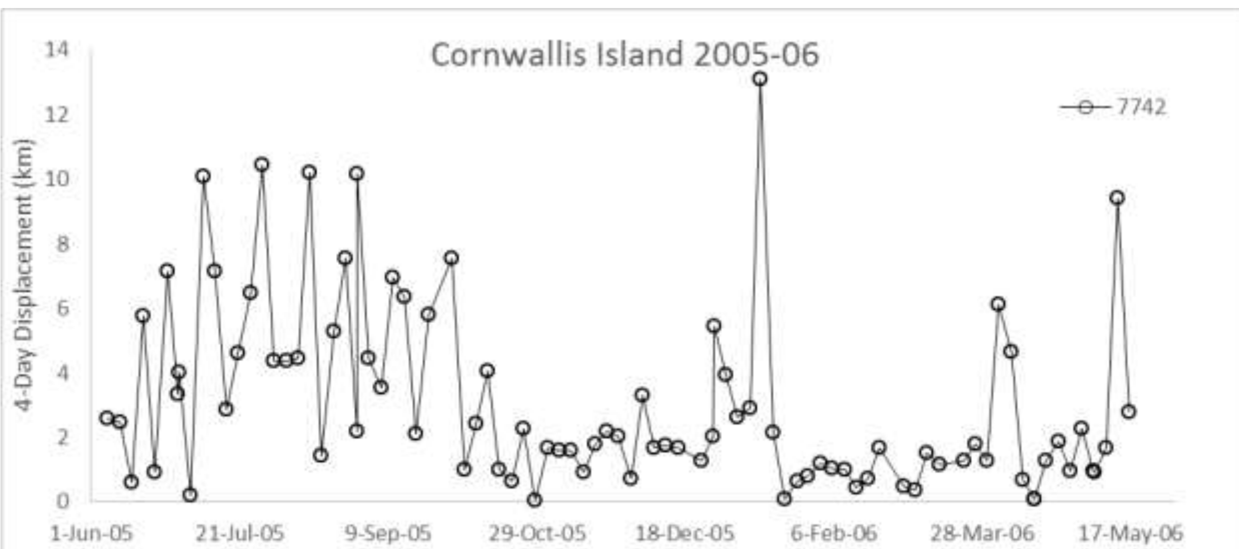

Figure 57. Four-day displacement of muskox 7742 on Cornwallis Island, June 2005-May 2006.

*Habitat Selection*

Habitat selection was calculated separately for individual muskoxen, for all year and for summer. Muskox locations and habitat classes are shown in Figure 58, Figure 59, and Figure 60. In addition, vegetation classes were available for Bathurst and Cornwallis islands (Brazel 2006) and are shown in Figure 61 and Figure 62 with muskox locations, although these more detailed classifications were not used to determine habitat selection.

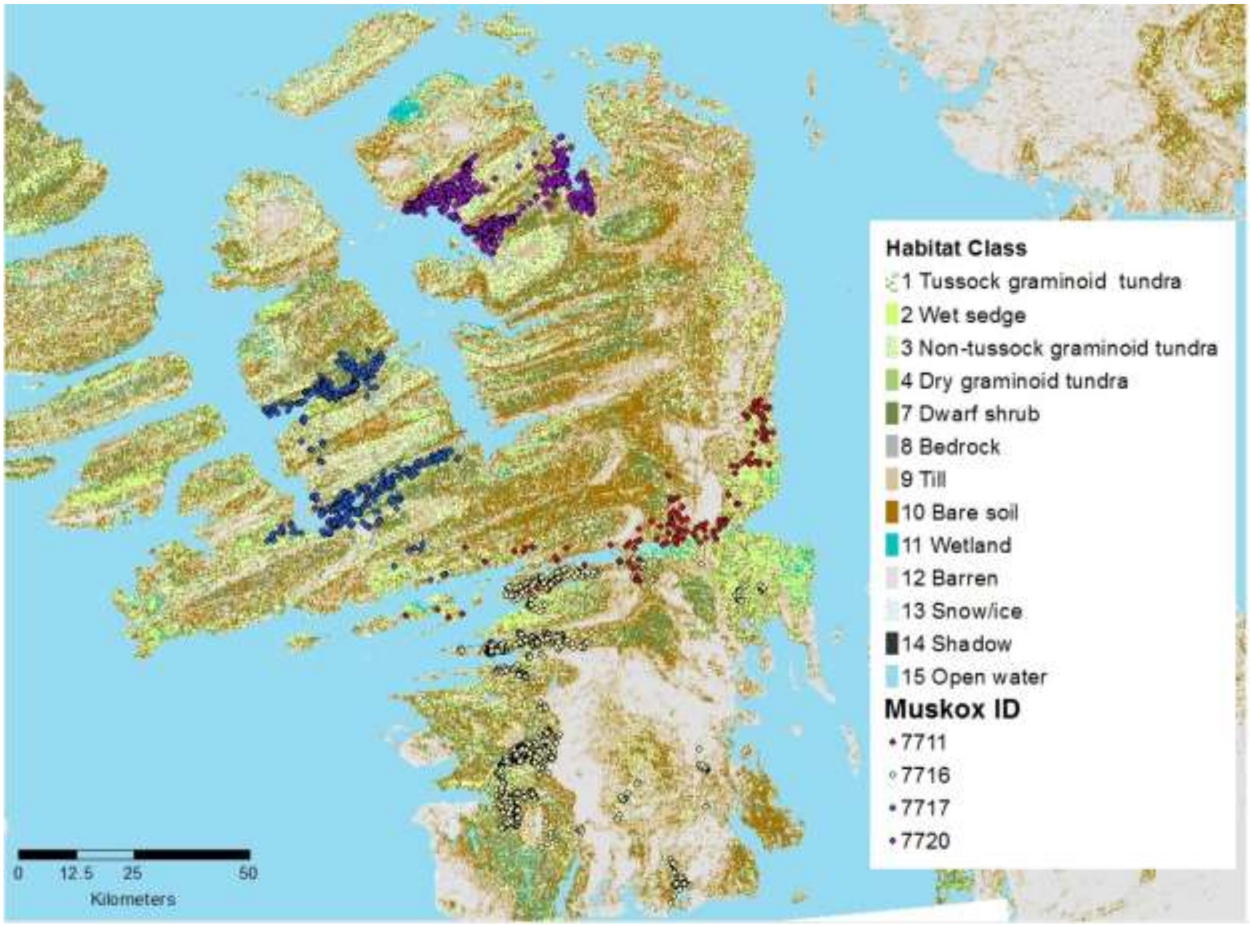


Figure 58. Telemetry locations of 4 collared muskoxen on Bathurst Island 2003-2006 in relation to habitat class (from Olthoff et al. 2008).

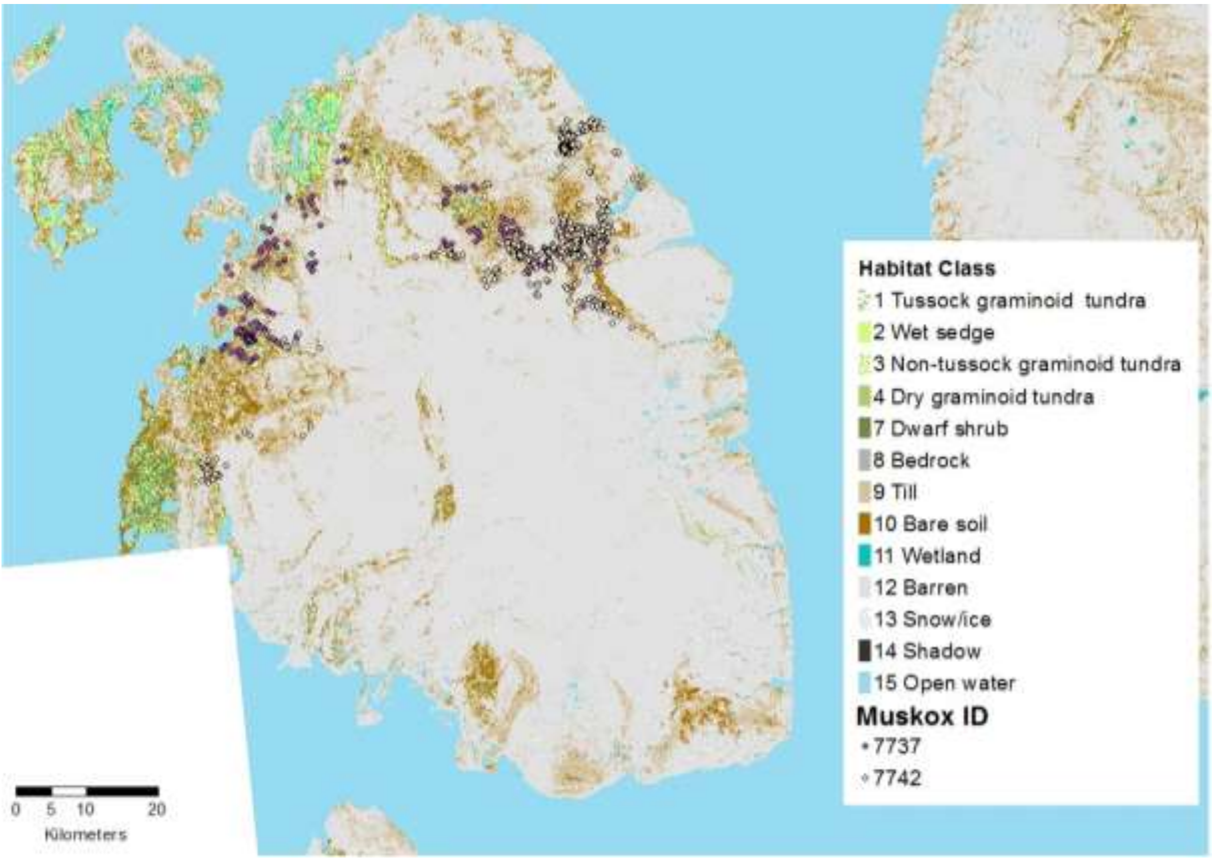


Figure 59. Telemetry locations of 2 collared muskoxen on Cornwallis Island 2003-2006 in relation to habitat class (from Olthoff et al. 2008).

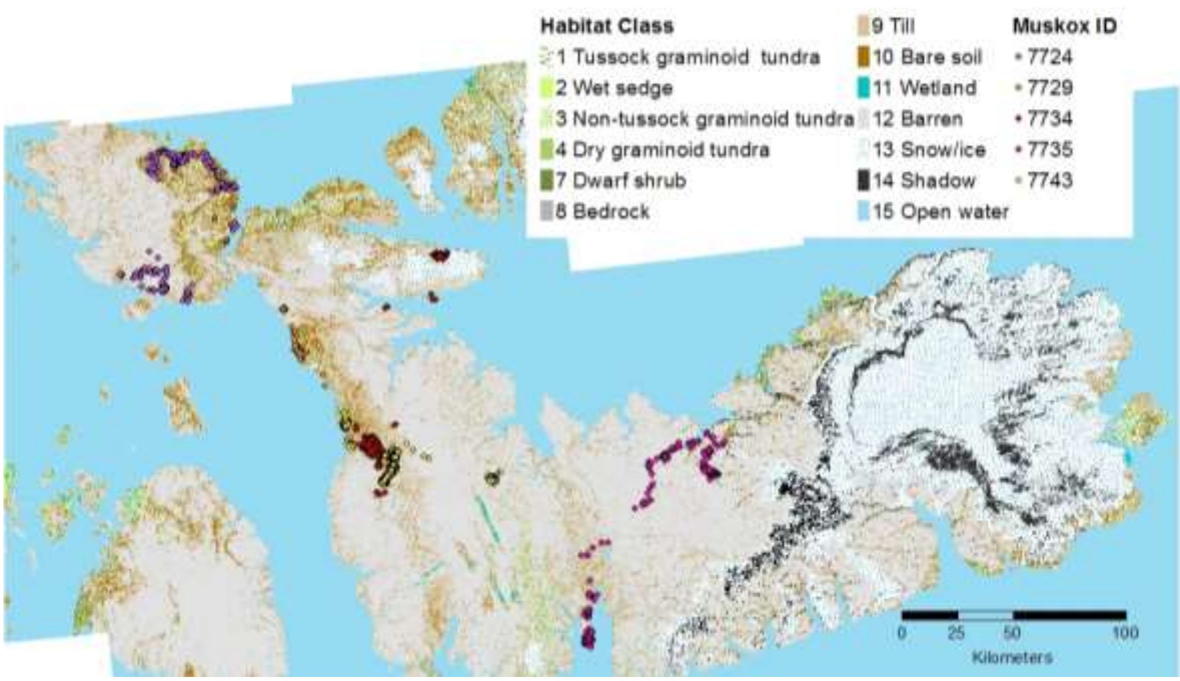


Figure 60. Telemetry locations of 5 collared muskoxen on Devon Island 2003-2006 in relation to habitat class (from Olthoff et al. 2008).

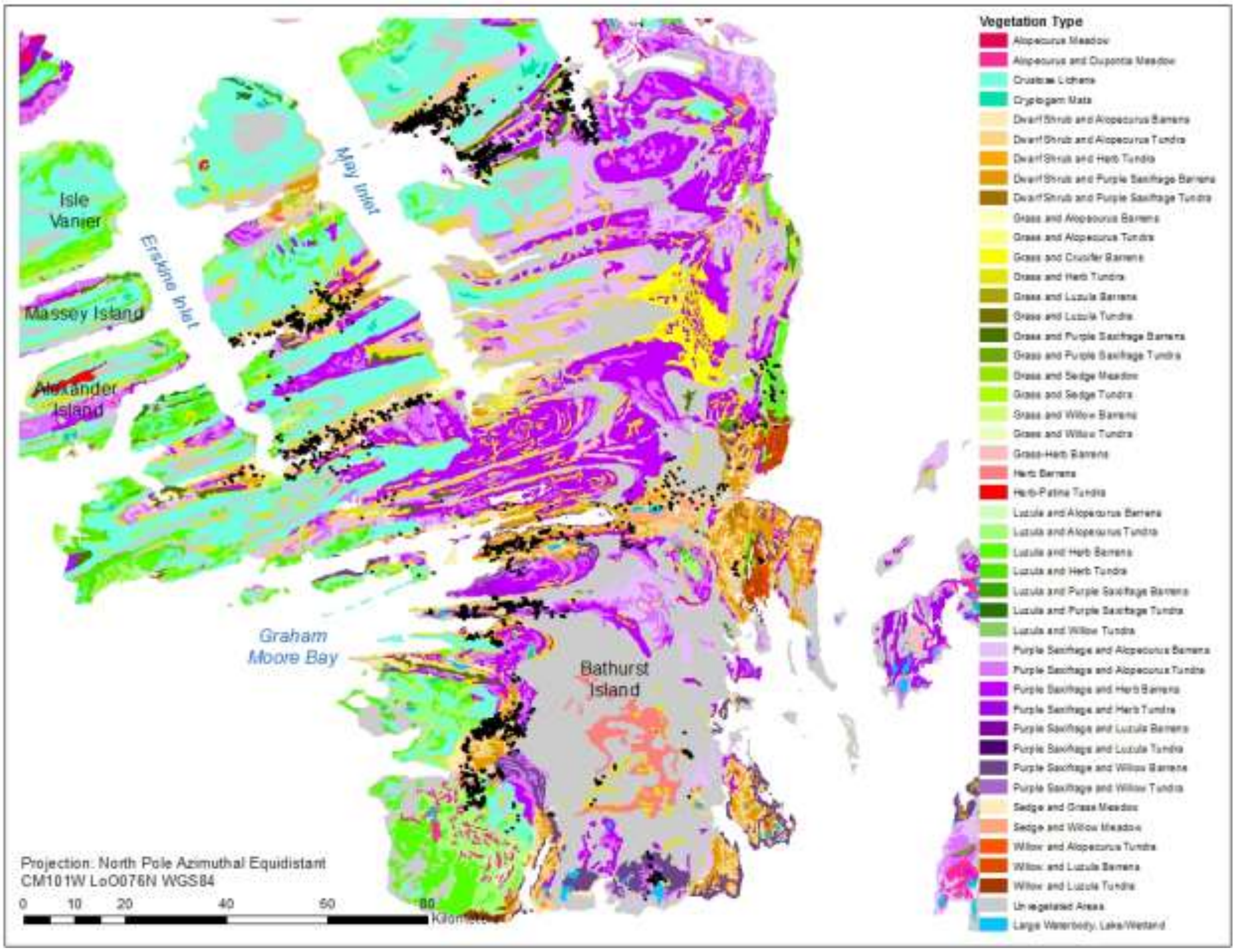


Figure 61. Muskox satellite telemetry locations 2003-2006 in all seasons on Bathurst Island with floristic community shown (from Brazel 2006).

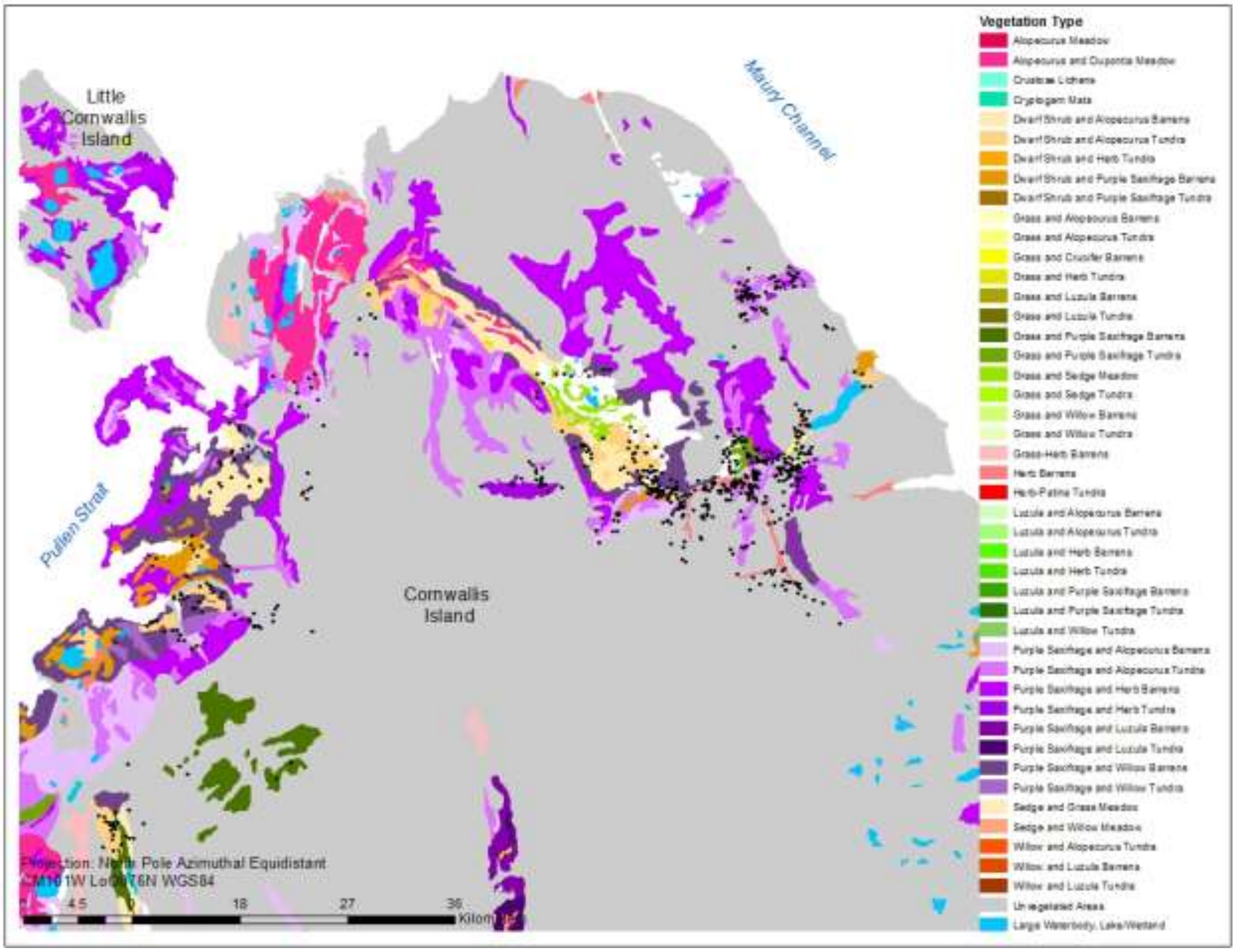


Figure 62. Muskox satellite telemetry locations 2003-2006 in all seasons on Cornwallis Island with floristic community shown (from Brazel 2006).

*Habitat Selection by Individuals*

Habitat selection was calculated separately for individual muskoxen, for all year (Jun 1 to May 31) and for summer (Jun 15 to Sep 15) and winter (Sep 16 to Jun 14). Available resources were defined by random points generated across the island the muskox inhabited, since muskoxen are not territorial and the entire island could have been available to any muskox on that island. Used points were taken as the class 3 PTT locations (summarized by year, season, and individual in Table 5). We ran several models including vegetation and land cover classes and elevation (Table 8). Coefficients for used-available resource selection functions for all individuals and seasons are presented in Appendix I, and model comparison is presented in Table 9.

Elevation was a significant factor in almost all models by season and individual, confirming observations by local hunters and field staff that muskoxen are usually found in low-lying areas like river valleys. Although a RSF relying only on elevation was not the best model, it did come close for some individuals in some seasons. There was generally selection against open water in all seasons. Although coefficients were generally negative for snow and ice when these areas were included in models, they were usually not significant. This category appears to include ice piled against shorelines and snow banks that persist into the summer, rather than strictly icefields, so it may not be accurate as the season progresses or across years. The barren classification may also be problematic, and some muskoxen showed selection for it in the full land cover model in both seasons, but apparently avoided barren areas based on the 2 models using a subset of land cover data; other muskoxen showed no selection for barren areas.

Tussock graminoid tundra was selected significantly by more muskoxen in winter than in summer based on the RSF models using a subset of land cover classes, although it was selected by 8 and 7 muskoxen in winter and summer respectively based on an RSF including all vegetation classes. This vegetation class may be more likely associated with wind-swept areas that provide more efficient foraging during the snow-covered seasons. Bare soil and cryptogram areas were selected by some muskoxen, also generally in the winter. The full land cover model suggested selection of sparsely vegetated areas in both seasons by several muskoxen, but selection was not as clear in the models using only a subset of land cover data. Wet sedge areas were significantly selected by more muskoxen in winter according to the land cover models, which may be due to more restricted movements in areas of known forage during the winter. More selection may also have been detected in the summer for this and other land cover classes if more locations were available.

Table 8. Models for resource selection functions.

| **Model** | **Explanatory Variables** |
|---|---|
| Elevation | Elevation |
| Vegetation | Elevation, Vegetation Classes 1, 2, 3, 4, 7, 8, 9, 10, 11, 12 |
| Landcover1 | Elevation, Vegetation Classes 1, 2, 11, 12, 13, 15 |
| Landcover2 | Elevation, Vegetation Classes 1, 2, 3, 9, 10, 12, 15 |

Table 9. Model comparison with AIC and ΔAIC for resource selection functions for collared muskoxen on Bathurst, Devon, and Cornwallis islands, 2003-2006. Bold AIC scores represent the best performing model.

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | AIC | AIC | AIC | AIC | AIC | AIC | AIC | AIC | AIC | AIC |
| | ΔAIC | ΔAIC | ΔAIC | ΔAIC | ΔAIC | ΔAIC | ΔAIC | ΔAIC | ΔAIC | ΔAIC |
| *All Seasons* | | | | | | | | | | |
| Elevation | 1096.4 | 4657.4 | 2779.2 | 4373.0 | 2016.1 | 4284.1 | 3409.8 | 1004.9 | 1871.5 | 3230.0 |
| | 24.9 | 327.6 | 177.9 | 209.2 | 262.2 | 911.0 | 133.3 | 94.4 | 118.7 | 462.7 |
| Vegetation | 1077.5 | **4329.8** | **2601.3** | **4163.8** | **1753.9** | 3578.9 | 3289.4 | 912.9 | 1758.0 | **2767.3** |
| | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 205.8 | 12.9 | 2.4 | 5.2 | 0.0 |
| Landcover 1 | **1071.5** | 4405.4 | 2646.8 | 4235.0 | 1798.2 | **3373.1** | 3278.8 | 917.3 | 1766.5 | 2845.6 |
| | 0.0 | 75.6 | 45.5 | 71.2 | 44.3 | 0.0 | 2.3 | 6.9 | 13.7 | 78.3 |
| Landcover 2 | 1076.3 | 4370.6 | 2615.7 | 4198.9 | 1795.4 | 3580.4 | **3276.5** | **910.5** | **1752.8** | 2778.5 |
| | 4.8 | 40.8 | 14.4 | 35.1 | 41.5 | 207.3 | 0.0 | 0.0 | 0.0 | 11.2 |
| *Summer (Jun 15 - Sep 15)* | | | | | | | | | | |
| Elevation | 534.8 | 2086.2 | 1156.9 | 2784.5 | 657.7 | 1925.3 | 2014.2 | 535.9 | 990.1 | 1184.6 |
| | 8.6 | 110.4 | 62.2 | 522.4 | 50.4 | 321.4 | 126.9 | 46.5 | 46.0 | 75.0 |
| Vegetation | 543.4 | **1975.8** | 1096.4 | 2617.5 | **607.3** | **1603.9** | 1890.1 | 491.5 | 948.8 | 1116.6 |
| | 17.2 | 0.0 | 1.7 | 355.4 | 0.0 | 0.0 | 2.8 | 2.1 | 4.7 | 7.0 |
| Landcover 1 | **526.2** | 1987.5 | 1103.0 | **2262.1** | 613.5 | 1667.2 | 1941.5 | 492.6 | 948.0 | 1120.8 |
| | 0.0 | 11.7 | 8.3 | 0.0 | 6.2 | 63.3 | 54.2 | 3.2 | 3.9 | 11.2 |
| Landcover 2 | 531.3 | 1998.8 | **1094.7** | 2649.6 | 615.5 | **1603.9** | **1887.3** | **489.4** | **944.1** | **1109.6** |
| | 5.1 | 23.0 | 0.0 | 387.5 | 8.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Winter (Sep 16 - Jun 14)* | | | | | | | | | | |
| Elevation | 521.8 | 3768.5 | 2222.7 | 2868.7 | 1670.9 | 3233.0 | 2086.6 | 703.2 | 1416.4 | 2543.4 |
| | 21.2 | 267.9 | 125.8 | 95.1 | 207.5 | 424.5 | 74.9 | 58.7 | 93.6 | 410.0 |
| Vegetation | **500.6** | **3500.6** | **2096.9** | **2773.6** | **1463.4** | 2811.6 | 2053.4 | 649.2 | 1326.5 | **2133.4** |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 41.7 | 4.8 | 3.7 | 0.0 |
| Landcover 1 | 501.1 | 3581.5 | 2130.6 | 2812.7 | 1501.3 | 2908.6 | **2011.7** | 653.7 | 1336.1 | 2212.8 |
| | 0.4 | 80.9 | 33.7 | 39.1 | 37.9 | 100.1 | 0.0 | 9.2 | 13.3 | 79.4 |
| Landcover 2 | 508.2 | 3524.3 | 2110.3 | 2774.8 | 1495.8 | **2808.5** | 2028.9 | **644.5** | **1322.8** | 2148.8 |
| | 7.6 | 23.7 | 13.4 | 1.2 | 32.4 | 0.0 | 17.2 | 0.0 | 0.0 | 15.4 |

*Habitat Selection by Island*

Habitat selection was also calculated by pooling used locations of all collared muskoxen on an island and distributing random points across the island. Models including all vegetation classes performed best for Devon and Bathurst, with significant selection for tussock graminoid tundra, moist/dry non-tussock graminoid/dwarf shrub tundra, wet sedge, bare soil, sparsely vegetated till/colluvium, and barren areas on all 3 islands islands (Table 10). Dry graminoid tundra and prostrate dwarf shrub tundra were selected on Bathurst and Devon islands although no significant selection appeared on Cornwallis Island, and they were not selected during summer on Devon Island. Wetland areas were only selected on Bathurst Island in both seasons. Lower elevations were consistently favoured on all islands.

Models with a subset of land cover classes performed best for Cornwallis Island. Under these models, barren classes were generally avoided in both seasons. Open water was avoided, and permanent snow/ice was avoided on Devon Island, which was the only island with glaciers and ice fields. Persistent snow fields are present on the other islands but may not be as reliably classified due to their smaller size and the presence of darker dirt and detritus over parts of snowfields by late summer. Tussock graminoid tundra was selected on Bathurst and Devon islands. Bare soil and sparsely vegetated colluvium/till were selected on Devon Island. Low elevations were consistently selected on all 3 islands, although the model based only on elevation performed the poorest in all cases.

Table 10. Resource selection function for muskoxen collared on Bathurst Island (4 individuals), Devon Island (5 individuals) and Cornwallis Island (2 individuals) 2003-2006 based on elevation only. Bold font indicates significance at $p<0.05$; italic font indicates $p<0.1$.

| | Bathurst | Devon | Cornwallis |
|---|---|---|---|
| | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE |
| *All Seasons* | | | |
| Intercept | **1.293** | **0.346** | **1.055** |
| | 0.049 | 0.044 | 0.097 |
| DEM | **-0.021** | **-0.013** | **-0.024** |
| | 0.001 | 0.000 | 0.001 |
| AIC | 7574.3 | 8248.9 | 2222.1 |
| *Summer (Jun 15 - Sep 15)* | | | |
| Intercept | 0.097 | **-0.849** | *-0.393* |
| | 0.061 | 0.061 | 0.128 |
| DEM | **-0.018** | **-0.012** | **-0.018** |
| | 0.001 | 0.000 | 0.001 |
| AIC | 4399.8 | 4145.2 | 1252.5 |
| *Winter (Sep 16 - Jun 14)* | | | |
| Intercept | **0.769** | *-0.142* | **0.643** |
| | 0.054 | 0.049 | 0.106 |
| DEM | **-0.020** | **-0.012** | **-0.025** |
| | 0.001 | 0.000 | 0.001 |
| AIC | 5891.5 | 6386.8 | 1679.7 |

Table 11. Resource selection functions for muskoxen collared on Bathurst (4 individuals), Devon (5 individuals) and Cornwallis (2 individuals) islands, 2003-2006, based on vegetation classes. Bold font indicates significance at $p<0.05$; italic font indicates $p<0.1$.

| | Bathurst | Devon | Cornwallis |
|---|---|---|---|
| | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE |
| *All Seasons* | | | |
| Intercept | **-0.542** | **-1.587** | **-1.067** |
| | 0.128 | 0.133 | 0.293 |
| Elevation | **-0.023** | **-0.013** | **-0.025** |
| | 0.001 | 0.000 | 0.001 |
| 1 Tussock graminoid tundra | **2.459** | **4.058** | **3.454** |
| | 0.156 | 0.181 | 0.401 |
| 2 Wet sedge | **2.277** | **2.555** | **2.161** |
| | 0.155 | 0.250 | 0.423 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | **2.669** | **2.454** | **3.964** |
| | 0.180 | 0.231 | 0.555 |
| 4 Dry graminoid/prostrate dwarf shrub tundra | **4.133** | **2.346** | 2.192 |
| | 0.942 | 0.548 | 1.273 |
| 7 Prostrate dwarf shrub tundra | **2.117** | **1.660** | *1.236* |
| | 0.163 | 0.290 | 0.614 |
| 8 Sparsely vegetated bedrock | 0.471 | 0.130 | NA |
| | 0.340 | 0.628 | NA |
| 9 Sparsely vegetated till/colluvium | **1.862** | **2.072** | **2.624** |
| | 0.152 | 0.145 | 0.325 |
| 10 Bare soil with cryptogram crust, frost boils | **2.249** | **2.903** | **3.000** |
| | 0.148 | 0.153 | 0.339 |
| 11 Wetland | **2.012** | *1.044* | 0.482 |
| | 0.225 | 0.374 | 0.875 |
| 12 Barren | **1.442** | **1.555** | **1.929** |
| | 0.168 | 0.147 | 0.316 |
| AIC | 7179.1 | 7302.4 | 2062.4 |
| *Summer (Jun 15 - Sep 15)* | | | |
| Intercept | **-2.165** | **-2.898** | **-2.762** |
| | 0.241 | 0.235 | 0.593 |
| Elevation | **-0.021** | **-0.012** | **-0.019** |
| | 0.001 | 0.001 | 0.002 |
| 1 Tussock graminoid tundra | **2.873** | **3.894** | **3.508** |
| | 0.267 | 0.282 | 0.691 |

| | Bathurst | Devon | Cornwallis |
|---|---|---|---|
| | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE |
| 2 Wet sedge | **2.676** | **2.326** | *2.083* |
| | 0.267 | 0.398 | 0.756 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | **2.609** | **2.388** | **3.803** |
| | 0.311 | 0.374 | 0.860 |
| 4 Dry graminoid/prostrate dwarf shrub tundra | **4.952** | -10.140 | -10.804 |
| | 1.057 | 245.800 | 535.411 |
| 7 Prostrate dwarf shrub tundra | **2.601** | *1.498* | *2.120* |
| | 0.275 | 0.498 | 0.878 |
| 8 Sparsely vegetated bedrock | 0.632 | 0.942 | NA |
| | 0.580 | 0.772 | NA |
| 9 Sparsely vegetated till/colluvium | **2.366** | **2.395** | **2.873** |
| | 0.264 | 0.248 | 0.621 |
| 10 Bare soil with cryptogram crust, frost boils | **2.784** | **2.736** | **3.472** |
| | 0.259 | 0.260 | 0.629 |
| 11 Wetland | **2.885** | 1.020 | 1.352 |
| | 0.324 | 0.648 | 1.236 |
| 12 Barren | **1.861** | **1.780** | **2.179** |
| | 0.285 | 0.253 | 0.616 |
| AIC | 4156.2 | 3807.1 | 1179.0 |
| *Winter (Sep 16 - Jun 14)* | | | |
| Intercept | **-0.800** | **-1.944** | **-1.303** |
| | 0.138 | 0.153 | 0.320 |
| Elevation | **-0.023** | **-0.012** | **-0.027** |
| | 0.001 | 0.000 | 0.002 |
| 1 Tussock graminoid tundra | **2.263** | **3.914** | **3.413** |
| | 0.170 | 0.202 | 0.436 |
| 2 Wet sedge | **2.079** | **2.499** | **2.073** |
| | 0.169 | 0.274 | 0.455 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | **2.678** | **2.355** | **3.883** |
| | 0.196 | 0.261 | 0.581 |
| 4 Dry graminoid/prostrate dwarf shrub tundra | **3.454** | **2.530** | 2.458 |
| | 1.110 | 0.546 | 1.281 |
| 7 Prostrate dwarf shrub tundra | **1.887** | **1.701** | 0.557 |
| | 0.180 | 0.322 | 0.836 |
| 8 Sparsely vegetated bedrock | 0.351 | -0.722 | NA |

| | Bathurst | Devon | Cornwallis |
|---|---|---|---|
| | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE |
| | 0.385 | 1.032 | NA |
| 9 Sparsely vegetated till/colluvium | **1.572** | **1.826** | **2.521** |
| | 0.168 | 0.168 | 0.358 |
| 10 Bare soil with cryptogram crust, frost boils | **1.963** | **2.836** | **2.739** |
| | 0.163 | 0.173 | 0.374 |
| 11 Wetland | **1.432** | *1.024* | 0.078 |
| | 0.260 | 0.423 | 1.134 |
| 12 Barren | **1.175** | **1.340** | **1.786** |
| | 0.188 | 0.170 | 0.348 |
| AIC | 5579.4 | 5635.7 | 1555.8 |

Table 12. Resource selection functions for satellite collared muskoxen on Bathurst (4 individuals), Devon (5 individuals), and Cornwallis (2 individuals) islands, 2003-2006, based on land cover classes expected to be used or avoided by muskoxen. Bold font indicates significance at p<0.05; italic font indicates p<0.1.

| | Bathurst | Devon | Cornwallis |
|---|---|---|---|
| | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE |
| *All Seasons* | | | |
| Intercept | **1.569** | **0.730** | **1.696** |
| | 0.063 | 0.055 | 0.126 |
| Elevation | **-0.023** | **-0.013** | **-0.025** |
| | 0.001 | 0.000 | 0.001 |
| 1 Tussock graminoid tundra | **0.334** | **1.746** | *0.691* |
| | 0.088 | 0.126 | 0.277 |
| 2 Wet sedge | 0.154 | 0.241 | -0.602 |
| | 0.090 | 0.215 | 0.319 |
| 11 Wetland | -0.110 | **-1.271** | *-2.280* |
| | 0.187 | 0.352 | 0.832 |
| 12 Barren | **-0.685** | **-0.756** | **-0.834** |
| | 0.108 | 0.066 | 0.117 |
| 13 Permanent ice/snow | *-1.455* | **-3.329** | *-1.919* |
| | 0.614 | 0.510 | 0.883 |
| 15 Open water | **-2.164** | **-2.398** | **-2.927** |
| | 0.144 | 0.162 | 0.343 |
| AIC | 7248.7 | 7385.5 | 2074.1 |
| *Summer (Jun 15 –Sep 15)* | | | |
| Intercept | **0.417** | **-0.478** | 0.308 |

| | | | |
|---|---|---|---|
| | 0.078 | 0.075 | 0.161 |
| Elevation | **-0.021** | **-0.012** | **-0.019** |
| | 0.001 | 0.001 | 0.002 |
| 1 Tussock graminoid tundra | *0.297* | **1.470** | 0.432 |
| | 0.115 | 0.164 | 0.361 |
| 2 Wet sedge | 0.099 | -0.097 | *-0.990* |
| | 0.118 | 0.327 | 0.486 |
| 11 Wetland | 0.308 | *-1.402* | -1.720 |
| | 0.219 | 0.607 | 1.093 |
| 12 Barren | **-0.715** | **-0.646** | **-0.899** |
| | 0.151 | 0.099 | 0.162 |
| 13 Permanent ice/snow | -0.428 | **-3.618** | -1.513 |
| | 0.604 | 1.005 | 1.115 |
| 15 Open water | **-2.802** | **-2.289** | **-3.405** |
| | 0.279 | 0.260 | 0.736 |
| AIC | 4179.8 | 3828.5 | 1183.1 |
| *Winter (Sep 16 – Jun 14)* | | | |
| Intercept | **1.053** | **0.236** | **1.306** |
| | 0.070 | 0.062 | 0.141 |
| Elevation | **-0.023** | **-0.012** | **-0.027** |
| | 0.001 | 0.000 | 0.002 |
| 1 Tussock graminoid tundra | **0.376** | **1.751** | *0.805* |
| | 0.098 | 0.135 | 0.300 |
| 2 Wet sedge | *0.197* | 0.329 | -0.535 |
| | 0.100 | 0.232 | 0.341 |
| 11 Wetland | *-0.444* | *-1.147* | *-2.530* |
| | 0.224 | 0.398 | 1.095 |
| 12 Barren | **-0.713** | **-0.820** | **-0.822** |
| | 0.126 | 0.078 | 0.137 |
| 13 Permanent ice/snow | -13.860 | **-3.195** | *-2.295* |
| | 176.500 | 0.585 | 1.141 |
| 15 Open water | **-1.857** | **-2.327** | **-2.726** |
| | 0.156 | 0.193 | 0.371 |
| AIC | 5648.3 | 5725.9 | 1566.8 |

Table 13. Resource selection functions for satellite collared muskoxen on Bathurst (4 individuals), Devon (5 individuals), and Cornwallis (2 individuals) islands, 2003-2006, based on land cover classes expected to be used or avoided by muskoxen. Bold font indicates significance at p<0.05; italic font indicates p<0.1.

| | Bathurst | Devon | Cornwallis |
|---|---|---|---|
| | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE |
| *All Seasons* | | | |
| Intercept | **1.414** | **-0.700** | 0.083 |
| | 0.088 | 0.148 | 0.366 |
| Elevation | **-0.023** | **-0.013** | **-0.025** |
| | 0.001 | 0.000 | 0.001 |
| 1 Tussock graminoid tundra | **0.509** | **3.183** | **2.306** |
| | 0.111 | 0.187 | 0.451 |
| 2 Wet sedge | *0.326* | **1.676** | *1.013* |
| | 0.112 | 0.256 | 0.474 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | **0.723** | **1.580** | **2.817** |
| | 0.137 | 0.235 | 0.592 |
| 9 Sparsely vegetated till/colluvium | -0.087 | **1.195** | **1.477** |
| | 0.104 | 0.153 | 0.385 |
| 10 Bare soil with cryptogram crust, frost boils | *0.300* | **2.026** | **1.852** |
| | 0.097 | 0.161 | 0.397 |
| 12 Barren | **-0.508** | **0.681** | *0.781* |
| | 0.127 | 0.153 | 0.377 |
| 15 Open Water | **-2.007** | **-0.967** | *-1.314* |
| | 0.157 | 0.213 | 0.487 |
| AIC | 7210.2 | 7318.4 | 2057.5 |
| *Summer (Jun 15 – Sep 15)* | | | |
| Intercept | *0.368* | **-2.338** | *-1.020* |
| | 0.112 | 0.288 | 0.499 |
| Elevation | **-0.021** | **-0.012** | **-0.019** |
| | 0.001 | 0.001 | 0.002 |
| 1 Tussock graminoid tundra | *0.351* | **3.338** | *1.764* |
| | 0.143 | 0.323 | 0.605 |
| 2 Wet sedge | 0.153 | **1.768** | 0.340 |
| | 0.145 | 0.429 | 0.682 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | 0.093 | **1.832** | *2.059* |
| | 0.208 | 0.405 | 0.792 |
| 9 Sparsely vegetated till/colluvium | -0.154 | **1.839** | *1.128* |
| | 0.136 | 0.293 | 0.523 |
| 10 Bare soil with cryptogram crust, frost boils | *0.264* | **2.179** | *1.727* |
| | 0.125 | 0.304 | 0.533 |

| | Bathurst | Devon | Cornwallis |
|---|---|---|---|
| | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE |
| 12 Barren | **-0.660** | **1.225** | 0.434 |
| | 0.173 | 0.295 | 0.515 |
| 15 Open Water | **-2.752** | -0.428 | *-2.076* |
| | 0.291 | 0.381 | 0.876 |
| AIC | 4171.4 | 3809.5 | 1174.5 |
| *Winter (Sep 16 – Jun 14)* | | | |
| Intercept | **0.840** | **-1.013** | -0.475 |
| | 0.101 | 0.163 | 0.443 |
| Elevation | **-0.023** | **-0.012** | **-0.027** |
| | 0.001 | 0.000 | 0.002 |
| 1 Tussock graminoid tundra | **0.619** | **2.998** | **2.589** |
| | 0.126 | 0.203 | 0.526 |
| 2 Wet sedge | **0.436** | **1.577** | *1.247* |
| | 0.127 | 0.277 | 0.546 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | **1.032** | **1.440** | **3.059** |
| | 0.152 | 0.262 | 0.652 |
| 9 Sparsely vegetated till/colluvium | -0.072 | **0.907** | **1.697** |
| | 0.121 | 0.170 | 0.464 |
| 10 Bare soil with cryptogram crust, frost boils | *0.319* | **1.918** | **1.915** |
| | 0.114 | 0.176 | 0.477 |
| 12 Barren | *-0.469* | *0.426* | *0.962* |
| | 0.149 | 0.171 | 0.455 |
| 15 Open Water | **-1.641** | **-1.078** | -0.945 |
| | 0.172 | 0.246 | 0.562 |
| AIC | 5604.5 | 5649.6 | 1.55E+03 |

Table 14. Model comparison with AIC and ΔAIC for resource selection functions for collared muskoxen on Bathurst (4 individuals), Devon (5 individuals), and Cornwallis (2 individuals) islands, 2003-2006. Bold font indicates significance at $p<0.05$; italic font indicates $p<0.1$.

| | Bathurst | Devon | Cornwallis |
|---|---|---|---|
| | AIC | AIC | AIC |
| | ΔAIC | ΔAIC | ΔAIC |
| *All Seasons* | | | |
| Elevation | 7574.3 | 8248.9 | 2222.1 |
| | 395.2 | 946.5 | 164.6 |
| Vegetation | 7179.1 | 7302.4 | 2062.4 |
| | 0.0 | 0.0 | 4.9 |
| Land cover 1 | 7248.7 | 7385.5 | 2074.1 |
| | 69.6 | 83.1 | 16.6 |
| Land cover 2 | 7210.2 | 7318.4 | 2057.5 |
| | 31.1 | 16.0 | 0.0 |
| *Summer (Jun 15 – Sep 15)* | | | |
| Elevation | 4399.8 | 4145.2 | 1252.5 |
| | 243.6 | 338.1 | 78.0 |
| Vegetation | 4156.2 | 3807.1 | 1179.0 |
| | 0.0 | 0.0 | 4.5 |
| Land cover 1 | 4179.8 | 3828.5 | 1183.1 |
| | 23.6 | 21.4 | 8.6 |
| Land cover 2 | 4171.4 | 3809.5 | 1174.5 |
| | 15.2 | 2.4 | 0.0 |
| *Winter (Sep 16 – Jun 14)* | | | |
| Elevation | 5891.5 | 6386.8 | 1679.7 |
| | 312.1 | 751.1 | 126.5 |
| Vegetation | 5579.4 | 5635.7 | 1555.8 |
| | 0.0 | 0.0 | 2.6 |
| Land cover 1 | 5648.3 | 5725.9 | 1566.8 |
| | 68.9 | 90.2 | 13.6 |
| Land cover 2 | 5604.5 | 5649.6 | 1553.2 |
| | 25.1 | 13.9 | 0.0 |

## Discussion

Although compared to modern collars the satellite collars deployed in 2003 generally had low accuracy, low fix success, and a fix schedule too coarse for detailed movement or selection studies, the information gathered informs our knowledge of muskoxen movement, home range use, and habitat selection on Devon, Bathurst, and Cornwallis islands. There was a clear focus in all seasons on discrete lowland areas, typically along rivers, wetland complexes, and coastlines, which support relatively lush vegetation. Movements among these parts of the home range appeared to take place over relatively short timeframes. Some animals made forays into other areas, notably 7717 on southern Bathurst Island, and 7734, from Baring Bay across Devon Island to the Colin Archer Peninsula. Movement among discrete patches of habitat is likely necessary where these patches are small and widely separated – only 9% of Devon Island is hummocky moss/sedge or frost boil moss/sedge meadows (Pearce 1991).

*Site Fidelity and Displacement*

Residents of Grise Fiord and Resolute Bay have observed caribou and muskoxen moving to different areas when the vegetation becomes depleted, returning years to decades later once it has regenerated. People are usually referring to caribou, but they point out that muskoxen will move as well, especially during harsh winters when food becomes inaccessible under ice crusts (for example, 1996-97 on Bailey Point, Melville Island, and from Bathurst Island to Cornwallis Island in 1967, 1973, and 1995; Gunn and Adamczewski 2003). Aastrup (2003) tagged muskoxen in eastern Greenland and noted locations of re-sighted or harvested individuals, finding some as far as 120 km from their original capture location, although most animals remained within 40-60 km. Although Aastrup (2003) noted little site fidelity, he did observe tagged muskoxen returning to the area where they had been tagged. Muskoxen on the north slope of Alaska moved between seasonal ranges 20-30 km apart, although some moved much farther, a maximum distance of 114 km between calving and summer ranges (Reynolds 1998). Muskoxen on the Canadian mainland moved a maximum 140 km between seasonal ranges, although these ranges partially overlapped (Gunn and Fournier 2000). Longer movements have been recorded (a 3-year-old cow moved 320 km to and from Nelson Island, Patten 1997). Tener (1965) and B. McLean (pers. comm. in Gunn and Adamczewski 2003) found that muskoxen on the Canadian Arctic Archipelago made shorter seasonal migrations than on the mainland. Thirteen of 20 Banks Island muskoxen remained within 50 km of their capture locations between October 1985 and August 1987, and all relocations were within 80 km of where they were originally captured (Gunn and Adamczewski 2003). Banks Island is unique in the Arctic Archipelago, as a large island without a highly indented shoreline, allowing for warmer, more continental temperatures inland and productive vegetation (Thomas et al. 1981). On other islands, the topography, glacial till, drainage, and weather interact to form pockets of favorable habitat and localized high muskox density (Thomas et al. 1981), and muskoxen move among these grazing areas (Gray 1973). The muskoxen on Bathurst, Cornwallis, and Devon islands tended to make punctuated movements between feeding areas that are up to 60-90 km apart, well within the range of movements and migrations reported elsewhere. The two muskoxen on northern Bathurst Island moved between feeding areas within a 30-40 km radius. The timing of the longest displacements varied among individuals.

Obvious seasonal movement and returning to the same areas or ranges seasonally year after year was only apparent for 7717, although suitable habitat may be used by many herds over the course of the year (Gray 1973). She used the east side of a valley by May Inlet in the fall, the western part of the valley in the winter, and the neighboring valley to the north in the summer. It is not clear whether this pattern would have been repeated if the collar had been active for a longer time span. The other muskoxen used different ranges in different seasons and years. Areas visited in summer could also be visited in winter, as demonstrated by 7737 on Cornwallis Island moving between northwest and northeast coasts, and 7716 visiting all 4 lowland areas in her home range within a single summer (Crying Fox Creek/Variscan River, Misty River north, Misty River south, Polar Bear Pass). The same area might be used in several seasons, occasionally with winter use following summer use (as in 7743, where the use was confined to a very small area), but usually with more time between visits. For example, 7724 used Inglis Sound in summer 2003 then moved to the Ensorcellement River for winter 2003 and summer 2004, then returned to Inglis Sound. Larter and Nagy (2004) found muskoxen remaining in sedge meadows during the darkest months on Banks Island, an area of high muskox density, and moving to new, ungrazed pastures with the return of daylight in February. Several of the muskoxen collared in this study continued to move to new pastures in the dark season from November to January. Gray (1973), observing muskoxen over winter 1970-71, found no herds in his study area in Polar Bear Pass, although they moved into and out of the valley during the rest of the year. He also noted seasonal use of different slopes, ridges, and water features (Gray 1973), a scale of selection that we cannot investigate with this dataset, but which may partially explain a lack of seasonal range selection if it occurs at a different scale.

Parker and Ross (1976) observed muskoxen travelling and feeding at Bailey Point (Melville Island) and Mokka Fiord (Axel Heiberg Island) in summer 1974. The average displacement for muskox herds was 216-603 m/hr, with a maximum displacement of 3.04 km in one hour. If the muskoxen followed an approximately 2.5-hour feeding-resting/ruminating cycle (Gray 1973), that would suggest daily displacements of about 2-6 km. The Mokka Fiord muskoxen were generally more mobile than the Bailey Point animals, which had more access to wet sedge meadows (Parker and Ross 1976). Wilkinson et al. (1976) noted that muskox movements within feeding areas could be almost negligible, punctuated with longer movements from one feeding area to another, such that an 'average' daily displacement was not necessarily informative. Muskoxen could be in one feeding area for up to 10 days (Wilkinson et al. 1976), and so the collar schedule in this study likely missed movements within and among feeding areas. Averaging displacements over 4 days loses the fine-scale movements that Parker and Ross (1976) were recording while observing muskoxen, likely explaining the lower displacements reported here, although the punctuated movements observed by Wilkinson et al. (1976) were detected in this study. The displacement values here are a proxy for the actual displacement, relative values that can be used to examine changes over time and among islands.

Telemetry data also revealed at least one and likely 2 muskoxen crossing sea ice. Muskoxen are known to cross water bodies when ice is present. Aastrup (2003) suggested muskoxen cross fiords up to 6 km wide (and possibly as far as 45 km across the ice), although the crossings in this study were much shorter. While swimming appears to be extremely rare, it has been reported (Resolute Bay HTA, pers. comm.). No icing events were known to have occurred on Devon or Bathurst Island when collars were active, so ice crossings related to desperation movements may not be represented by this dataset.

Without knowing whether or not the collared muskoxen had calves each year, it is not possible to determine whether shorter displacements, for example those seen on Bathurst Island in April 2005 and 2006, could be linked to calving. The calving period for muskoxen in Polar Bear Pass stretches from mid-April to mid-June (Gray and Rowell 1976). It may be possible to detect calving in muskoxen by changes in movement rates, as is possible for caribou and moose (DeMars et al. 2013, Singh et al. 2014, Severud et al. 2015), but our data lack the temporal resolution in location points and the field verification of reproductive status needed to evaluate whether this is feasible.

*Habitat Selection*

Resource selection functions determined for individual muskoxen suggested that wet sedge, moist tussock tundra, bare soil, bare till, and wetland were selected. Bedrock, dry non-tussock tundra, dwarf shrub, and ice were not selected, or not by many individuals. Similar patterns were seen when the RSFs were determined for all muskoxen on a single island. Boyce (2006) suggested that selection varies across scale when there is a trade-off between resources or when there is significant topographic relief. The study area examined here generally had low topographic relief and the wide distribution of the forage species utilized (Schaeffer and Messier 1995).

The selection of habitats likely varies over the course of the year depending on the availability of forage and its accessibility. Summer resource selection could be compared with previous work that has relied on observations of herds during the summer, but winter observations in the High Arctic have been limited by daylight and harsh field conditions. Parker and Ross (1976) noted that muskoxen on Melville and Axel Heiberg Islands spent early summer on hills and ridges where new growth was present on willows, forbs, and grasses, but by early July they moved to lowland areas to exploit sedges. Muskoxen appeared to move in response to snow melt patterns near Kugluktuk, but responded to the green-up of willow around Bathurst Inlet (Gunn and Adamczewski 2003). Staaland and Thing (1991) and Larter et al. (2002) found muskoxen selecting willow in early summer in Greenland and on Banks Island, respectively. This coincides with a period of rumen mucosal enlargement, allowing increased nutrient uptake, which may allow muskoxen to focus on high quality willow forage (Staaland and Thing 1991, Hoffman 2000, Larter et al. 2002), although willow stems are consumed throughout the year (Larter et al. 2002).

The preference of muskoxen for well-vegetated lowlands is well-known by Inuit and biologists (Henry *et al.,* 1986, O'Brien 1988, Gray 1973, Parker and Ross 1976, Thing *et al.* 1987, Thomas *et al.* 1981, Ferguson 1991, Larter and Nagy 1997, Taylor 2005). St.-Pierre (2003) found muskoxen were closely associated with high productivity (25-50 g biomass/$m^2$) areas on northern Ellesmere Island, and these areas had muskox densities ten times higher than nearby unvegetated areas (Manseau et al. 2004). Muskoxen rely primarily on willow (*Salix* spp.) and graminoid sedges, particularly *Carex aquatilis* var. *stans*, *Eriophorum triste*, and *E. scheuchzeri,* on the Queen Elizabeth Islands (Parker 1978). In particular, *C. aquatilis* var. *stans* was important in muskox diets on eastern Melville Island (Thomas and Edmonds 1984) and Banks Island (Wilkinson et al 1976).

The potential for competition between muskoxen and caribou for forage has been examined across their range with the general consensus that while caribou and muskoxen may overlap in range and even habitat at times, there is generally little competition for food since muskoxen focus on grasses and sedges, particularly in wet meadows, which caribou avoid in favour of habitats rich in forbs and willow (Parker and Ross 1976, Wilkinson et al. 1976, Thomas and Edmonds 1984, Staaland et al. 1997, Thomas et al. 1999). Ruminants fall along a continuum, utilizing high quantity, low quality food (grazers; muskoxen), intermediate food (intermediate feeders; caribou), and low quantity, high quality foods (concentrate selectors) (Hoffman 1989). Hoffman (1989, 2000) proposed that muskoxen, grazers with a large gut capacity, could subsist off lower quality forage while smaller, more selective caribou would need to focus on easily digestible high-quality forage. Vincent and Gunn (1981) contend that although previous work has not supported competition between the two species, hunters have repeatedly raised concerns about competition for forage and avoidance of muskoxen by caribou, and it is possible that the research was not carried out in areas where muskox density was high enough to have an impact. Staaland and Olesen (1991) noted high graminoid content in the rumens of both barren-ground caribou and muskoxen in Greenland where population densities were high, but did not address competition between the two species. In contrast to the work on Melville, Axel Heiberg, and northwest Victoria islands (Parker and Ross 1976, Wilkinson et al. 1976, Thomas and Edmonds 1984, Staaland et al. 1997, Thomas et al. 1999), Larter et al. (2002) and Larter and Nagy (2004) found overlap in caribou and muskox diet on Banks Island for 5 months during summer. They suggested this could be due to the large muskox population, which may compete with the caribou at critical times of year (Larter et al. 2002). Furthermore, if herbivory had a detrimental effect on willow, caribou would likely be more affected than muskoxen, since they are more selective feeders (Larter and Nagy 2004). However, no competition between Peary caribou and muskoxen has been documented on the Queen Elizabeth Islands, even under extreme weather conditions (Miller 1998).

Although this work confirms muskox use of wetlands and sedge meadows, there was some selection for upland sites with dwarf shrubs and dry tundra as well. This could reflect early summer foraging before sedges are available and utilization of wind-scoured snow free slopes. Locations of muskoxen in sedge meadows even in late winter suggest wind-scoured slopes are not key to accessing forage (Parker and Ross 1976, Jenkins et al 2011, Anderson 2014), provided they can crater through the snow (usually 20-50 cm, Thomas and Edmonds 1984). It could also indicate overlap in foraging habitats. Larter and Nagy (1997) reanalyzed the work of Wilkinson et al. (1976) and Shank et al. (1978), determining muskoxen and caribou do have substantial diet overlap – the sedges, willows, legumes, and avens that make up ≥90% of the muskox monthly diet also account for ≥65% of the Peary caribou monthly diet (Larter et al. 2002). Competition is difficult to define and confirm in the field (Vincent and Gunn 1981), and it may depend on the densities of the species involved (Larter and Nagy 2004).

Ferguson (1991) used Landsat imagery, verified in the field in 1988 and 1989, on Banks Island to examine muskox habitat, and found wet sedge meadows, graminoid tundra, and graminoid/dwarf shrub tundra were important summer foraging habitat. The lowland habitats were easily distinguishable from upland habitat types, with 88% accuracy (Ferguson 1991), a distinctness that also suggests those habitat classes may be well represented in this analysis. Pearce (1991) used SPOT satellite imagery to map muskox habitat on Devon Island and also noted that the well-vegetated lowlands were easily distinguished from the sparsely vegetated beach ridges and uplands.

There may be some issues with detecting sparsely-vegetated landcover classes, as the Landsat thematic mapper values can be dominated by the background values for soil, bedrock, or colluvium where vegetation is scarce, making it less reliable for distinguishing polar desert and semi-desert vegetation classes (Frank 1988, Ferguson 1991). Sparsely vegetated areas can also be associated with a variety of topographic features, soil types, and moisture regimes.

Although this telemetry dataset is limited in number of study animals and number and accuracy of locations, it is useful for examining broad movement patterns and range use. Additional work with this dataset and telemetry locations from 11 Peary caribou collared in the same areas at the same time should be pursued to examine interactions between in the two species.

## Management Implications

*Muskox Management Units*

The space use information presented here supports the current High Arctic muskox management units (MMUs). Under the Management Plan for High Arctic Muskoxen of the Qikiqtaaluk Region, Bathurst Island and Cornwallis Island are in the same management unit, MX-05, and Devon Island is MX-04. MMUs are meant to reflect population boundaries, and while location data is only one line of evidence for establishing population boundaries, it can be used in combination with Inuit qaujimajatuqangit, particularly in areas or times people seldom travel. The overlapping home ranges of muskoxen on Bathurst Island and Cornwallis Island suggest muskoxen can move extensively on the islands, even if they are usually localized in small habitat patches. The lack of movement between Cornwallis and Bathurst islands should not be considered proof of isolation, as the study period was brief, and even during this study muskoxen crossed frozen fiords and bays. Muskoxen on Devon Island moved from the southern and western shores to Jones Sound, suggesting interchange across the island among the relatively isolated lowlands.

*Development and Land Use Planning*

The locations of the collared muskoxen in this study provide a clear picture of some important habitat patches for muskoxen on Devon, Cornwallis, and Bathurst islands. Individual muskoxen primarily used 2-5 habitat patches in a year, so any activity with a detrimental impact on the habitat, or that disturbs the muskoxen or otherwise makes the area unsuitable to muskox occupation, could put more pressure on the remaining habitat. Social species inhabiting dispersed habitat patches and with long life spans, low reproductive rates, and low dispersal of juveniles are particularly susceptible to alienation of otherwise suitable habitat (Geist 1971, Gray 1973). It is also important to consider the unsuitable habitat linking these habitat patches to allow muskoxen to move among them any time of the year. Knowing the movement patterns of muskoxen on the islands also reinforces the importance of considering impacts to habitat on one side of an island impacting muskoxen on the other side of the island. This is an important consideration for any developments establishing a zone of impact and preparing monitoring and mitigation plans.

Protection of seasonal ranges, including rut ranges and calving grounds, is not feasible for muskoxen on Devon, Bathurst, and Cornwallis islands in the same way that it can be applied to migratory caribou. Instead, the patches of good habitat that are used in all seasons should be considered as rut, calving, and seasonal ranges, and muskoxen may be present there during any season. Restrictions on activities can still be applied based on the season, but would be applied to muskox ranges in general, which may be used by several herds throughout the year, not to spatiotemporally discrete calving, post-calving, summer, rut, or winter ranges during the corresponding seasons.

*Localized Harvest Impacts*

The site fidelity and patchiness of muskox habitat on Bathurst, Devon, and Cornwallis islands, along with the fairly specific habitat requirements, mean that there are places where muskoxen can be reliably located. Harvesters have long known about these areas, especially those which are easily accessible. Overharvest in one area may temporarily deplete the local population because muskoxen do not move as extensively as caribou, but they do move among several habitat patches in a year, so short-term overharvest will likely not have an obvious, immediate, local impact. Continued intensive harvest in a few key areas could draw the population down as muskoxen move into the area and are harvested, and if the harvest rate exceeds immigration. Current harvest levels on the islands are minimal, and no population-level impacts are expected, but increasing pressure from Baffin Island communities seeking country food while Baffin Island caribou populations are at low density could rapidly alter the hunting effort. Coordination and monitoring by local hunters and trappers associations/organizations, the Department of Environment, and other co-management partners will be required to ensure that harvest practices remain sustainable, even at high muskox densities.

*Survey Methodology*

Habitat selection is tied to abundance, where animals are more abundant in selected habitats (Boyce et al. 2016). Incorporating habitat selection into survey methodology, for example by allocating effort according to different strata based on expected abundance or distribution patterns, can increase the precision of estimates reduce survey costs. New technologies like high resolution satellite imagery work best for monitoring wildlife where specific habitat variables associated with a species are known – unfortunately, it has not worked for muskoxen so far (LaRue et al. 2016). Since muskoxen in the High Arctic are typically monitored during the same surveys as Peary caribou, any stratification or other alterations to survey design will likely need to account for habitats selected by both species.

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**Appendix I. Individual resource selection functions for muskoxen on Bathurst, Cornwallis, and Devon islands, 2003-06.**

Table 15. Results of a resource selection function using only elevation, by season and individual for collared muskoxen on Bathurst, Devon, and Cornwallis islands, 2003-2006. Bold font indicates significance at p<0.05; italic font indicates p<0.1.

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| | All Seasons | | | | | | | | | |
| Intercept | **-2.078** | **0.201** | **-0.532** | *0.143* | **-1.444** | **-0.773** | **-1.128** | *-0.342* | **0.612** | **-1.667** |
| | 0.130 | 0.060 | 0.075 | 0.059 | 0.083 | 0.060 | 0.066 | 0.134 | 0.103 | 0.076 |
| Elevation | **-0.016** | **-0.018** | **-0.019** | **-0.019** | **-0.016** | **-0.012** | **-0.012** | **-0.023** | **-0.022** | **-0.008** |
| | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.0004 | 0.001 | 0.002 | 0.001 | 0.0004 |
| AIC | 1096.4 | 4657.4 | 2779.2 | 4373.0 | 2016.1 | 4284.1 | 3409.8 | 1004.9 | 1871.5 | 3230.0 |
| | Summer (Jun 15-Sep 15) | | | | | | | | | |
| Intercept | **-3.298** | **-1.328** | **-1.741** | **-0.619** | **-2.896** | **-2.115** | **-1.650** | **-1.618** | **-0.833** | **-3.099** |
| | 0.214 | 0.092 | 0.120 | 0.075 | 0.159 | 0.097 | 0.086 | 0.197 | 0.145 | 0.140 |
| Elevation | **-0.012** | **-0.014** | **-0.020** | **-0.018** | **-0.016** | **-0.010** | **-0.014** | **-0.018** | **-0.017** | **-0.007** |
| | 0.002 | 0.001 | 0.002 | 0.001 | 0.002 | 0.001 | 0.001 | 0.002 | 0.002 | 0.001 |
| AIC | 534.8 | 2086.2 | 1156.9 | 2784.5 | 657.7 | 1925.3 | 2014.2 | 535.9 | 990.1 | 1184.6 |
| | Winter (Sep 16-Jun 14) | | | | | | | | | |
| Intercept | **-2.799** | -0.126 | **-0.941** | **-0.587** | **-1.737** | **-1.139** | **-2.032** | **-0.731** | *0.226* | **-1.972** |
| | 0.192 | 0.066 | 0.084 | 0.073 | 0.093 | 0.069 | 0.092 | 0.156 | 0.114 | 0.087 |
| Elevation | **-0.020** | **-0.018** | **-0.018** | **-0.018** | **-0.015** | **-0.012** | **-0.010** | **-0.025** | **-0.023** | **-0.008** |
| | 0.003 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 |
| AIC | 521.8 | 3768.5 | 2222.7 | 2868.7 | 1670.9 | 3233.0 | 2086.6 | 703.2 | 1416.4 | 2543.4 |

Table 16. Resource selection function by season and individual for muskoxen collared on Bathurst, Devon, and Cornwallis islands, 2003-2006, including elevation and vegetation class (not including open water or permanent snow/ice). Bold font indicates significance at p<0.05; italic font indicates p<0.1.

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| | All Seasons | | | | | | | | | |
| Intercept | **-3.342** | **-1.953** | **-2.282** | **-1.267** | **-5.065** | **-2.800** | **-2.363** | **-2.226** | **-1.487** | **-4.261** |
| | 0.415 | 0.222 | 0.254 | 0.162 | 0.709 | 0.224 | 0.187 | 0.468 | 0.345 | 0.413 |
| Elevation | **-0.018** | **-0.022** | **-0.023** | **-0.021** | **-0.016** | **-0.012** | **-0.013** | **-0.024** | **-0.024** | **-0.008** |
| | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 |
| 1 Tussock graminoid tundra | *1.260* | **2.924** | **2.520** | **2.000** | **4.911** | **4.300** | *1.090* | **3.338** | **3.394** | **5.082** |
| | 0.518 | 0.247 | 0.290 | 0.198 | 0.742 | 0.266 | 0.354 | 0.592 | 0.450 | 0.435 |
| 2 Wet sedge | **1.978** | **2.565** | **2.455** | **1.864** | **4.788** | **1.673** | **2.116** | **2.190** | **1.959** | **3.042** |
| | 0.470 | 0.248 | 0.287 | 0.199 | 0.775 | 0.449 | 0.347 | 0.613 | 0.485 | 0.549 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | *1.781* | **3.439** | **2.907** | **1.601** | **4.588** | **2.447** | 0.797 | **3.142** | **4.011** | **3.338** |
| | 0.592 | 0.267 | 0.333 | 0.261 | 0.788 | 0.355 | 0.505 | 0.875 | 0.586 | 0.493 |
| 4 Dry graminoid/prostrate dwarf shrub tundra | -13.000 | **5.051** | *3.615* | *3.098* | -8.259 | -11.310 | 1.409 | -11.340 | *2.588* | **3.597** |
| | 4441.000 | 1.025 | 1.437 | 1.320 | 366.740 | 408.200 | 1.089 | 535.411 | 1.284 | 0.676 |
| 7 Prostrate dwarf shrub tundra | *1.158* | **2.784** | **2.638** | *0.787* | **5.095** | -0.379 | 0.342 | 1.333 | 1.092 | -11.710 |
| | 0.547 | 0.252 | 0.296 | 0.240 | 0.763 | 1.038 | 0.629 | 0.902 | 0.738 | 324.600 |
| 8 Sparsely vegetated bedrock | -13.310 | *1.143* | 0.586 | -0.499 | *2.597* | -13.190 | 0.479 | NA | NA | -11.100 |
| | 534.400 | 0.449 | 0.656 | 0.624 | 1.247 | 461.500 | 0.761 | NA | NA | 291.300 |
| 9 Sparsely vegetated | **1.589** | **2.230** | **1.514** | **1.538** | **3.784** | **2.090** | **1.843** | **2.582** | **2.559** | **2.170** |

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| till/colluvium | | | | | | | | | | |
| | 0.474 | 0.247 | 0.299 | 0.194 | 0.721 | 0.240 | 0.205 | 0.510 | 0.377 | 0.428 |
| 10 Bare soil with cryptogram crust, frost boils | **1.581** | **2.570** | **1.953** | **2.016** | **4.714** | **3.282** | **1.057** | **3.112** | **2.861** | **3.454** |
| | 0.468 | 0.242 | 0.285 | 0.187 | 0.722 | 0.242 | 0.254 | 0.520 | 0.392 | 0.427 |
| 11 Wetland | **2.166** | **1.782** | *1.428* | **2.117** | *2.985* | *1.413* | -12.620 | 0.914 | 0.203 | 0.954 |
| | 0.569 | 0.354 | 0.449 | 0.268 | 1.021 | 0.530 | 250.800 | 1.183 | 1.140 | 1.092 |
| 12 Barren | 0.893 | **1.532** | **1.350** | **1.178** | **2.879** | **1.198** | **1.449** | *1.379* | **2.031** | **2.101** |
| | 0.547 | 0.275 | 0.325 | 0.215 | 0.732 | 0.249 | 0.209 | 0.508 | 0.368 | 0.424 |
| AIC | 1077.5 | 4329.8 | 2601.3 | 4163.8 | 1753.9 | 3578.9 | 3289.4 | 912.9 | 1758.0 | 2767.3 |
| | Summer (Jun 15-Sep15) | | | | | | | | | |
| Intercept | **-4.466** | **-3.753** | **-4.415** | **-2.732** | **-5.758** | **-4.897** | **-3.123** | **-3.907** | **-3.172** | **-6.118** |
| | 0.711 | 0.505 | 0.711 | 0.311 | 1.002 | 0.581 | 0.273 | 1.009 | 0.720 | 1.005 |
| Elevation | **-0.014** | **-0.017** | **-0.025** | **-0.021** | **-0.016** | **-0.008** | **-0.016** | **-0.017** | **-0.019** | **-0.007** |
| | 0.003 | 0.001 | 0.002 | 0.001 | 0.002 | 0.001 | 0.001 | 0.003 | 0.002 | 0.001 |
| 1 Tussock graminoid tundra | 1.277 | **3.278** | **3.342** | **2.615** | **4.092** | **5.111** | 0.751 | *3.137* | **3.583** | **4.971** |
| | 0.854 | 0.530 | 0.749 | 0.344 | 1.070 | 0.603 | 0.583 | 1.157 | 0.819 | 1.032 |
| 2 Wet sedge | 0.991 | **2.800** | **3.292** | **2.611** | *3.777* | *2.576* | 1.144 | *2.721* | 1.290 | **4.004** |
| | 0.879 | 0.535 | 0.746 | 0.342 | 1.170 | 0.831 | 0.662 | 1.150 | 1.034 | 1.128 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | 1.286 | **3.107** | **3.635** | **1.962** | **4.198** | **2.909** | 1.276 | *3.834* | **3.535** | *3.404* |
| | 1.039 | 0.574 | 0.809 | 0.446 | 1.136 | 0.742 | 0.659 | 1.311 | 1.018 | 1.161 |
| 4 Dry graminoid/prostrate dwarf shrub tundra | -12.340 | **5.664** | -6.239 | **4.532** | -8.568 | -11.020 | -11.230 | -9.660 | -12.390 | -10.240 |

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| | 4504.000 | 1.234 | 357.505 | 1.347 | 605.443 | 710.900 | 609.700 | 535.412 | 1455.000 | 723.300 |
| 7 Prostrate dwarf shrub tundra | 1.228 | **3.133** | **3.766** | **1.793** | **4.538** | -13.030 | -14.400 | *2.684* | 1.440 | -11.910 |
| | 0.886 | 0.536 | 0.745 | 0.378 | 1.096 | 880.600 | 859.700 | 1.267 | 1.268 | 884.700 |
| 8 Sparsely vegetated bedrock | -12.520 | 1.277 | 1.662 | -0.183 | *3.290* | -12.390 | 0.657 | NA | NA | -11.330 |
| | 552.000 | 0.884 | 1.243 | 1.061 | 1.435 | 786.300 | 1.061 | NA | NA | 799.000 |
| 9 Sparsely vegetated till/colluvium | *1.658* | **2.623** | **2.629** | **2.175** | *2.990* | **2.506** | **2.375** | *2.785* | **2.848** | *2.893* |
| | 0.786 | 0.532 | 0.757 | 0.342 | 1.033 | 0.597 | 0.292 | 1.050 | 0.750 | 1.020 |
| 10 Bare soil with cryptogram crust, frost boils | *1.698* | **2.763** | **3.030** | **2.822** | **3.761** | **3.892** | 0.765 | **3.594** | **3.314** | **3.576** |
| | 0.778 | 0.527 | 0.742 | 0.331 | 1.035 | 0.594 | 0.404 | 1.050 | 0.762 | 1.029 |
| 11 Wetland | 1.761 | 1.161 | **3.026** | **3.235** | *2.968* | *2.355* | -13.690 | 2.446 | -11.750 | -11.420 |
| | 1.017 | 0.883 | 0.858 | 0.389 | 1.430 | 0.927 | 665.100 | 1.480 | 524.700 | 722.400 |
| 12 Barren | 1.149 | *1.617* | *2.159* | **1.884** | 1.945 | *1.637* | **1.762** | 1.318 | *2.406* | *2.792* |
| | 0.860 | 0.585 | 0.803 | 0.363 | 1.075 | 0.608 | 0.303 | 1.062 | 0.743 | 1.016 |
| AIC | 543.4 | 1975.8 | 1096.4 | 2617.5 | 607.3 | 1603.9 | 1890.1 | 491.5 | 948.8 | 1116.6 |
| | Winter (Sep 16-Jun14) | | | | | | | | | |
| Intercept | **-4.029** | **-2.150** | **-2.417** | **-1.530** | **-5.765** | **-2.950** | **-3.040** | **-2.428** | **-1.722** | **-4.460** |
| | 0.582 | 0.241 | 0.269 | 0.180 | 1.002 | 0.242 | 0.249 | 0.519 | 0.380 | 0.452 |
| Elevation | **-0.021** | **-0.022** | **-0.022** | **-0.020** | **-0.016** | **-0.012** | **-0.011** | **-0.028** | **-0.025** | **-0.007** |
| | 0.004 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.003 | 0.002 | 0.001 |
| 1 Tussock graminoid tundra | 0.985 | **2.765** | **2.268** | **1.632** | **5.293** | **3.767** | *1.280* | **3.421** | **3.306** | **5.040** |
| | 0.785 | 0.271 | 0.311 | 0.226 | 1.030 | 0.292 | 0.430 | 0.659 | 0.493 | 0.474 |
| 2 Wet sedge | **2.398** | **2.494** | **2.225** | **1.329** | **5.226** | *1.339* | **2.441** | *1.848* | **2.070** | **2.607** |

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| | 0.647 | 0.271 | 0.307 | 0.231 | 1.057 | 0.534 | 0.396 | 0.701 | 0.520 | 0.651 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | -13.830 | **3.538** | **2.680** | **1.413** | **4.816** | **2.235** | 0.334 | 2.209 | **4.089** | **3.306** |
| | 920.400 | 0.291 | 0.358 | 0.301 | 1.084 | 0.400 | 0.761 | 1.222 | 0.615 | 0.539 |
| 4 Dry graminoid/prostrate dwarf shrub tundra | -13.990 | **4.538** | *3.647* | -8.545 | -8.621 | -11.130 | 1.650 | -14.140 | *2.843* | **3.740** |
| | 12010.000 | 1.206 | 1.425 | 217.203 | 610.833 | 406.800 | 1.074 | 2400.000 | 1.295 | 0.701 |
| 7 Prostrate dwarf shrub tundra | -0.194 | **2.658** | **2.251** | 0.012 | **5.430** | -0.221 | 0.896 | -12.830 | 0.895 | -12.530 |
| | 1.171 | 0.277 | 0.322 | 0.323 | 1.051 | 1.041 | 0.648 | 601.800 | 0.858 | 535.700 |
| 8 Sparsely vegetated bedrock | -14.430 | *1.100* | 0.224 | -0.715 | -10.964 | -13.030 | 0.274 | NA | NA | -11.920 |
| | 1429.000 | 0.505 | 0.777 | 0.750 | 736.398 | 461.400 | 1.048 | NA | NA | 481.500 |
| 9 Sparsely vegetated till/colluvium | *1.426* | **2.026** | **1.170** | **1.156** | **4.195** | **1.945** | **1.264** | **2.492** | **2.442** | **1.901** |
| | 0.690 | 0.273 | 0.327 | 0.224 | 1.012 | 0.260 | 0.277 | 0.572 | 0.418 | 0.473 |
| 10 Bare soil with cryptogram crust, frost boils | 1.308 | **2.469** | **1.621** | **1.463** | **5.163** | **3.017** | **1.202** | **2.850** | **2.632** | **3.403** |
| | 0.688 | 0.264 | 0.308 | 0.215 | 1.012 | 0.263 | 0.319 | 0.589 | 0.436 | 0.467 |
| 11 Wetland | **2.668** | **1.898** | 0.691 | *0.910* | *2.961* | 1.059 | -12.130 | -13.310 | 0.460 | 1.134 |
| | 0.736 | 0.376 | 0.590 | 0.375 | 1.429 | 0.650 | 256.900 | 857.600 | 1.152 | 1.107 |
| 12 Barren | 0.641 | **1.445** | *1.115* | *0.719* | *3.322* | **1.012** | **1.176** | *1.432* | **1.835** | **1.821** |
| | 0.840 | 0.303 | 0.355 | 0.255 | 1.021 | 0.273 | 0.277 | 0.567 | 0.407 | 0.468 |
| AIC | 500.6 | 3500.6 | 2096.9 | 2773.6 | 1463.4 | 2811.6 | 2053.4 | 649.2 | 1326.5 | 2133.4 |

Table 17. Resource selection functions including elevation and land cover classes expected to influence muskox distribution, by season and individual for muskoxen collared on Bathurst, Devon, and Cornwallis islands, 2003-2006. Bold font indicates significance at p<0.05; italic font indicates p<0.1.

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| | All Seasons | | | | | | | | | |
| Intercept | **-1.847** | **0.599** | *-0.244* | **0.362** | **-0.858** | **-0.339** | **-0.723** | *0.489* | **1.210** | **-1.606** |
| | 0.172 | 0.078 | 0.099 | 0.078 | 0.102 | 0.076 | 0.081 | 0.179 | 0.134 | 0.099 |
| Elevation | **-0.018** | **-0.021** | **-0.023** | **-0.021** | **-0.016** | **-0.012** | **-0.013** | **-0.024** | **-0.024** | **-0.008** |
| | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 |
| 1 Tussock graminoid tundra | -0.232 | *0.332* | *0.458* | *0.357* | *0.722* | **1.842** | -0.550 | 0.606 | *0.703* | **2.433** |
| | 0.321 | 0.109 | 0.143 | 0.115 | 0.229 | 0.148 | 0.309 | 0.364 | 0.296 | 0.161 |
| 2 Wet sedge | *0.485* | -0.019 | *0.396* | 0.221 | 0.598 | *-0.786* | 0.476 | -0.532 | *-0.734* | 0.392 |
| | 0.239 | 0.115 | 0.140 | 0.118 | 0.321 | 0.394 | 0.300 | 0.417 | 0.356 | 0.373 |
| 11 Wetland | 0.673 | *-0.794* | -0.626 | *0.475* | -1.206 | *-1.045* | -14.260 | -1.806 | *-2.492* | -1.696 |
| | 0.404 | 0.280 | 0.375 | 0.216 | 0.739 | 0.483 | 250.500 | 1.097 | 1.093 | 1.015 |
| 12 Barren | -0.599 | **-1.059** | **-0.712** | **-0.466** | **-1.292** | **-1.258** | -0.192 | **-1.355** | **-0.657** | **-0.544** |
| | 0.360 | 0.162 | 0.205 | 0.141 | 0.180 | 0.111 | 0.103 | 0.192 | 0.129 | 0.124 |
| 13 Ice/snow | 1.039 | -13.520 | -1.149 | -1.960 | -15.223 | **-3.777** | **-2.161** | -15.268 | -1.466 | -15.110 |
| | 0.787 | 181.300 | 1.065 | 1.062 | 303.016 | 1.005 | 0.588 | 535.331 | 0.879 | 234.700 |
| 15 Open water | **-1.878** | **-2.526** | **-2.215** | **-1.622** | **-4.032** | **-2.255** | **-2.169** | **-2.642** | **-2.995** | **-2.233** |
| | 0.532 | 0.234 | 0.294 | 0.181 | 0.717 | 0.243 | 0.277 | 0.498 | 0.423 | 0.423 |
| AIC | 1071.5 | 4405.4 | 2646.8 | 4235.0 | 1798.2 | 3373.1 | 3278.8 | 917.3 | 1766.5 | 2845.6 |
| | Summer (Jun 15-Sep 15) | | | | | | | | | |
| Intercept | **-2.864** | **-0.964** | **-1.298** | **-0.338** | **-2.319** | **-1.878** | **-1.147** | *-0.791* | -0.207 | **-3.061** |
| | 0.260 | 0.118 | 0.156 | 0.098 | 0.193 | 0.123 | 0.104 | 0.247 | 0.184 | 0.181 |

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| Elevation | **-0.015** | **-0.017** | **-0.025** | **-0.021** | **-0.017** | **-0.009** | **-0.015** | **-0.017** | **-0.019** | **-0.007** |
| | 0.003 | 0.001 | 0.002 | 0.001 | 0.002 | 0.001 | 0.001 | 0.003 | 0.002 | 0.001 |
| 1 Tussock graminoid tundra | -0.277 | *0.481* | 0.225 | 0.221 | 0.671 | **2.128** | *-1.242* | 0.026 | 0.609 | **1.924** |
| | 0.486 | 0.163 | 0.246 | 0.152 | 0.406 | 0.192 | 0.522 | 0.575 | 0.402 | 0.295 |
| 2 Wet sedge | -0.570 | 0.005 | 0.175 | 0.216 | 0.355 | -0.418 | -0.849 | -0.393 | *-1.679* | 0.958 |
| | 0.537 | 0.185 | 0.238 | 0.150 | 0.624 | 0.605 | 0.609 | 0.581 | 0.758 | 0.542 |
| 11 Wetland | 0.194 | *-1.633* | -0.091 | **0.841** | -0.451 | -0.631 | -14.690 | -0.668 | -14.714 | -17.460 |
| | 0.747 | 0.728 | 0.489 | 0.239 | 1.032 | 0.731 | 405.100 | 1.102 | 524.745 | 3236.000 |
| 12 Barren | -0.394 | **-1.180** | *-0.958* | *-0.510* | **-1.449** | **-1.316** | -0.262 | **-1.790** | *-0.571* | -0.239 |
| | 0.484 | 0.295 | 0.379 | 0.189 | 0.391 | 0.196 | 0.141 | 0.306 | 0.186 | 0.219 |
| 13 Ice/snow | *1.847* | -13.236 | -0.010 | -1.261 | -14.753 | -15.540 | *-2.597* | -14.300 | -0.999 | -14.860 |
| | 0.786 | 313.954 | 1.074 | 1.063 | 499.640 | 375.300 | 1.009 | 588.220 | 1.118 | 397.600 |
| 15 Open water | -16.553 | **-2.758** | **-3.790** | **-2.461** | *-3.264* | **-2.645** | **-1.957** | *-3.035* | **-3.589** | *-2.578* |
| | 769.091 | 0.518 | 1.014 | 0.339 | 1.019 | 0.592 | 0.312 | 1.034 | 1.024 | 1.017 |
| AIC | 526.2 | 1987.5 | 1103.0 | 2262.1 | 613.5 | 1667.2 | 1941.5 | 492.6 | 948.0 | 1120.8 |
| | Winter (Sep 16-Jun 14) | | | | | | | | | |
| Intercept | **-2.939** | **0.286** | **-0.719** | **-0.402** | **-1.155** | **-0.684** | **-1.727** | 0.072 | **0.853** | **-1.929** |
| | 0.295 | 0.086 | 0.114 | 0.097 | 0.113 | 0.085 | 0.114 | 0.213 | 0.151 | 0.114 |
| Elevation | **-0.021** | **-0.022** | **-0.021** | **-0.020** | **-0.016** | **-0.012** | **-0.011** | **-0.028** | **-0.025** | **-0.007** |
| | 0.004 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.003 | 0.002 | 0.001 |
| 1 Tussock graminoid tundra | -0.100 | *0.275* | **0.538** | **0.479** | *0.701* | **1.507** | -0.017 | *0.894* | *0.742* | **2.516** |
| | 0.553 | 0.124 | 0.161 | 0.141 | 0.254 | 0.173 | 0.366 | 0.410 | 0.323 | 0.173 |
| 2 Wet sedge | **1.313** | 0.012 | *0.499* | 0.179 | 0.634 | -0.924 | **1.149** | -0.664 | -0.500 | 0.081 |

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| | 0.334 | 0.128 | 0.158 | 0.151 | 0.348 | 0.481 | 0.325 | 0.500 | 0.374 | 0.479 |
| 11 Wetland | *1.581* | *-0.573* | -1.029 | -0.237 | -1.632 | *-1.204* | -13.420 | -15.818 | -2.111 | -1.390 |
| | 0.495 | 0.292 | 0.530 | 0.334 | 1.024 | 0.608 | 255.600 | 858.311 | 1.095 | 1.015 |
| 12 Barren | -0.444 | **-1.044** | *-0.617* | *-0.436* | **-1.252** | **-1.245** | -0.090 | **-1.097** | **-0.728** | **-0.698** |
| | 0.623 | 0.183 | 0.234 | 0.183 | 0.200 | 0.131 | 0.143 | 0.233 | 0.150 | 0.149 |
| 13 Ice/snow | -12.047 | -14.200 | -13.251 | -13.614 | -14.977 | **-3.406** | *-1.819* | -14.791 | -1.872 | -15.850 |
| | 511.957 | 300.700 | 306.285 | 306.409 | 305.657 | 1.006 | 0.718 | 528.432 | 1.138 | 391.000 |
| 15 Open water | -1.062 | **-2.411** | **-1.819** | **-1.099** | **-4.430** | **-2.075** | **-2.784** | **-2.429** | **-2.795** | **-2.095** |
| | 0.649 | 0.256 | 0.308 | 0.204 | 1.008 | 0.263 | 0.591 | 0.557 | 0.455 | 0.464 |
| AIC | 501.1 | 3581.5 | 2130.6 | 2812.7 | 1501.3 | 2908.6 | 2011.7 | 653.7 | 1336.1 | 2212.8 |

Table 18. Resource selection functions by season and individual for muskoxen collared on Bathurst, Devon, and Cornwallis islands 2003-2006, based on elevation and land cover classes expected to influence distribution.

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| | All Seasons | | | | | | | | | |
| Intercept | **-1.912** | 0.503 | -0.001 | -0.172 | **-1.445** | **-2.991** | **-1.677** | *-1.439* | -0.256 | **-3.863** |
| | 0.258 | 0.108 | 0.137 | 0.130 | 0.230 | 0.387 | 0.229 | 0.622 | 0.402 | 0.459 |
| Elevation | **-0.019** | -0.021 | **-0.023** | **-0.021** | **-0.016** | **-0.012** | **-0.013** | **-0.024** | **-0.024** | **-0.007** |
| | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 |
| 1 Tussock graminoid tundra | -0.136 | 0.452 | 0.232 | **0.911** | **1.310** | **4.483** | 0.415 | **2.543** | **2.166** | **4.662** |
| | 0.381 | 0.137 | 0.174 | 0.159 | 0.309 | 0.407 | 0.376 | 0.713 | 0.490 | 0.472 |
| 2 Wet sedge | *0.579* | 0.096 | 0.168 | **0.774** | *1.186* | **1.861** | **1.444** | 1.399 | 0.730 | **2.629** |
| | 0.314 | 0.141 | 0.171 | 0.161 | 0.382 | 0.546 | 0.369 | 0.734 | 0.525 | 0.580 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | 0.409 | 0.959 | *0.615* | *0.515* | *1.000* | **2.631** | 0.132 | *2.346* | **2.784** | **2.912** |
| | 0.462 | 0.162 | 0.227 | 0.229 | 0.404 | 0.470 | 0.519 | 0.960 | 0.617 | 0.525 |
| 9 Sparsely vegetated till/colluvium | 0.202 | -0.243 | **-0.774** | *0.450* | 0.190 | **2.275** | **1.178** | *1.787* | *1.332* | **1.748** |
| | 0.309 | 0.134 | 0.187 | 0.152 | 0.250 | 0.391 | 0.236 | 0.646 | 0.423 | 0.465 |
| 10 Bare soil with cryptogram crust, frost boils | 0.192 | 0.097 | *-0.335* | **0.928** | **1.118** | **3.467** | 0.387 | **2.317** | **1.634** | **3.036** |
| | 0.303 | 0.124 | 0.165 | 0.143 | 0.255 | 0.392 | 0.282 | 0.654 | 0.437 | 0.466 |
| 12 Barren | -0.497 | -0.939 | **-0.938** | 0.089 | *-0.704* | **1.380** | **0.793** | 0.583 | 0.805 | **1.667** |
| | 0.415 | 0.182 | 0.228 | 0.179 | 0.274 | 0.395 | 0.237 | 0.644 | 0.414 | 0.459 |
| 15 Open water | *-1.811* | -2.428 | **-2.457** | **-1.086** | **-3.445** | 0.396 | **-1.213** | -0.713 | *-1.529* | 0.022 |
| | 0.566 | 0.246 | 0.309 | 0.209 | 0.746 | 0.450 | 0.350 | 0.778 | 0.569 | 0.616 |

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| AIC | 1076.3 | 4370.6 | 2615.7 | 4198.9 | 1795.4 | 3580.4 | 3276.5 | 910.5 | 1752.8 | 2778.5 |
| | Summer (Jun 15-Sep 15) | | | | | | | | | |
| Intercept | **-2.978** | **-1.011** | **-0.959** | **-0.569** | **-2.499** | **-4.627** | **-3.521** | *-1.660* | *-1.942* | -18.320 |
| | 0.394 | 0.168 | 0.203 | 0.153 | 0.381 | 0.718 | 0.585 | 0.620 | 0.742 | 352.100 |
| Elevation | **-0.015** | **-0.017** | **-0.025** | **-0.021** | **-0.017** | **-0.008** | **-0.016** | **-0.016** | **-0.019** | **-0.007** |
| | 0.003 | 0.001 | 0.002 | 0.001 | 0.002 | 0.001 | 0.001 | 0.003 | 0.002 | 0.001 |
| 1 Tussock graminoid tundra | -0.155 | *0.518* | -0.116 | *0.462* | 0.855 | **4.839** | 1.148 | 0.883 | *2.353* | 17.160 |
| | 0.577 | 0.207 | 0.282 | 0.196 | 0.522 | 0.729 | 0.777 | 0.827 | 0.832 | 352.100 |
| 2 Wet sedge | -0.449 | 0.044 | -0.166 | *0.457* | 0.538 | *2.305* | 1.541 | 0.470 | 0.060 | 16.200 |
| | 0.619 | 0.224 | 0.275 | 0.194 | 0.705 | 0.928 | 0.838 | 0.823 | 1.048 | 352.100 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | -0.102 | 0.336 | 0.177 | -0.185 | 0.980 | *2.636* | *1.672* | 1.578 | *2.306* | 15.590 |
| | 0.804 | 0.291 | 0.401 | 0.340 | 0.637 | 0.845 | 0.835 | 1.029 | 1.029 | 352.100 |
| 9 Sparsely vegetated till/colluvium | 0.242 | -0.140 | *-0.829* | 0.024 | -0.233 | *2.234* | **2.771** | 0.529 | *1.619* | 15.080 |
| | 0.456 | 0.208 | 0.297 | 0.189 | 0.430 | 0.723 | 0.589 | 0.666 | 0.765 | 352.100 |
| 10 Bare soil with cryptogram crust, frost boils | 0.279 | 0.001 | -0.427 | **0.671** | 0.531 | **3.619** | 1.161 | *1.339* | *2.084* | 15.770 |
| | 0.444 | 0.197 | 0.257 | 0.169 | 0.441 | 0.721 | 0.653 | 0.668 | 0.776 | 352.100 |
| 12 Barren | -0.271 | **-1.144** | *-1.299* | -0.269 | *-1.261* | 1.363 | **2.157** | -0.940 | 1.177 | 14.980 |
| | 0.576 | 0.322 | 0.404 | 0.226 | 0.511 | 0.728 | 0.593 | 0.680 | 0.756 | 352.100 |
| 15 Open water | -16.438 | **-2.711** | **-4.129** | **-2.229** | *-3.083* | 0.101 | 0.419 | -2.168 | -1.852 | 12.680 |
| | 769.006 | 0.532 | 1.023 | 0.359 | 1.071 | 0.922 | 0.655 | 1.183 | 1.252 | 352.200 |

| | 7711 | 7716 | 7717 | 7720 | 7724 | 7734 | 7735 | 7737 | 7742 | 7743 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient | Coefficient |
| | SE | SE | SE | SE | SE | SE | SE | SE | SE | SE |
| AIC | 531.3 | 1998.8 | 1094.7 | 2649.6 | 615.5 | 1603.9 | 1887.3 | 489.4 | 944.1 | 1109.6 |
| | Winter (Sep 16-Jun 14) | | | | | | | | | |
| Intercept | **-2.768** | 0.202 | **-0.556** | **-1.378** | **-1.903** | **-3.313** | **-2.033** | -16.245 | -0.527 | **-3.909** |
| | 0.414 | 0.121 | 0.161 | 0.201 | 0.278 | 0.456 | 0.249 | 591.510 | 0.441 | 0.464 |
| Elevation | **-0.022** | **-0.022** | **-0.021** | **-0.020** | **-0.016** | **-0.012** | **-0.011** | **-0.028** | **-0.025** | **-0.007** |
| | 0.003 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.003 | 0.002 | 0.001 |
| 1 Tussock graminoid tundra | -0.241 | *0.403* | *0.396* | **1.484** | **1.447** | **4.122** | 0.297 | 17.238 | **2.116** | **4.461** |
| | 0.635 | 0.155 | 0.201 | 0.230 | 0.359 | 0.479 | 0.427 | 591.510 | 0.536 | 0.476 |
| 2 Wet sedge | *1.171* | 0.133 | 0.354 | **1.180** | *1.380* | *1.697* | **1.465** | 15.664 | 0.877 | *2.037* |
| | 0.456 | 0.158 | 0.197 | 0.236 | 0.431 | 0.657 | 0.392 | 591.510 | 0.563 | 0.654 |
| 3 Moist/dry non-tussock graminoid/dwarf shrub tundra | -14.020 | **1.168** | *0.800* | **1.266** | *0.982* | **2.588** | -0.624 | 16.026 | **2.899** | **2.719** |
| | 554.665 | 0.177 | 0.255 | 0.298 | 0.489 | 0.551 | 0.757 | 591.511 | 0.650 | 0.539 |
| 9 Sparsely vegetated till/colluvium | 0.209 | *-0.338* | *-0.703* | **1.007** | 0.355 | **2.300** | 0.304 | 16.309 | *1.253* | *1.318* |
| | 0.502 | 0.155 | 0.223 | 0.225 | 0.298 | 0.460 | 0.265 | 591.510 | 0.467 | 0.474 |
| 10 Bare soil with cryptogram crust, frost boils | 0.088 | 0.105 | -0.253 | **1.315** | **1.322** | **3.372** | 0.231 | 16.667 | *1.442* | **2.826** |
| | 0.501 | 0.140 | 0.195 | 0.217 | 0.302 | 0.462 | 0.312 | 591.510 | 0.484 | 0.470 |
| 12 Barren | -0.581 | **-0.917** | *-0.758* | *0.570* | -0.508 | *1.363* | 0.239 | 15.249 | 0.646 | *1.223* |
| | 0.698 | 0.206 | 0.263 | 0.258 | 0.323 | 0.466 | 0.258 | 591.510 | 0.456 | 0.463 |
| 15 Open water | -1.231 | **-2.324** | **-1.981** | -0.121 | **-3.682** | 0.553 | **-2.478** | 13.891 | *-1.416* | -0.119 |
| | 0.712 | 0.270 | 0.328 | 0.270 | 1.039 | 0.519 | 0.631 | 591.510 | 0.617 | 0.646 |
| AIC | 508.2 | 3524.3 | 2110.3 | 2774.8 | 1495.8 | 2808.5 | 2028.9 | 644.5 | 1322.8 | 2148.8 |