EVIDENCE THAT THE CAPE BATHURST, BLUENOSE-WEST, AND BLUENOSE-EAST CALVING GROUNDS ARE NOT THEORETICAL AND JUSTIFICATION FOR DIVISION OF THE "BLUENOSE" HERD INTO THE CAPE BATHURST, BLUENOSE-WEST, AND BLUENOSE-EAST HERDS

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ABSTRACT

This paper was prepared to address the following claims made by Mr. John Andre (2007):

> In the late 1990s, the ENR did not magically find three more herds of caribou. They simply carved the Bluenose Herd and the Bathurst Herd up, for study purposes, into five herds instead of two, based on theoretical calving grounds. In the 1978–79 Bluenose Caribou Survey they said this:
>
> > The precise location of calving grounds varied between 1978 and 1979, but remained roughly centered in the area east of Hornaday River. Hawley *et al.* (1976; 1979) believed that calving might have occurred on Bathurst Peninsula in 1974–1976. However, in 1978 and 1979 we sighted only one and three cow/calf pairs in the area respectively.
>
> One cow in 1978. Three cows in 1979 to 2,400 caribou in 2005. Why didn't the government show that trendline??? (Andre, 2007). In other words, the government created the Cape Bathurst Herd in 2000, knowing that the "herd" was not always faithful to the

Cape Bathurst calving ground, and that, eventually, that herd would fail.

Evidence that the Cape Bathurst, Bluenose-West, and Bluenose-East calving grounds are not theoretical and justification for division of the “Bluenose” herd into the Cape Bathurst, Bluenose-West, and Bluenose-East Herds is provided.

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In 1950, Banfield (1954) described two herds of barren-ground caribou (*Rangifer tarandus groenlandicus*) in the area south of the Arctic coast from the Mackenzie Delta east to Kugluktuk (previously Coppermine) and north of Great Bear Lake in the Northwest Territories (NT) and Nunavut (NU), Canada. These he named the Great Bear and Colville Lake herds. In 1967, Thomas (1969) assumed that these two herds were one population that he called the Bluenose herd. The area around Bluenose Lake was recognized as the calving area of the herd (Thomas, 1969). By 1974, the range of the Bluenose caribou herd was considered to be the area between the Mackenzie and Coppermine rivers lying north of Great Bear Lake and south of the Arctic Ocean (Figure 1) (Hawley *et al.*, 1976).

In 1974, Hawley *et al.* (1979) began a 3-year study to investigate the size, composition, seasonal distribution, and movements of the Bluenose herd. Common names of places referred to in this report are provided in Figure 2. Hawley *et al.* (1979) flew an extensive survey of the range of the Bluenose herd during 24 to 29 April 1974 (Figure 1). Caribou were observed over a large area but four high density concentrations were recorded including: (1) on the Cape Bathurst Peninsula in the vicinity of the Old Horton River (approximately 4,800 caribou; (2) on the Parry Peninsula (approximately 300 caribou); (3) near Paulatuk (south of the Parry Peninsula and Paulatuk and extending northeastward to near Clinton Point) (approximately 45,900 caribou); and (4) in

the Bloody River area (east of Horton Lake) (approximately 44,000 caribou) (Hawley *et al.*, 1979).

In 1974, Hawley *et al.* (1979) mapped four general spring migration routes from the late winter ranges to calving areas (Figure 3). These included: (1) from the area of the Smoke to Anderson rivers to calving sites on the Cape Bathurst Peninsula; (2) from the areas of Lac Rendez-vous to Ewariege Lake to calving sites east of the Hornaday River in the western Melville Hills and near Langton Bay on the Cape Bathurst Peninsula; (3) from the area of Horton Lake to Bloody River to calving sites near Bluenose Lake; and (4) from the area of the Rae and Richardson rivers west of the Coppermine river to calving sites near Bluenose Lake. Hawley *et al.* flew few flights in the 25 May to 12 June 1974 period when calving occurred so the calving grounds and the relative densities of caribou on them were not investigated thoroughly.

The ranges used by the caribou during the winter 1974–75 included: (1) the area from the mouth of the Kugaluk River south to the Mackenzie River near Thunder River and east to Lac Rendez-vous and Ewariege and Horton Lakes (western winter range); and (2) the area around the northeastern shores of Great Bear Lake including Caribou Point (eastern winter range) (Figure 4). Hawley *et al.* (1979) mapped three general migration routes from these ranges to calving areas in 1975 including: (1) from the western portion of the western winter range to calving areas on the upper Cape Bathurst Peninsula; (2) from the eastern portion of the western winter range to calving areas in the western Melville Hills; and (3) the eastern winter range to calving areas around Bluenose Lake (Figure 4).

Unlike 1974, there was a very high density of animals on the calving areas on the north side of the Melville Hills, low densities around Bluenose Lake, and few calving caribou immediately east of the Hornaday River (Hawley *et al.*, 1979). The western calving group (on the Cape Bathurst Peninsula) calved north of Harrowby Bay and the Old Horton River channel. Few caribou calved in the Smoking Hills area.

In May and June 1976, Hawley *et al.* (1979) surveys were restricted to probable pre-calving and calving areas. These surveys revealed three main calving areas including: (1) on the Cape Bathurst Peninsula around Harrowby Bay; (2) an area about 30 km from the coast north of the Brock River to just south of the Little Hornaday River and east of the Hornaday River; and (3) an area of scattered calving around the northern parts of Bluenose Lake, including the upper parts of the Croker and Roscoe rivers (Hawley *et al.*, 1979) (Figure 5). A large high-density area of non-breeders was observed south of the Cape Bathurst Peninsula calving area to the Anderson River Delta and eastward to Lac Rendez-vous and the Parry Peninsula (Figure 5). The distribution of calving caribou in 1976 was the same as in 1974 and 1975 but the exact locales, boundaries, and densities were different (Hawley *et al.*, 1979).

Surveys designed to obtain estimates of population size and productivity for the “Bluenose” herd were conducted in 1978 and 1979 by Brackett *et al.* (1979) and in 1981 and 1983 by Latour and Heard (1985) and Latour *et al.* (1986), respectively. Brackett *et al.* (1979) surveyed the Cape Bathurst Peninsula but only detected one cow/calf pair in 1978 and three cow/calf pairs in 1979.

Reconnaissance survey transects were spaced at 20-km intervals in 1978 and 1979 (Brackett *et al.*, 1979), and, as a result, small concentrations of calving caribou may have been missed. Following the reconnaissance surveys they delineated and re-surveyed three strata in the Melville Hills and one in the area north of Bluenose Lake in 1978. In 1979, they delineated and re-surveyed two strata in the Melville Hills and one northeast of Bluenose Lake.

Latour and Heard (1985) observed no concentrations of calving females on the Cape Bathurst Peninsula, although two newborn calves were observed there in 1981. These animals were thought to be Bluenose caribou; however, the possibility of them being reindeer could not be discounted (Latour and Heard, 1985). Latour *et al.* (1986) did not survey the northern portion of the Cape Bathurst Peninsula in 1983 so calving concentrations may have been missed. In addition, reconnaissance survey transects were spaced at 25-km intervals in 1981 (Latour *et al.*, 1986) and, as a result, small concentrations of calving caribou may have been missed. Following reconnaissance surveys in 1981, Latour and Heard (1985) delineated and re-surveyed four adjacent strata in the Melville Hills and one in the area north and north east of Bluenose Lake. Similarly, in 1983, Latour *et al.* (1986) delineated and re-surveyed three adjacent strata in the Melville Hills and west to the area south of Paulatuk, one strata in the area southeast of Bluenose Lake in the head waters of the Rae River, and one northeast of Bluenose Lake near the coast.

McLean and Fraser (1992) evaluated the calving ground fidelity of the Bluenose caribou herd between 1986 and 1988. The majority of their radio-

collared cows were located within the area of the Melville Hills during the calving period in 1986, 1987, and 1988. In some years the distribution of collared cows extended westward from the Melville Hills to the area south of Paulatuk (McLean and Fraser 1992). We mapped the locations of radio-collared cows obtained by McLean and Fraser (1992) during the calving period. Two radio-collared cows were on the Cape Bathurst Peninsula during the calving period in June 1986, 3 in 1987, and 2 in 1988. Cow 39B was on the Cape Bathurst Peninsula during the calving period in all three years. Cow 45BC, captured in February 1987, was on the Cape Bathurst Peninsula during the calving period in early June 1987 and 1988. Cow 43BC was on the Cape Bathurst Peninsula during the calving period in early June 1987 but was found at the base of the Peary Peninsula in 1988. McLean and Fraser (1992) also collared 2 cows in the Dismal Lakes area in March 1988. Both of these cows were found northeast of Bluenose Lake during the calving period in June 1989. These data indicate that there were cows on the Cape Bathurst and near Bluenose Lake during the calving period in the mid to late-1980s. Some radio-collared cows showed repeated use of the Cape Bathurst Peninsula during the calving period. McLean and Fraser (1992) did not provide information on the number of caribou associated with these radio-collared cows, however, they photographed approximately 13,500 and 14,200 caribou on the Cape Bathurst Peninsula in early July 1986 and 1987, respectively.

Tracking studies conducted between 1996 and 2007 indicated that cows equipped with satellite collars within and south of the range ascribed to the Bluenose herd (Hawley *et al.*, 1979) continued to use one of 3 distinct calving

areas including: (1) on the Cape Bathurst Peninsula; (2) in the Melville Hills; and (3) in the area around Bluenose Lake east to include the area around the Rae and Richardson rivers (Nagy *et al.*, 2005). Based on the herd concept, where herds are identified based on use of traditional calving grounds (Thomas, 1969; Gunn and Miller, 1986), caribou calving in these areas are now referred to as belonging to the Cape Bathurst (area 1), Bluenose-West (area 2), and Bluenose-East herds (area 3).

The Cape Bathurst calving ground was surveyed in 2000 and 2001 by Theberge and Nagy (2001) (Table 1) and in 2002, 2003, 2004, 2005, and 2006 by Nagy and Johnson (2007a) (Table 1). A total of 382 cows were counted on transect in 2000, 148 in 2001, 801 in 2002, 1,194 in 2003, and 823 in 2004. A total of 427 cows were photographed on the Cape Bathurst calving ground in 2005 and 577 in 2006 (Table 1). These are not population estimates; they are the numbers of cows observed on transect that, along with the number of calves observed on transect, were used to calculate calf:cow ratios.

The Bluenose-West calving ground was surveyed in 2000 and 2001 by Theberge and Nagy (2001) (Table 2) and in 2002, 2003, 2004, and 2005 by Nagy and Johnson (2007b) (Table 2). A total of 1,446 cows were counted on transect on the Bluenose-West calving ground in 2000, 2,267 in 2001, 3,192 in 2002, 3,926 in 2003, and 2,452 in 2004. A total of 789 cows were photographed in 2005 (Table 2). These are not population estimates; they are the numbers of cows observed on transect, that along with the number of calves observed on transect, were used to calculate calf:cow ratios.

These data indicate that the existence of calving grounds on the Cape Bathurst Peninsula, Melville Hills, and the Bluenose Lake/Rae-Richardson rivers areas are not theoretical. Calving caribou have used this area since the mid-1970s.

PART II: EVIDENCE FOR THE EXISTENCE OF THREE HERDS WITHIN THE RANGE OF THE BLUENOSE HERD

INTRODUCTION

The Bluenose herd used three general calving areas in the mid-1970s including one on the Cape Bathurst Peninsula, one in the Melville Hills, and one near Bluenose Lake (Hawley *et al.*, 1979). The observations of Brackett *et al.* (1982), Latour and Heard (1985), and Latour *et al.* (1986) were consistent with those of Hawley *et al.* (1979); calving was observed in the Melville Hills and Bluenose Lake areas in 1978, 1979, 1981, and 1983. Only a few calves were observed on the Cape Bathurst Peninsula in 1978, 1979, and 1981; however, small concentrations of calving caribou may have been missed because of the wide spacing of reconnaissance transects (20 to 25 km). These data indicate that the calving areas identified by Hawley *et al.* (1979) were in use during the late 1970s and early 1980s. Based on McLean and Fraser (1992) telemetry observations, these three calving areas were in use during the mid- to late 1980s. In 1994, distribution information from population and telemetry surveys of the Bluenose herd done between 1966 and 1993 were analyzed using a computer geographic information system (GIS) to define the seasonal ranges of the herd. That analysis indicated there were three calving grounds within the range of the “Bluenose” herd (Figure 6). Caribou management has been based on the herd concept, where herds are identified based on use of traditional calving grounds (Thomas, 1969; Gunn and Miller, 1986). Applying this approach, these data indicated that there were two, and possibly three, herds within the range of the

"Bluenose" caribou herd. Therefore, in March 1996, satellite tracking and genetic studies similar to those done to define polar bear populations (Bethke *et al.*, 1996) were initiated to identify the number of caribou herds within the range ascribed to the "Bluenose" herd. Tissue samples were also collected for genetic comparisons from Porcupine (*R. t. granti*) and Bathurst (*R. t. groenlandicus*) barren-ground caribou, Dolphin & Union island caribou (*R. t. groenlandicus*), boreal caribou (*R. t. caribou*), and reindeer that occupied ranges adjacent to the Bluenose herd. The results of the satellite tracking study are presented here; the results of the genetic study are presented in Zittlau (2004).

METHODS

We captured and equipped 15 adult female caribou with ARGOS or GPS satellite collars (Telonics Inc., Mesa, Arizona, USA) in March 1996 (Figure 7). These were deployed near Inuvik (n=5), Colville Lake (n=5), and Dismal Lakes (n =5). Subsequent to the initial collaring effort we deployed collars on an additional 103 female caribou during the caribou years 1996–1997 to 2005–2006 (Table 1) (Figure 8). The caribou were captured using a net gun fired from a Bell 206 helicopter. Capture efforts were conducted over open tundra and lakes during periods when there was: (1) sufficient snow to impede the movement of caribou and cushion their fall after netting; (2) good contrasting light conditions; (3) little or no wind; and (4) temperatures were not severe (> -30^{o}C). The duty cycle of ARGOS satellite collars varied during the study period but were generally programmed to transmit every day during mid-May to mid-July and every 5 to 10

days during the rest of the year. The GPS collars provided 3 locations per day (0100 h, 0900 h, and 1700 h). The resulting data were analyzed to determine if there was more than one herd within the range of the Bluenose herd as follows.

1. Visual Assessment of Location Data

ArcMap 9.2 (Environmental Systems Research Institute) was used to map and color code the movement data for each satellite-collared caribou. Each caribou was assigned a color code based on the first calving ground it used subsequent to capture, i.e., on the Cape Bathurst Peninsula, in the Melville Hills, or in the Bluenose Lake area. This allowed for a subjective visual assessment of the data.

2. Cluster Analysis of Location Data

We performed cluster analyses (Bethke *et al.*, 1996; Amstrup *et al.*, 2004) using the radio-collar locations for individual caribou that: (1) provided records of movements for a complete caribou year (1 June year one to 31 May year 2) (Analysis 1); and (2) provided at least 2 locations each during the calving/post calving and rutting/fall periods (Analysis 2). The number of observations obtained for individual caribou varied depending on the duty cycle of the collars. We partitioned the dataset into 7-day periods starting on 1 June and selected the first location obtained during each week for each caribou. Based on seasonal changes in activity (Porcupine Caribou Technical Committee, 1993), the resulting locations were partitioned by season including: calving and post-calving (1 June to 25 June); early summer (26 June to 15 July); mid-summer (16 July to 7

August); late summer (8 August to 7 October); fall/rut (8 October to 31 October); fall/post-rut (1 November to 30 November); winter (1 December to 31 March); and spring/spring migration (1 April to 31 May). This removed bias caused by differences in sampling frequencies among caribou and seasons. Locations data sets used included those for caribou that calved on the Cape Bathurst Peninsula, in the Western Melville Hills, and near Bluenose Lake, as well as for the Bathurst herd.

The resulting locations were transformed from a geographic to a projected coordinate system of NAD 1983 projection datum of North America Lambert Conformal Conic (Central Meridian: –112, Standard Parallel 1: 62, Standard Parallel 2: 70, and Latitude of Origin: 0). We then used Hawth's Tools (Beyer 2007) to convert the latitude-longitude coordinate data to an x, y gird (Bethke et al. 1996). This transformation ensured that the locations represented uniform map scale and actual locations and distances over the land surface.

In Analysis 1, we derived a median easting and northing value for each season for each caribou using SPSS (SPSS Inc., 2002) to keep the ratio of observations to variables reasonable as recommended by (Bethke *et al.*, 1996). This gave a total of 16 variables (i.e. easting and northing median values for each of the 8 seasons). Cluster analyses were performed on the seasonal median locations using a squared Euclidean distance measure and Ward's group linkage method (WARD's) (Amstrup *et al.*, 2004; Amstrup *et al.*, 2004; Bethke *et al.*, 1996; McCune and Mefford, 2006; McCune and Mefford, 2006; Bethke *et al.*, 1996; Amstrup *et al.*, 2004; Bethke *et al.*, 1996; Amstrup *et al.*, 2004; McCune

and Mefford, 2006). In Analysis 2, the same clustering procedure was performed on the easting and northing values for the locations selected for each of the calving/post-calving and rutting/fall periods. This gave a total of eight variables (i.e. two easting and two northing values for the calving/post-calving period and two easting and two northing values for the rutting/fall period). For Analysis 1 and 2, the division of the cluster dendogram into clusters or herds was based on an objective assessment of the Duda and Hart pseudo t^2 statistic (StataCorp, 2005; Bethke *et al.*, 1996).

We used Ward's clustering algorithm because it calculates the mean for all variables in each cluster and then determines the distances (squared Euclidean distances) among all cluster means (Amstrup *et al.*, 2004). The distances are summed, and at each step in the algorithm the clusters merged are those two that result in the smallest increase in the overall sum of the squared within-cluster distances (Amstrup *et al.*, 2004). This makes Ward's method more robust to minor differences between cluster members than methods that measure distances between individual members and then average the differences to obtain a difference mean (Amstrup *et al.*, 2004). This also means that Ward's method tends to emphasize major differences among clusters more effectively than other methods (Amstrup *et al.*, 2004). As with Amstrup *et al.*, (2004), we were trying to differentiate among populations or subpopulations of caribou, and we were not as interested in minor differences among individuals as we were in major differences among groups of individuals.

3. Statistical comparison of the season distributions of herds using multi-response permutation procedures (MRPP)

Based on the results of the satellite tracking and cluster analysis, MRPP was used for pair-wise comparisons of the distributions of all possible “herds” during each season using PC-ORD version 5 (McCune and Mefford, 2006). Locations data sets used included those for caribou that calved on the Cape Bathurst Peninsula, in the Western Melville Hills, and near Bluenose Lake and for the Bathurst herd. MRPP compares the observed intra-group average distances between locations with the average distances that would have resulted from all possible combinations of the data under a null hypothesis (i.e. that the two groups are not different). If the null hypothesis is true, then each of the possible assignments (permutations) is equally likely (Slauson *et al.*, 1991).

Two analysis were conducted. In Analysis 1, we partitioned the dataset into 7-day periods and then selected the first location obtained during each 7-day period for each caribou to removed bias caused by differences in sampling frequencies among animals and seasons. In Analysis 2, we selected the first location obtained for each day that locations were available to remove some of the bias in sampling frequencies between ARGOS (one location every 1 to 10 days depending on duty cycle) and GPS collars (3 locations per day every day). In Analysis 1, all pair-wise comparisons were made between herds for each of the 8 seasons; in Analysis 2, all pair-wise comparisons were made between herds for the calving/post-calving, rutting/fall, and winter seasons.

For these analyses, the locations were transformed from a geographic to a projected coordinate system of NAD 1983 projection datum of North America Lambert Conformal Conic (Central Meridian: –112, Standard Parallel 1: 62, Standard Parallel 2: 70, and Latitude of Origin: 0). We then used Hawth's Tools (Beyer, 2007) to convert the latitude-longitude coordinate data to an x, y gird (Bethke *et al.*, 1996). This transformation ensured that the locations represented uniform map scale and actual locations and distances over the land surface.

4. Range of the Bluenose herd vs. those of herds identified using satellite tracking data

The longitude-latitude coordinate data for individual caribou assigned to each herd based on the results of the cluster analyses were pooled by herd and analyzed by season with the fixed kernel home range estimator (300-m grid cell size and LSCV smoothing function) using ArcView 3.2 (Environmental Systems Research Institute). This enabled plotting of harmonic contours representing the percent used distribution of caribou tracked in each herd by season for the period March 1996 to May 2004. Detailed methods and the results of these analyses are presented in Nagy *et al.* (2005). These analyses were updated in November 2006 (Nagy, unpublished data) and were used as background layers on some figures in this report.

For visual comparison, we mapped: (1) the calving areas described by Hawley *et al.* (1979) in relation to those used by satellite-collared cows; (2) the late winter movements of the Bluenose herd to calving areas as described by

Hawley *et al.*, (1979) with the late winter movements of the satellite collared cows to their respective calving ranges; and (3) the seasonal ranges of the herds in relationship to the range of the Bluenose herd as described by Hawley *et al.* (1979).

5. Mapping Population Range Boundaries

We mapped the boundaries of the range for each population by merging the 95% use distributions for all seasons for each herd using ArcView 3.2 (Environmental Systems Research Institute). Detailed methods and results of these analyses are presented in Nagy *et al.* (2005). These analyses were updated in November 2006 (Nagy, unpublished data) and were used as background layers on some figures in this report.

RESULTS AND DISCUSSION

1. Visual Assessment of Location Data

We obtained sufficient movement data for 108 females between 1996 and July 2007 to assign them to a herd based on where they first calved subsequent to capture (Table 3). The movements of these satellite-collared caribou, colour-coded based on whether they calved on the Cape Bathurst Peninsula, in the Melville Hills, or near Bluenose Lake, are shown on Figure 9. The movement patterns of caribou that calved in each of these areas are distinct and strongly indicate that there are three herds within the area described as the range of the

Bluenose herd (Hawley *et al.*, 1979)(Figure 9). For convenience we referred to the caribou that calved on the Cape Bathurst Peninsula as Cape Bathurst caribou, while those that calved in the Melville Hills and near Bluenose Lake as Bluenose-West and Bluenose-East caribou, respectively.

2.1 Cluster Analysis 1 of Location Data (based on seasonal median locations)

We obtained full caribou years of location data for 25 individual Cape Bathurst cows, 33 Bluenose-West cows, and 24 Bluenose-East cows (Table 4). In addition, there were data available for 42 individual Bathurst caribou. This gave a total of 47 full caribou years of data for the Cape Bathurst, 61 for the Bluenose-West, 43 for the Bluenose-East, and 89 for the Bathurst caribou that were used in cluster Analysis 1. For the cluster analysis of seasonal median locations for these caribou, the pseudo t^2 statistic remained small when caribou were grouped at the 15 to 4 cluster levels indicating that distinct groups were being formed (Rabe-Hesketh and Everett, 2007), but increased 1.9-fold between cluster levels 4 and 3 (Figure 10). This suggests that dissimilar groups were being clustered at cluster level 3. The cluster dendogram for 4 clusters is shown in Figure 11, 12, and 13.

At the 4-cluster level, all Bluenose-East caribou formed one group (Figure 11). This group also included 2 Bluenose-West caribou (BW050 in 2005 and 2006; and BW046 in 2005). These caribou calved in the Melville Hills but they used areas north and east of Great Bear Lake during the rest of the year. With

the exception of these two caribou, the remainder of the Bluenose-West caribou formed one group (Figure 11). This group also included one Cape Bathurst caribou (CB124 in 2003 and 2004). This caribou migrated south to the Colville Lake area following a coastal icing event in fall 2003; it remained in the central portion of the Bluenose-West range for the following two years before it returned to calve on the Cape Bathurst Peninsula in 2005. With the exception of this caribou, the remainder of the Cape Bathurst caribou formed one group (Figure 11). All Bathurst caribou formed one group (Figure 12). These analyses strongly indicate that there are three distinct herds of caribou within the range ascribed to the Bluenose herd (Hawley *et al.*, 1979) and these are different from the Bathurst herd.

2.2 Cluster Analysis 2 (based on 2 locations each for calving and rut periods)

We obtained two locations each during the calving and rut periods for 28 individual Cape Bathurst cows, 40 Bluenose-West cows, and 26 Bluenose-East cows (Table 5). In addition, there were data available for 55 individual Bathurst caribou. This gave a total of 57 caribou years of data for the Cape Bathurst, 71 for the Bluenose-West, 46 for the Bluenose-East, and 105 for the Bathurst caribou that were used in cluster Analysis 2. For the cluster analysis of calving and rut locations for these caribou, the pseudo t^2 statistic remained small when caribou were grouped at the 15 to 4 cluster levels indicating that distinct groups were being formed (Rabe-Hesketh and Everett, 2007), but increased 2.7-fold

between cluster levels 4 and 3 (Figure 13). This suggests that dissimilar groups were being clustered at cluster level 3. The cluster dendogram for 4 clusters is shown in Figure 15, 16 and 17.

At the 4-cluster level, the majority of Cape Bathurst caribou formed one group (Figure 15). This group included 5 Bluenose-West caribou (BW087 and BW077 in 2002, BW067 in 1996, and BW068 and BW082 in 2001). This was expected as the western extent of the Bluenose-West range overlaps the eastern extent of the Cape Bathurst caribou range. With the exception of these 6 caribou, the remainder of the Bluenose-West caribou formed one group (Figure 15 and 16). This group also included two Cape Bathurst caribou (CB124 in 2004 and CB117 in 2003). These caribou migrated south into the range of the Bluenose-West herd during fall 2003 following a coastal icing event. The fate of CB117 is unknown as the collar failed during the winter of 2003–2004; CB 124 returned to the Cape Bathurst range by the calving period in 2005. All Bluenose-East caribou formed one group (Figure 16 and 17); all Bathurst caribou formed one group (Figure 17). These analyses strongly indicate that there are three distinct herds of caribou within the range ascribed to the Bluenose herd (Hawley *et al.*, 1979) and these are different from the Bathurst herd.

3. Statistical comparison of the season distribution of herds using multi-response permutation procedures (MRPP)

The probability values (p-values) for a smaller or equal delta for pair-wise comparisons of the distributions of radio-collar locations sub-sampled to one

location per caribou per week and pooled among years by season for each herd (Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst) supported rejection of the null hypothesis that the seasonal distributions of these caribou were not different (Table 4). Locations were obtained between March 1996 and June 2007. These analyses strongly indicate that there are three distinct herds of caribou within the range ascribed to the Bluenose herd (Hawley *et al.*, 1979). These herds have distinct seasonal ranges that are different from that of the Bathurst herd.

The probability values (p-values) for a smaller or equal delta for pair-wise comparisons of the distributions of radio-collar locations, sub-sampled to one location per day for days locations were available and pooled among years for the calving, rutting, and winter seasons for each herd (Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst) supported rejection of the null hypothesis that the calving, rut, and winter distributions of these herds were not different (Figures 18, 19, and 20) (Table 4). Locations were obtained between March 1996 and June 2007. These analyses strongly indicate that there are three distinct herds of caribou within the range ascribed to the Bluenose herd (Hawley *et al.*, 1979). These herds have distinct calving, rutting, and winter ranges that are different from that of the Bathurst herd.

4. Range of the Bluenose herd vs. those of herds identified using satellite tracking data

The distribution of calving areas documented during this study are shown in relationship to the range of the Bluenose herd (Hawley *et al.*, 1979) (Figure 23). These calving areas fell within the range of the Bluenose herd described by Hawley *et al. (*1979). With the exception of the calving area of the Bluenose-East caribou, the calving areas of the Cape Bathurst and Bluenose-West herds are almost identical to the calving areas Hawley *et al. (*1979) found on the Cape Bathurst Peninsula and in the Melville Hills (Figure 22). It appears that calving has shifted from the Bluenose Lake area to the Rae and Richardson rivers area (Figure 22). Although calving may have been missed in the mid-1970s because the area was not surveyed (Hawley *et al.*, 1979).

The migration routes used by radio-collared caribou to calving areas on the Cape Bathurst Peninsula, in the Melville Hills, and near Bluenose Lake (Rae and Richardson rivers area) area shown in relationship to migration routes and calving areas documented by Hawley *et al.* (1979) in 1974 and 1975 (Figures 23, 24, and 25). The migration routes used by Bluenose-West caribou (this study) are almost identical to those described by Hawley *et al.* (1979) for Bluenose caribou calving in the Melville Hills. The migration routes used by Cape Bathurst caribou (this study) are west of those described by Hawley *et al.* (1979) for caribou calving on the Bathurst Peninsula. However, during 1996 to 2007 Cape Bathurst caribou occupied winter ranges to the west of those described by Hawley *et al.*

(1979). Hawley *et al.* (1979) noted that there had been an unprecedented westward expansion of the winter range of the Bluenose herd which would have them within the areas currently used by Cape Bathurst caribou (this study). Similarly, Bluenose-East caribou winter east and south of Great Bear Lake and migrate on a northerly route to the Rae and Richardson rivers area for calving. Although Hawley *et al.* (1979) found calving areas around Bluenose Lake, their reconnaissance surveys during late May and early June did not cover the Rae and Richardson rivers area and, as a result, calving caribou may have gone undetected. In addition, Hawley *et al.* (1979) reported seeing tracks of caribou that migrated in a northeastern direction from Great Bear Lake to the Rae and Richardson river area prior to calving.

The calving (Figure 21), post-calving/early summer (Figure 28), mid-summer (Figure 29), late summer (Figure 30), rut/fall (Figure 31), post rut (Figure 32), winter (Figure 33), and spring/spring migration (Figure 34) ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds are shown in relationship to the range of the Bluenose herd (Hawley *et al.*, 1979). The seasonal ranges of the Bluenose-West herd fall within the range ascribed to the Bluenose herd. The calving, post-calving/early summer, mid-summer, and late summer ranges of the Cape Bathurst herd fall within the range ascribed to the Bluenose herd. The rut/fall, post-rut, winter, and spring/spring migration ranges of the Cape Bathurst herd extend beyond the western boundary of the range ascribed to the Bluenose herd, indicating that the western expansion of the Bluenose herd, as described by Hawley *et al.* (1979), continued after 1976. The

calving, post-calving/early summer, mid-summer and late summer ranges of the Bluenose-East herd fall within the range ascribed to the Bluenose herd. The rut/fall, post-rut, winter, and spring/spring migration ranges of the Bluenose-East herd extend beyond the southeastern boundary range ascribed to the Bluenose herd. These ranges occur on the east and south to Great Bear Lake. Hawley *et al.* (1979) did not have sufficient support to effectively track caribou beyond the Caribou Point area on Great Bear Lake.

5. Mapping Population Range Boundaries

The boundaries of the Cape Bathurst, Bluenose-West, and Bluenose-East herds are shown in relationship to that of the Bluenose herd in Figure 35.

CONCLUSIONS

The existence of three separate barren-ground caribou calving areas between the Mackenzie Delta, NT and Kugluktuk, NU was documented by Hawley *et al.* (1979) during 1974 to 1976.

Population and telemetry surveys conducted by Brackett *et al.* (1982), Latour and Heard (1985), Latour *et al.* (1986), and McLean and Fraser (1992) indicate that these calving areas were in use during the late 1970s to the mid-1980s.

Calving ground fidelity and telemetry surveys conducted by McLean and Fraser (1992) indicate that these calving grounds were in use during the mid-1980s.

Post-calving/early summer photo-census surveys conducted by McLean and Russell (1992) and Nagy and Fraser (2007) suggest that significant numbers of caribou were using the calving grounds on the Cape Bathurst Peninsula and in the Melville Hills during the mid-1980s to early 1990s.

Surveys conducted to obtain calf:cow ratios indicate that significant numbers of caribou calved on the Cape Bathurst Peninsula between 2000 and 2006 (Nagy and Johnson, 2007b). Surveys conducted to obtain calf:cow ratios indicate that significant numbers of caribou calved in the Melville Hills between 2000 and 2005 (Nagy and Johnson, 2007a). Similar data are not available for caribou that calved in the Bluenose Lake/Rae and Richardson rivers area.

Tracking studies conducted between 1996 and 2007 indicated that cows equipped with satellite collars within and south of the range ascribed to the Bluenose herd (south of Great Bear Lake) used one of three distinct calving areas between the Mackenzie Delta, NT and Kugluktuk, NU including: (1) on the Cape Bathurst Peninsula; (2) in the Melville Hills; and (3) in the area around Bluenose Lake east to include the area around the Rae and Richardson rivers.

Cluster analyses of location data for the eight caribou seasons (Porcupine Caribou Technical Committee, 1993) or for the calving and rutting seasons indicated that there are three distinct groups of barren-ground caribou within the range ascribed to the Bluenose herd. For convenience we refer to these as Cape Bathurst, Bluenose-West, and Bluenose-East herds. These groups of caribou are different from the Bathurst herd.

Pair-wise comparisons of the distribution of locations for Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst herds indicated that these caribou used significantly different seasonal ranges, and notably significantly different calving, rutting, and winter ranges.

Based on the concept that barren-ground caribou herds exhibit fidelity to calving grounds, the data presented here indicate that there are three distinct barren-ground caribou herds within the range ascribed to the Bluenose herd. These are the Cape Bathurst, Bluenose-West, and Bluenose-East herds. These herds are different from the Bathurst herd.

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Table 1. Calf:cow ratios documented at or near the peak of calving for the Cape Bathurst herd, 2000 to 2006.

					Statistical parameters for calf:cow ratios estimated using the Tukey-Jacknife method							
Year	**Dates of survey**	**No. of groups classified**	**No. of calves**	**No. of cows**	**Calves per 100 cows**	**SD**	**VAR**	**SE**	**CV**	**CI 95%**	**Lower 95%CI**	**Upper 95%CI**
2000[a]	11 June		246	382	64.40							
2001[a]	15 June	42	29	148	19.23	28.6419	4.8050	3.3824	17.6	8.7671	10.46	28.00
2002	22 to 23 June	163	260	801	32.35	32.3083	10.4383	2.5306	7.8	4.9751	27.37	37.32
2003	25 to 26 June	185	561	1194	47.00	26.1144	6.8196	1.9200	4.1	3.7733	43.23	50.77
2004	25 June	38	372	823	46.46	54.5500	29.7571	8.8492	19.0	17.577	28.88	64.03
2005	16 June	18	223	427	52.63	11.5371	1.3311	2.7193	5.2	5.4843	47.15	58.12
2006	18 June	29	189	577	32.92	18.8467	3.5520	3.4997	10.6	6.9808	25.94	39.90

a Original data from (Theberge and Nagy, 2001b).

Table 2. Calf:cow ratios documented at or near the peak of calving for the Bluenose-West herd, 2000 to 2005.

Year	Dates of survey	No. of groups classified	No. of calves	No. of cows	Statistical parameters for calf:cow ratios estimated using the Tukey-Jacknife method							
					Calves per 100 cows	SD	VAR	SE	CV	CI 95%	Lower 95%CI	Upper 95%CI
2000[a]	9 to 11 June		560	1446	38.73							
2001[a]	12 to 15 June	317	155	1094	14.01	31.2518	9.7668	1.7553	12.5	3.4457	10.57	17.46
2001[a]	23 to 26 June	86	1224	2267	54.08	21.3164	4.5439	2.2986	4.3	4.5316	49.55	58.62
2002	19 to 22 June	705	1769	3192	53.72	41.4863	17.2112	1.5625	2.9	3.0645	50.66	56.79
2003	21 to 25 June	820	2087	3926	53.24	52.2869	27.3392	1.8259	3.4	3.5810	49.65	56.82
2004	18 to 23 June	551	1493	2452	60.92	33.5779	11.2747	1.4305	2.3	2.8062	58.11	63.73
2005	19 to 21 June	44	470	789	59.36	24.5075	6.0062	3.6946	6.2	7.3251	52.04	66.69

a Original data from (Theberge and Nagy, 2001b).

Table 3. Number of adult female caribou captured and equipped with ARGOS or GPS satellite radio-collars in the Cape Bathurst, Bluenose-West, and Bluenose-East herds, 1996 to 2006.

Caribou Year	Herd				
	Bluenose-East	**Bluenose-West**	**Cape Bathurst**	**Unknown**	**Total**
1995-1996	5	5	4	1	15
1996-1997	3	2	-	-	5
1997-1998	5	-	-	-	5
1998-1999	-	13	2	-	15
1999-2000	-	-	-	-	-
2000-2001	-	-	-	-	-
2001-2002	-	8	10	1	19
2002-2003	3	1	-	-	4
2003-2004	-	-	-	-	-
2004-2005	7	9	8	4	28
2005-2006	8	8	7	4	27
Total	31	46	31	10	118

[1] Either satellite collar failed or the caribou was harvested or died before we had enough location data to assign the animal to a herd.

Table 4. Number of full years of locations data obtained for individual caribou by herd (cluster analysis 1).

	Number of caribou years of data available by year						Total Number of caribou years of data available (1996-2007)	Number of individual caribou with full years of data (1996-2007)
Herd	1	2	3	4	5	6		
Bathurst	9	26	2	3	2	-	89	42
Bluenose-East	14	4	3	3	-	-	43	24
Bluenose-West	16	12	1	3	-	1	61	33
Cape Bathurst	12	8	1	4	-	-	47	25
Total	51	50	7	13	2	1	240	124

Table 5. Number of caribou for which at least 2 locations were obtained at a 7-21 day time interval during the calving and rutting period (cluster analysis 2).

	Number of caribou years of data available by year												Total Number of Individuals
Herds	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total	
Bathurst	8	6	3	13	12	11	10	10	-	18	18	105	55
Bluenose-East	3	5	9	7	2	1	-	3	-	6	10	46	26
Bluenose-West	4	5	3	12	5	3	10	4	1	9	15	71	40
Cape Bathurst	4	3	3	4	1	1	11	8	3	7	12	57	28

Table 6. Test statistics for the multi-response permutation procedure (MRPP) comparisons of the distributions of the Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst caribou herds by season. (Locations were obtained between March 1996 and June 2007 and sub-sampled to one location per week).

Season and Herds Compared	Number of Locations (1)	Number of Locations (2)	Number of Caribou (1)	Number of Caribou (2)	MRPP Test Statistics[1] T	A	P
Calving/Post-Calving							
Bathurst (1) vs. Bluenose-East (2)	446	242	60	32	-462.7921776	0.62652646	0.00000000
Bathurst (1) vs. Bluenose-West (2)	446	420	60	50	-603.0580281	0.76244439	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	446	212	60	32	-462.0531056	0.83499213	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	242	420	32	50	-409.9095432	0.51492677	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	242	212	32	32	-316.2381695	0.79943301	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	420	212	50	32	-382.3705043	0.54972458	0.00000000
Early Summer							
Bathurst (1) vs. Bluenose-East (2)	364	187	59	30	-360.3322284	0.56881988	0.00000000
Bathurst (1) vs. Bluenose-West (2)	364	317	59	52	-470.6001301	0.73604829	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	364	158	59	32	-363.2204424	0.79794136	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	187	317	30	52	-249.0720966	0.36673531	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	187	158	30	32	-230.3092544	0.71344523	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	317	158	52	32	-299.6789461	0.58231889	0.00000000
Mid Summer							
Bathurst (1) vs. Bluenose-East (2)	346	172	58	30	-312.1573728	0.46949695	0.00000000
Bathurst (1) vs. Bluenose-West (2)	346	246	58	45	-399.0576166	0.68602141	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	346	96	58	21	-301.4174435	0.67877721	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	172	246	30	45	-223.0306007	0.46944892	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	172	96	30	21	-174.0780788	0.62915444	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	246	96	45	21	-78.63676208	0.1686105	0.00000000
Late Summer							
Bathurst (1) vs. Bluenose-East (2)	901	454	56	28	-721.7346439	0.38238313	0.00000000
Bathurst (1) vs. Bluenose-West (2)	901	651	56	43	-1052.543608	0.68665203	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	901	278	56	21	-807.2744266	0.68058523	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	454	651	28	43	-681.4023534	0.56928135	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	454	278	28	21	-498.3038063	0.69651798	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	651	278	43	21	-195.3974473	0.14488057	0.00000000
Fall/Rut							
Bathurst (1) vs. Bluenose-East (2)	416	161	58	26	-247.4290672	0.27051413	0.00000000
Bathurst (1) vs. Bluenose-West (2)	416	214	58	39	-413.5303095	0.57632445	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	416	100	58	19	-346.1669741	0.61034713	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	161	214	26	39	-201.0197683	0.41686848	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	161	100	26	19	-172.0092943	0.63921393	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	214	100	39	19	-112.5748456	0.27044599	0.00000000

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Season and Herds Compared	Number of Locations (1)	Number of Locations (2)	Number of Caribou (1)	Number of Caribou (2)	MRPP Test Statistics[1] T	A	P
Fall/Post-Rut							
Bathurst (1) vs. Bluenose-East (2)	498	170	54	26	-193.6916223	0.19703246	0.00000000
Bathurst (1) vs. Bluenose-West (2)	498	283	54	37	-486.107799	0.5430252	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	498	119	54	19	-385.7142701	0.54108507	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	170	283	26	37	-240.061316	0.4102782	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	170	119	26	19	-187.9101947	0.61980397	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	283	119	37	19	-159.50386	0.2888513	0.00000000
Winter							
Bathurst (1) vs. Bluenose-East (2)	1989	703	70	29	-865.1472312	0.23246805	0.00000000
Bathurst (1) vs. Bluenose-West (2)	1989	1040	70	48	-1819.941678	0.52380959	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	1989	516	70	32	-1555.995607	0.5514738	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	703	1040	29	48	-910.5684382	0.39068831	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	703	516	29	32	-815.3586509	0.62755759	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	1040	516	48	32	-713.7076452	0.33036038	0.00000000
Spring/Spring Migration							
Bathurst (1) vs. Bluenose-East (2)	1211	538	71	34	-618.6470362	0.21374046	0.00000000
Bathurst (1) vs. Bluenose-West (2)	1211	785	71	52	-1265.469117	0.52550817	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	1211	406	71	32	-1052.721195	0.5541129	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	538	785	34	52	-723.6882685	0.39224243	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	538	406	34	32	-622.5482387	0.57721914	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	785	406	52	32	-507.0576635	0.27005974	0.00000000

[1]MRPP Test Statistics

T = test statistic

A = 1 - (observed delta/expected delta)

A = 0 when heterogeneity within groups equals expectation by chance

A < 0 with more heterogeneity within groups than expected by chance

P = Probability of a smaller or equal delta

Table 7. Test statistics for the multi-response permutation procedure (MRPP) comparisons of the distributions of the Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst caribou herds for the calving/post-calving, fall/rut, and winter seasons. (Locations were obtained between March 1996 and June 2007 and sub-sampled to one per day for days locations were available).

Season and Herds Compared	Number of Locations		Number of Caribou		MRPP Test Statistics[1]		
	(1)	(2)	(1)	(2)	T	A	p
Calving/Post-calving							
Bathurst (1) vs. Bluenose-East (2)	1101	242	60	32	-859.4595818	0.52353895	0.00000000
Bathurst (1) vs. Bluenose-West (2)	1101	420	60	50	-1052.540162	0.72640107	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	1101	324	60	39	-996.514057	0.79602525	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	242	420	32	50	-409.9095678	0.51492682	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	242	324	32	39	-393.5285842	0.7967156	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	420	324	50	39	-457.6856918	0.5758514	0.00000000
Rut/Fall							
Bathurst (1) vs. Bluenose-East (2)	542	161	59	26	-279.5599581	0.24452277	0.00000000
Bathurst (1) vs. Bluenose-West (2)	542	214	59	39	-491.9567121	0.55267221	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	542	173	59	29	-485.5269555	0.65370159	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	161	214	26	39	-201.0197592	0.41686845	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	161	173	26	29	-221.4852209	0.66283424	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	214	173	39	29	-154.9474622	0.3104942	0.00000000
Winter							
Bathurst (1) vs. Bluenose-East (2)	2554	703	70	29	-945.4252594	0.20864605	0.00000000
Bathurst (1) vs. Bluenose-West (2)	2554	1040	70	48	-2106.96844	0.49706184	0.00000000
Bathurst (1) vs. Cape Bathurst (2)	2554	856	70	38	-2175.004155	0.59108663	0.00000000
Bluenose-East (1) vs. Bluenose-West (2)	703	1040	29	48	-910.5683875	0.39068828	0.00000000
Bluenose-East (1) vs. Cape Bathurst (2)	703	856	29	38	-1042.442483	0.64313397	0.00000000
Bluenose-West (1) vs. Cape Bathust (2)	1040	856	48	38	-870.0176822	0.34247198	0.00000000

[1]MRPP Test Statistics

T = test statistic

A = 1 - (observed delta/expected delta)

A = 0 when heterogeneity within groups equals expectation by chance

A < 0 with more heterogeneity within groups than expected by chance

P = Probability of a smaller or equal delta

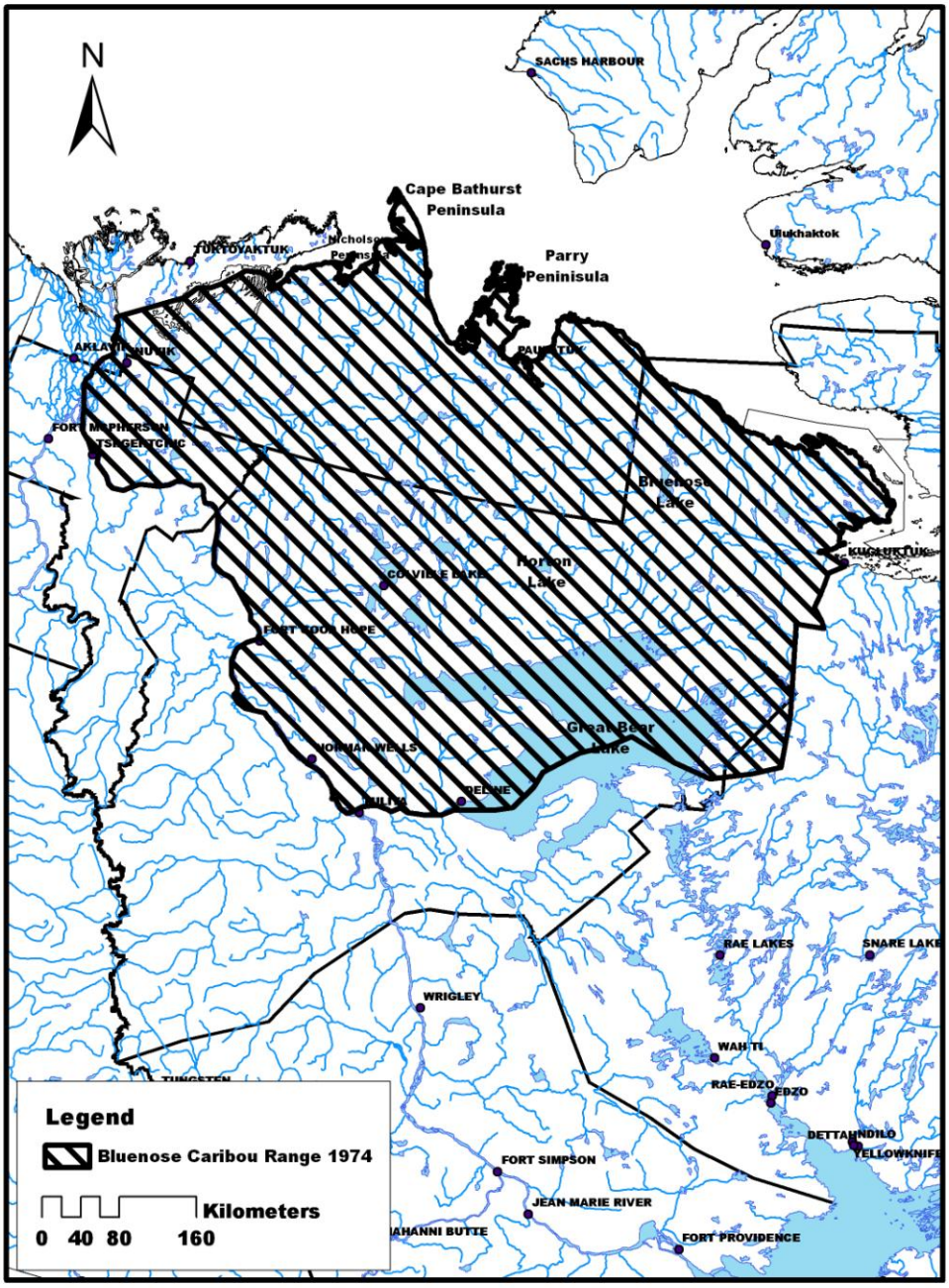

Figure 1. Bluenose caribou herd annual range (tentative description) and approximate area surveyed in late April 1974 by Hawley *et al.* (1976).

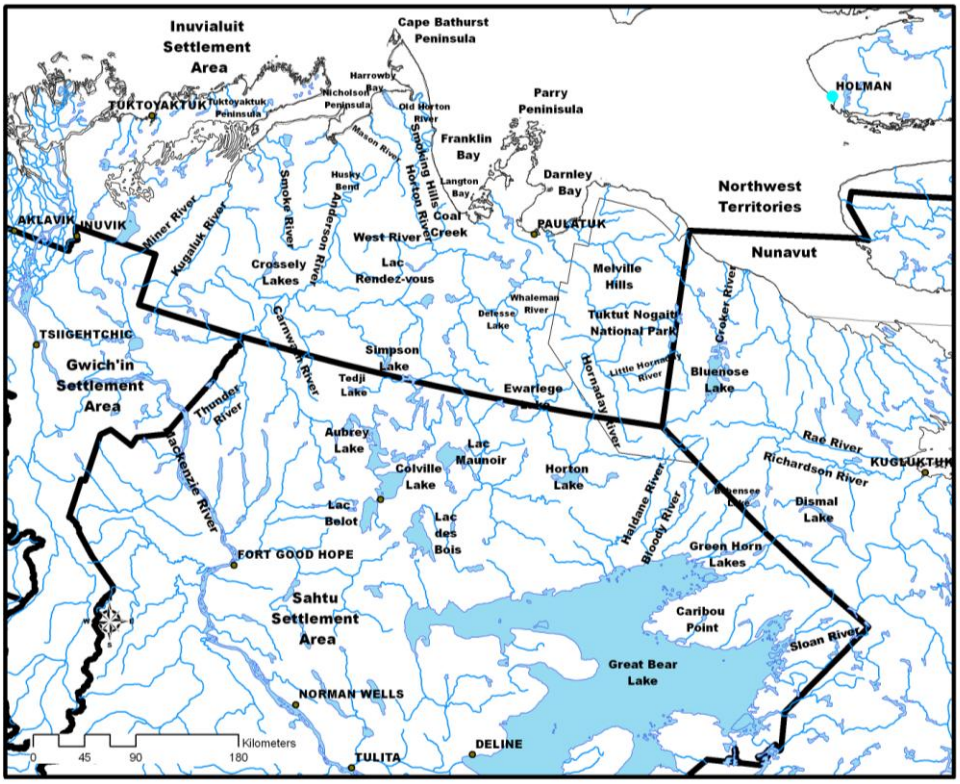

Figure 2. Areas within the range of the range of Bluenose caribou herd giving place names used in this report (Hawley *et al.*, 1979).

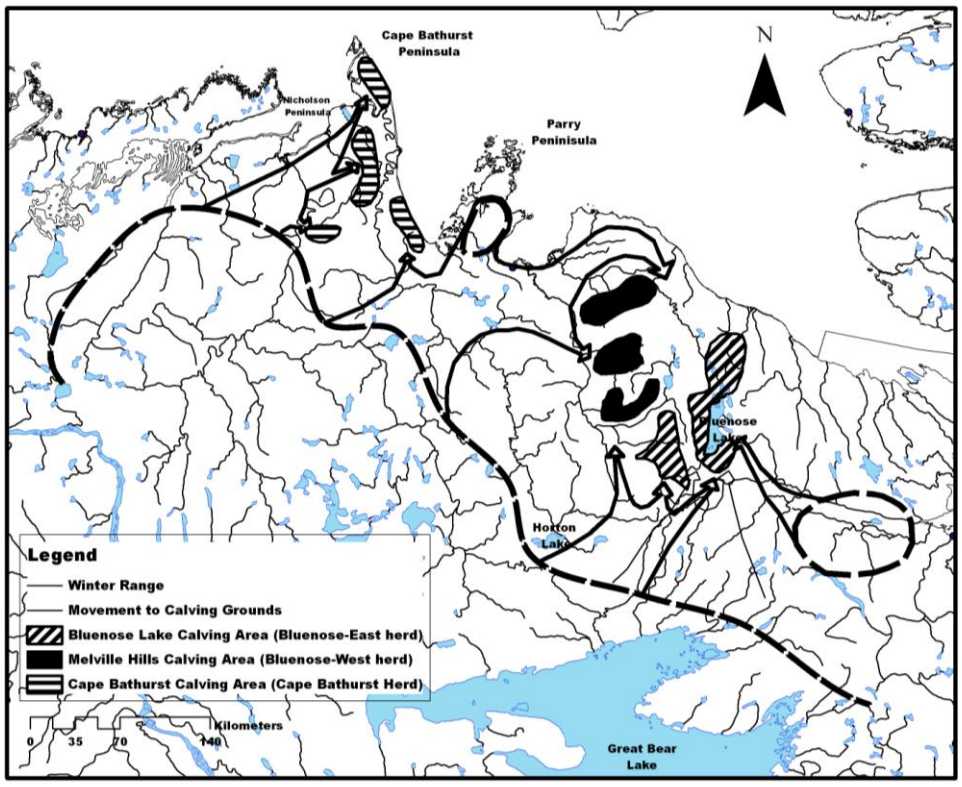

Figure 3. 1973-1974 winter range and spring migration routes to the 1974 calving grounds of the Bluenose herd (based on Figure 8 in Hawley *et al.* (1979)).

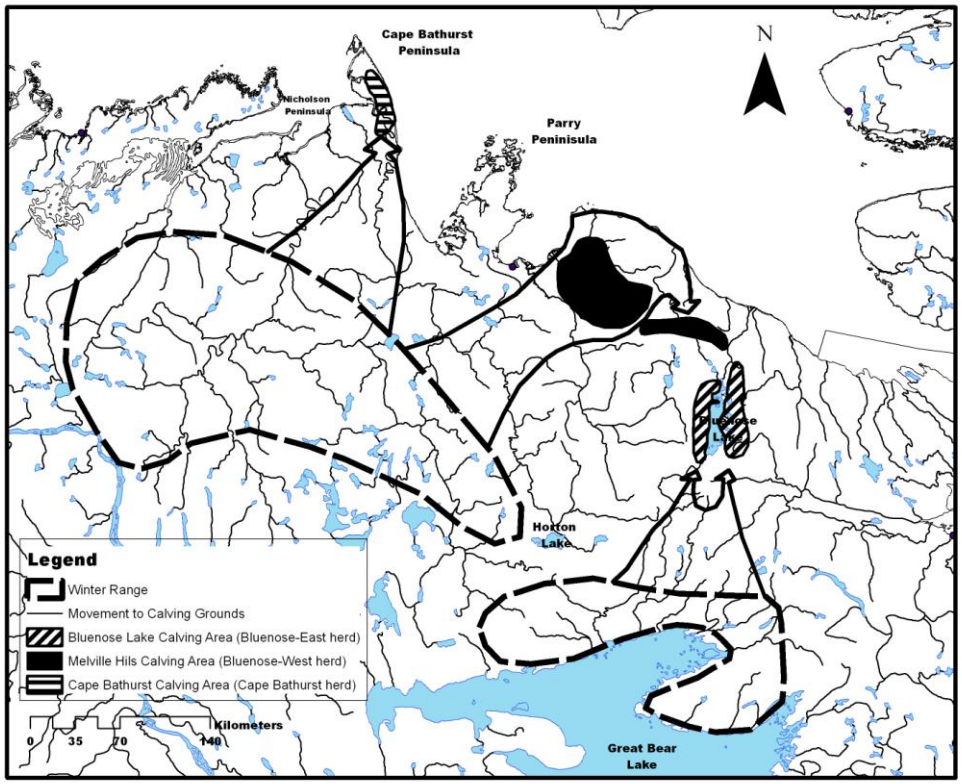

Figure 4. 1974–75 winter range and spring migration routes to the 1975 calving grounds of the Bluenose herd (based on Figure 10 in Hawley *et al.* (1979)).

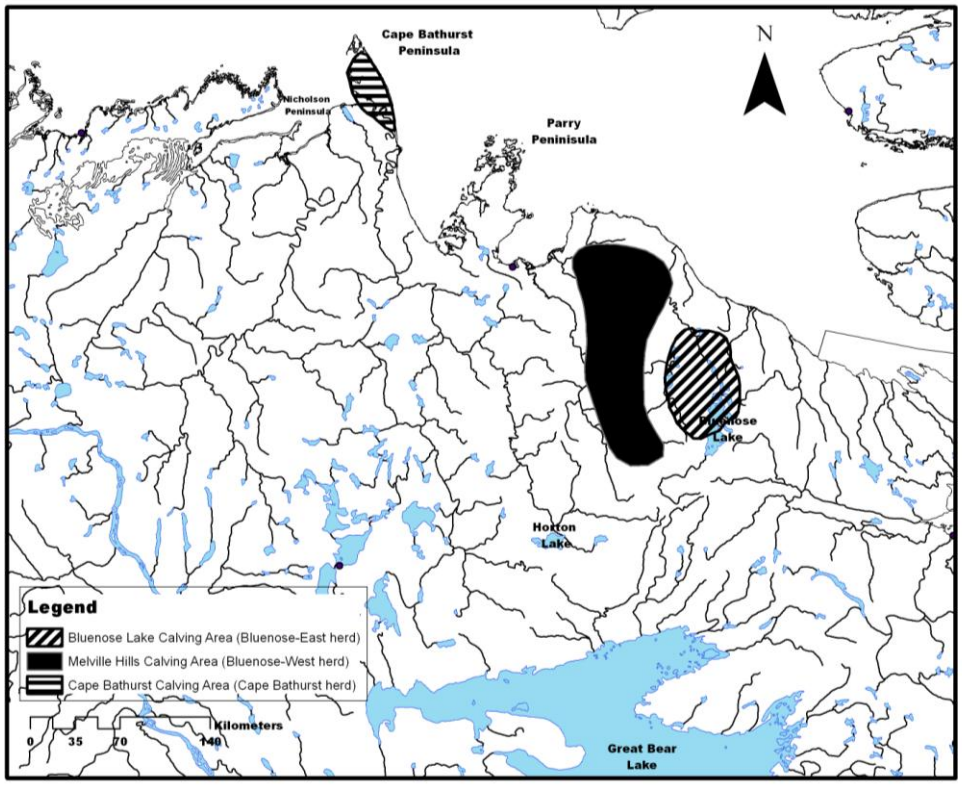

Figure 5. Calving areas used by the Bluenose caribou herd in 1976 (based on Figure 16 in Hawley *et al.* (1979)).

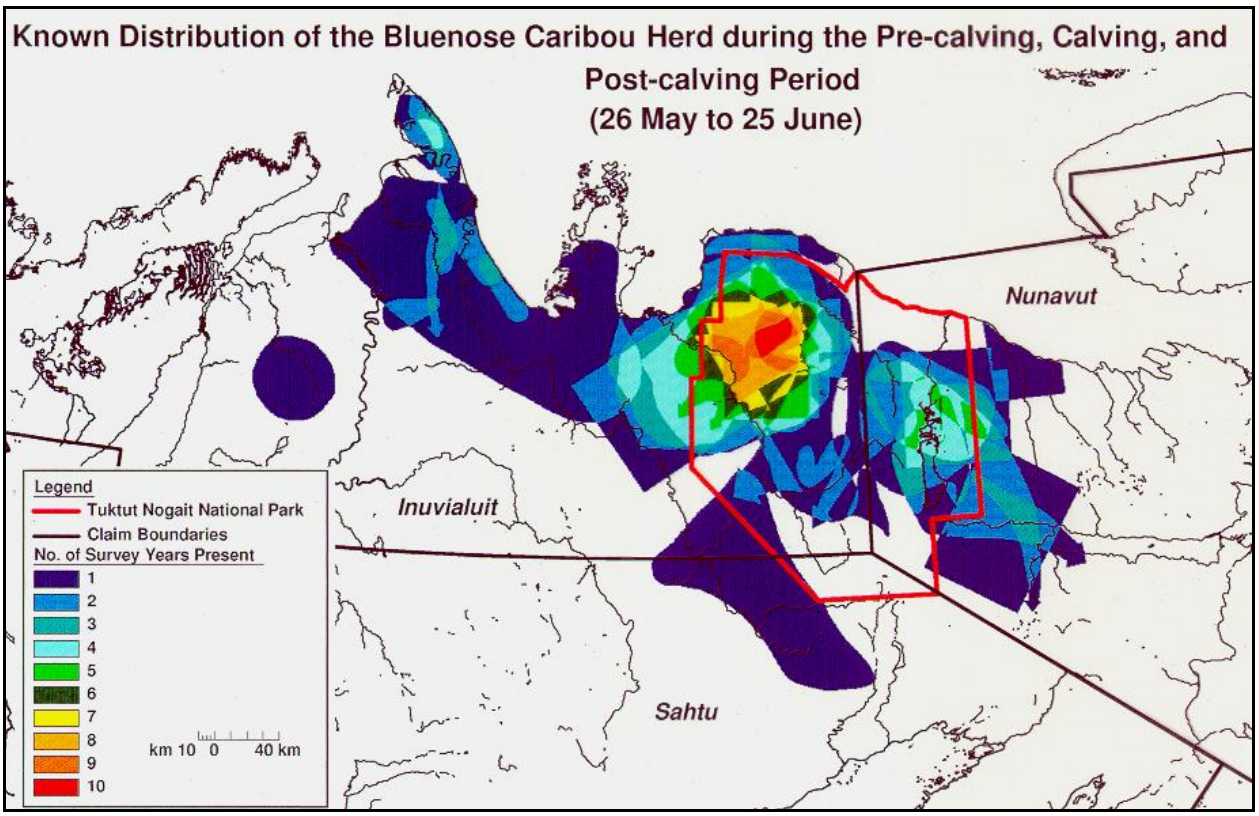

Figure 6. Distribution of the Bluenose caribou herd during the pre-calving, calving, and post-calving period (26 May to 25 June) based on Geographic Information System (GIS) analysis of information from population and telemetry surveys done between 1966 and 1993.

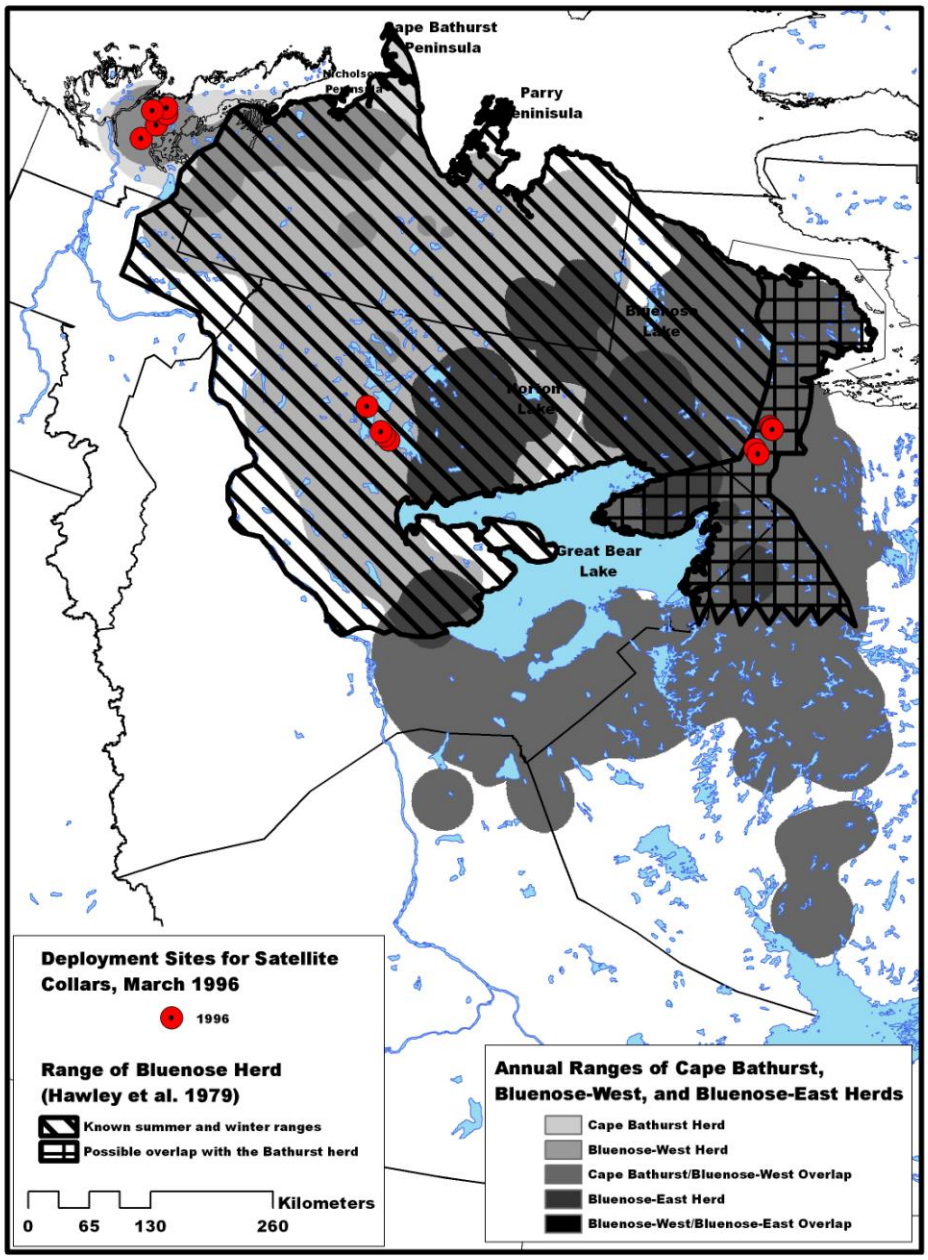

Figure 7. Distribution of capture sites for adult female caribou equipped with satellite collars in March 1996. The range of the Bluenose herd as defined by Hawley *et al.* (1979) and the annual ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East (95% utilization distribution) are shown.

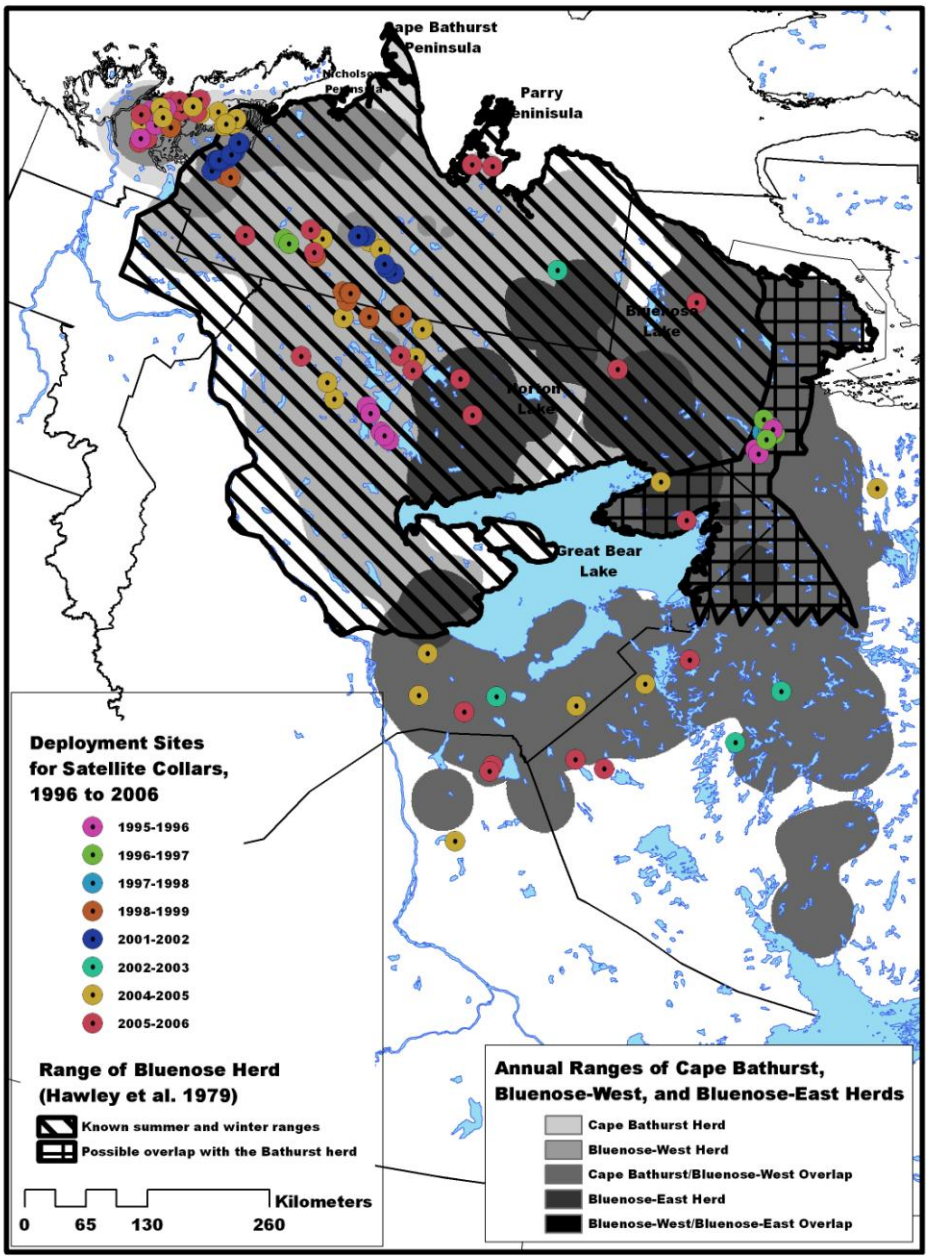

Figure 8. Distribution of capture sites for adult female caribou equipped with satellite collars during caribou years 1995–1996 to 2005–2006. The range of the Bluenose herd as defined by Hawley *et al.* (1979) and the annual ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East (95% utilization distribution) are shown.

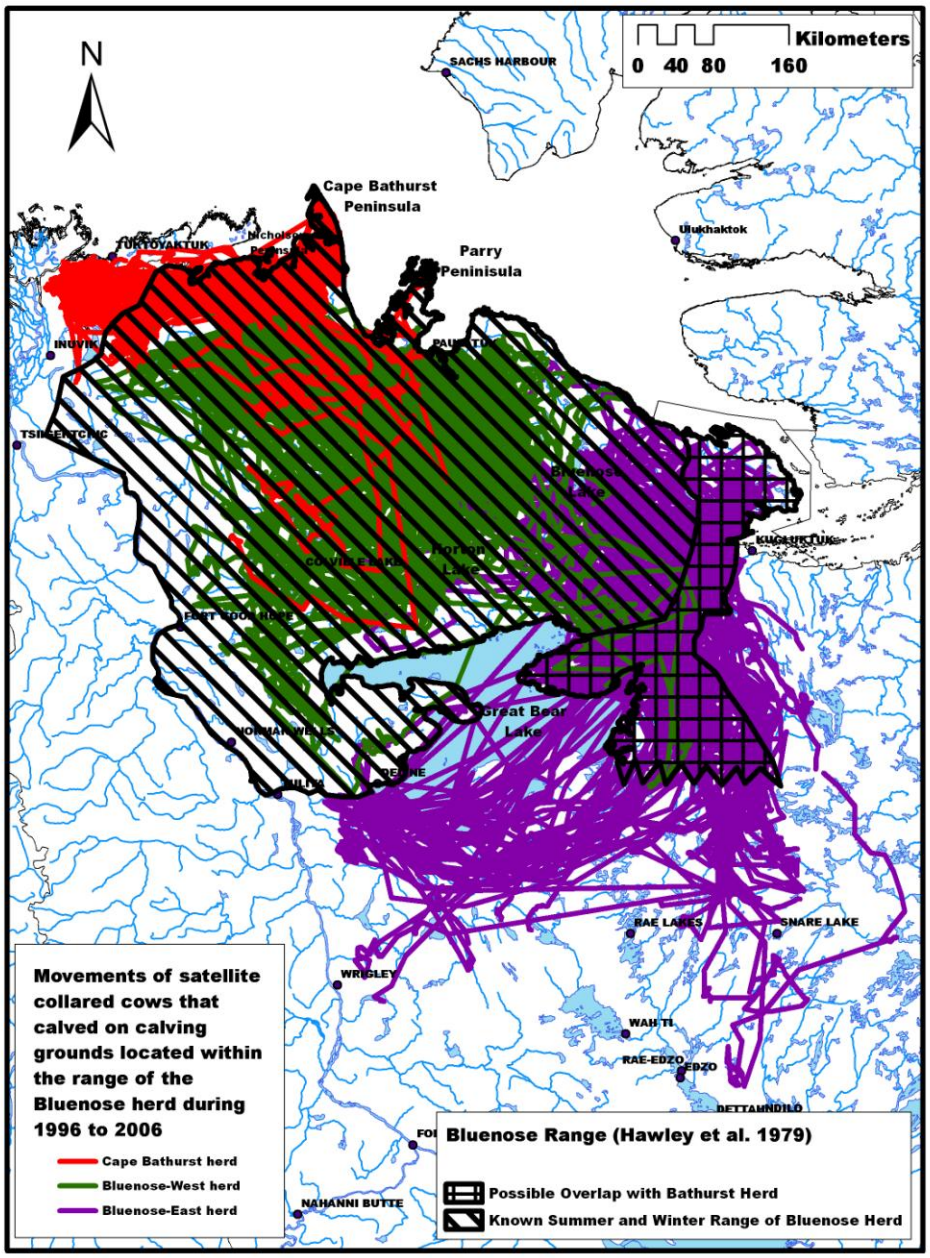

Figure 9. Movements of radio-collared female caribou tracked by satellite, March 1996 to June 2007, in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979). Movements are color-coded based on where the cows calved (red = Cape Bathurst; green = Melville Hills; purple = Bluenose Lake/Rae and Richardson rivers area).

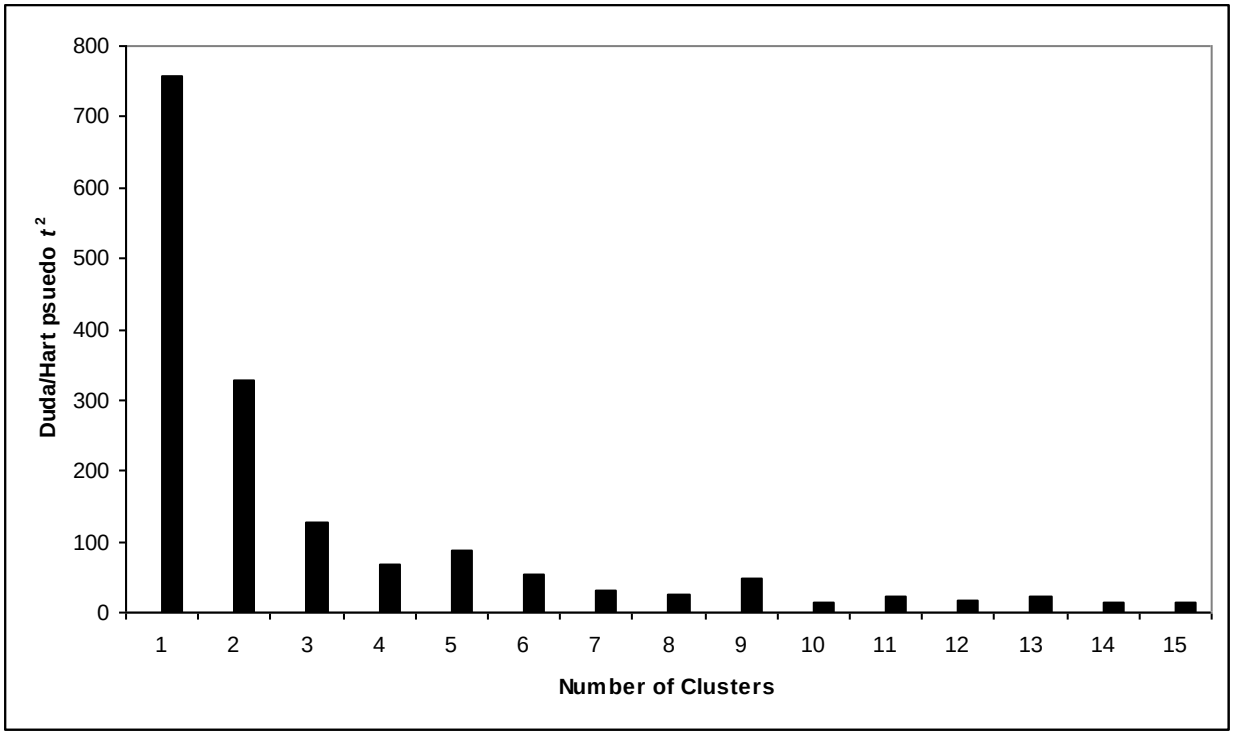

Figure 10. Distribution of the Duda/Hart pseudo t^2 statistic for 1–15 clusters, based on cluster analysis of the seasonal median locations of radio-collared cows that calved on the Cape Bathurst Peninsula, in the Melville Hills, in the Bluenose Lake area, and near Bathurst Inlet (Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst herds, respectively) using Ward's group linkage method. Data were pooled among years for each season.

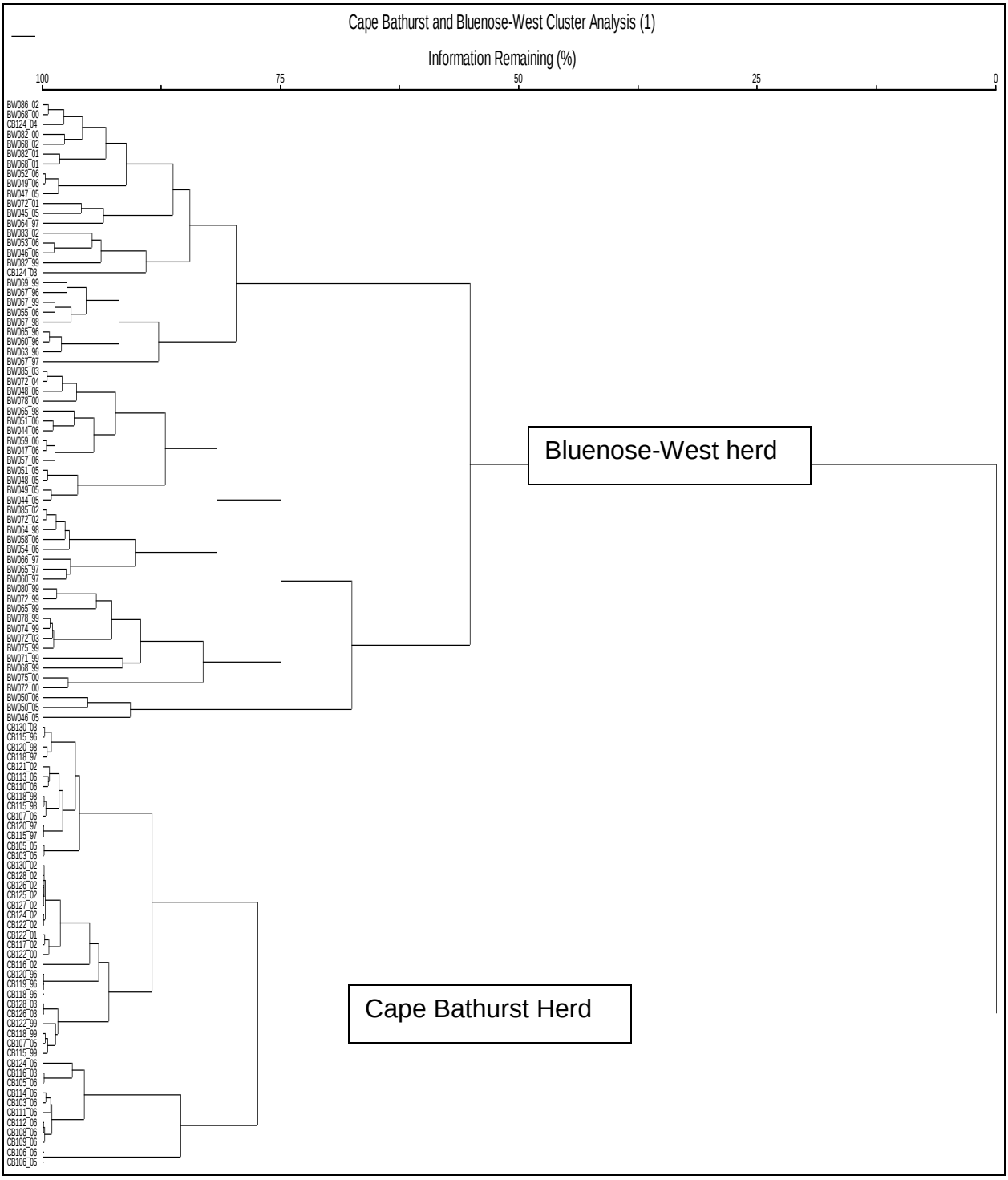

Figure 11. Cluster dendogram based on the Euclidean distance between clusters calculated using Ward's group linkage method for seasonal median locations for Cape Bathurst and Bluenose-West caribou. Data were pooled among years for each season.

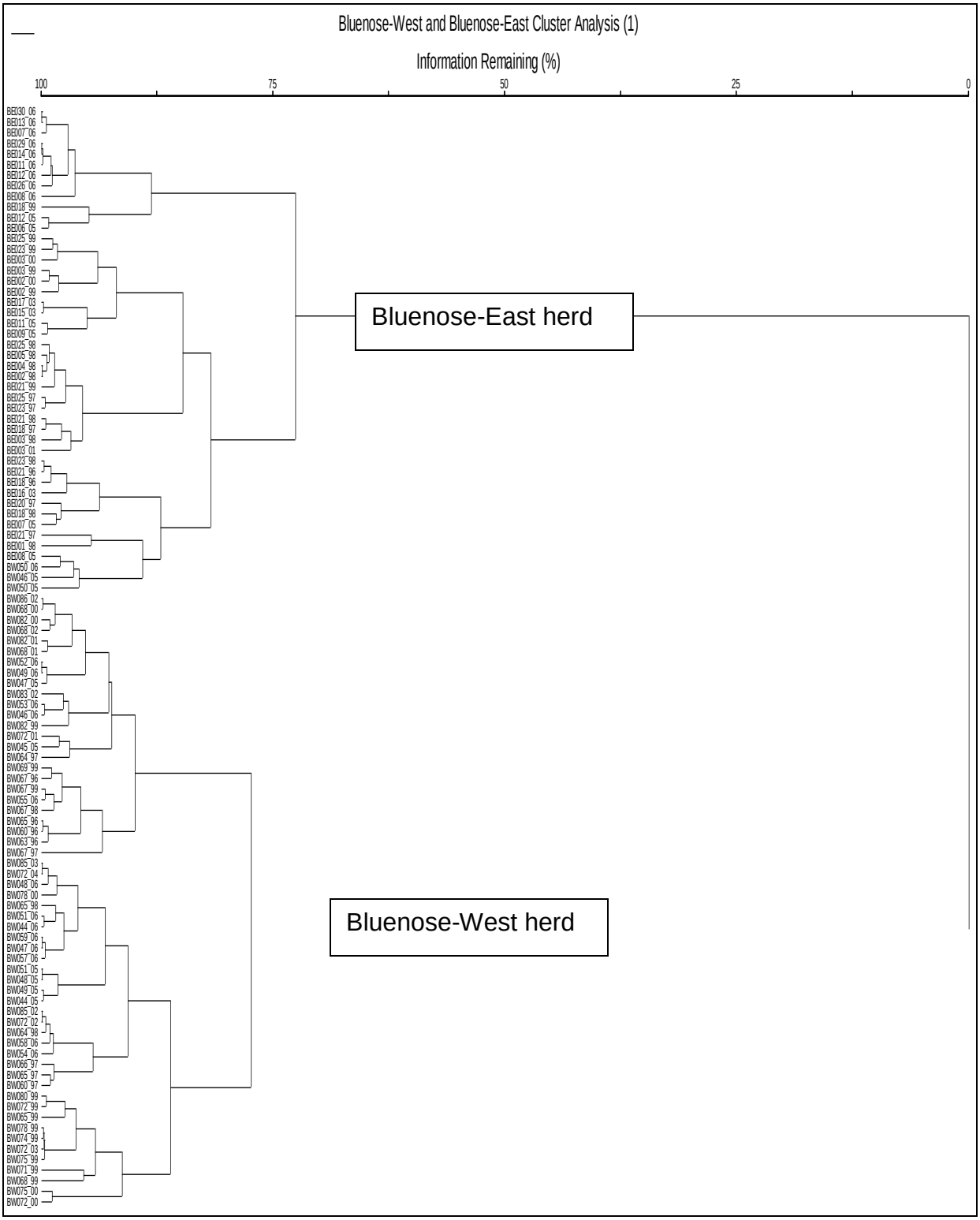

Figure 12. Cluster dendogram based on the Euclidean distance between clusters calculated using Ward's group linkage method for seasonal median locations for Bluenose-West and Bluenose-East caribou. Data were pooled among years for each season.

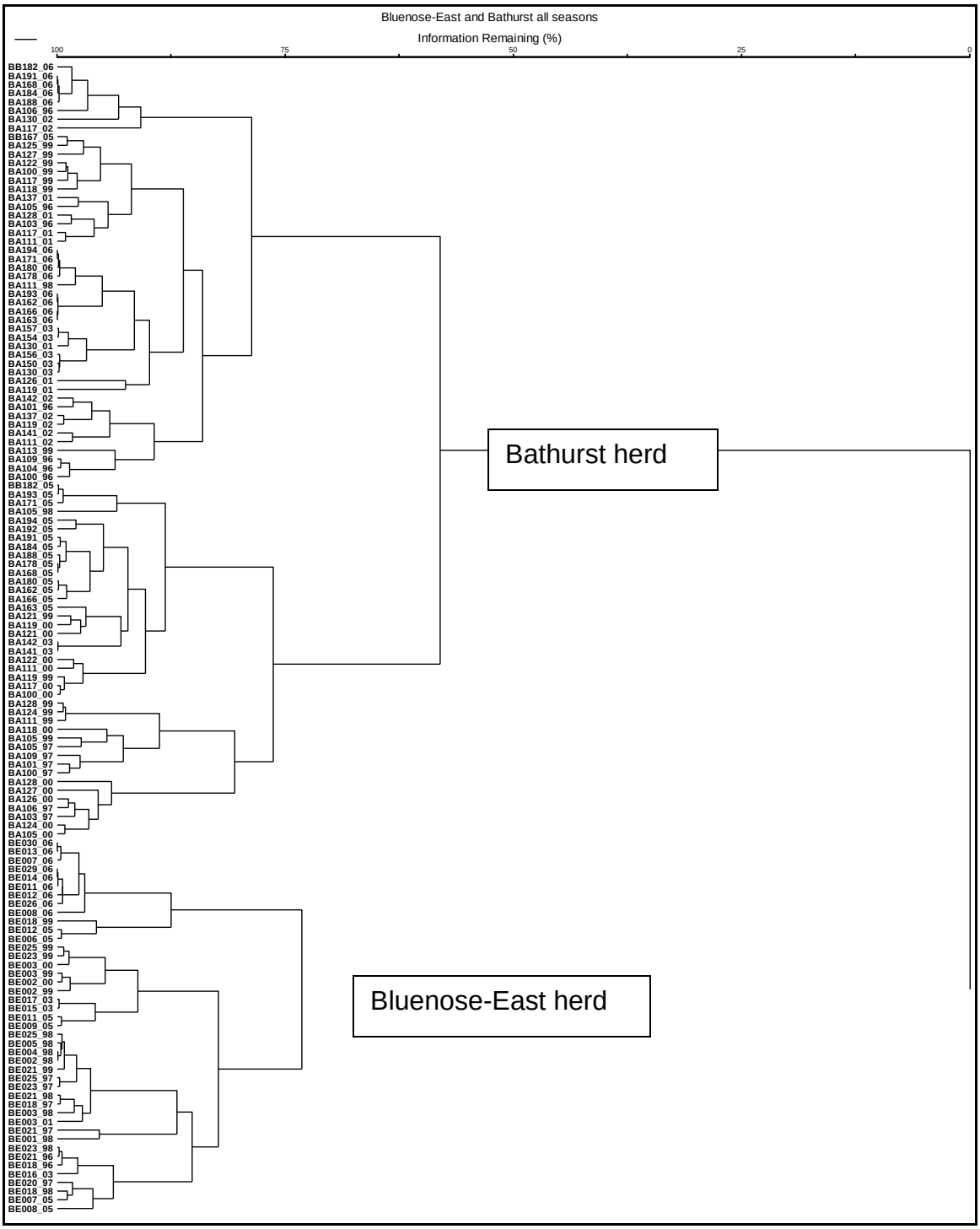

Figure 13. Cluster dendogram based on the Euclidean distance between clusters calculated using Ward's group linkage method for seasonal median locations for caribou that calved in the Bluenose Lake area and near Bathurst Inlet (Bluenose-East herds and Bathurst herds, respectively). Data were pooled among years for each season.

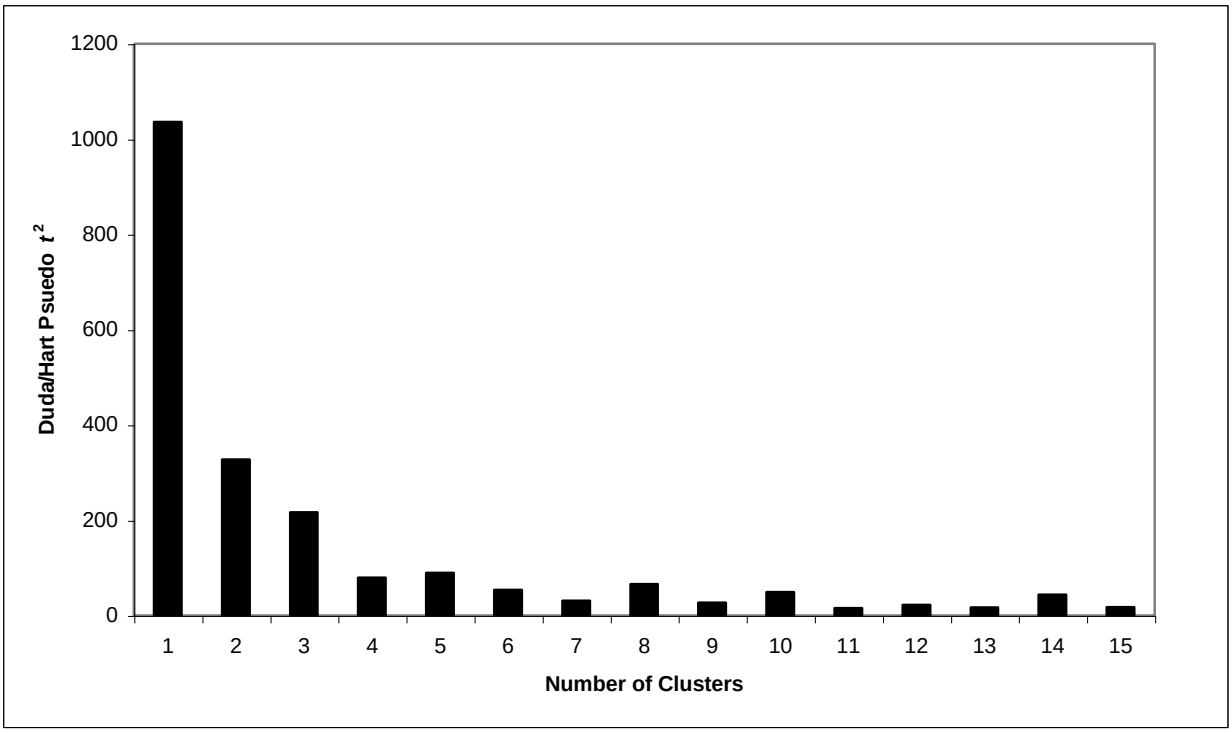

Figure 14. Distribution of the Duda/Hart pseudo t^2 statistic for 1-15 clusters, based on cluster analysis of locations obtained for radio-collared cows during calving (n = 2) and the rut (n = 2) for cows that calved on the Cape Bathurst Peninsula, in the Melville Hills, in the Bluenose Lake area, and near Bathurst Inlet (Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst herds, respectively) using Ward's group linkage method.

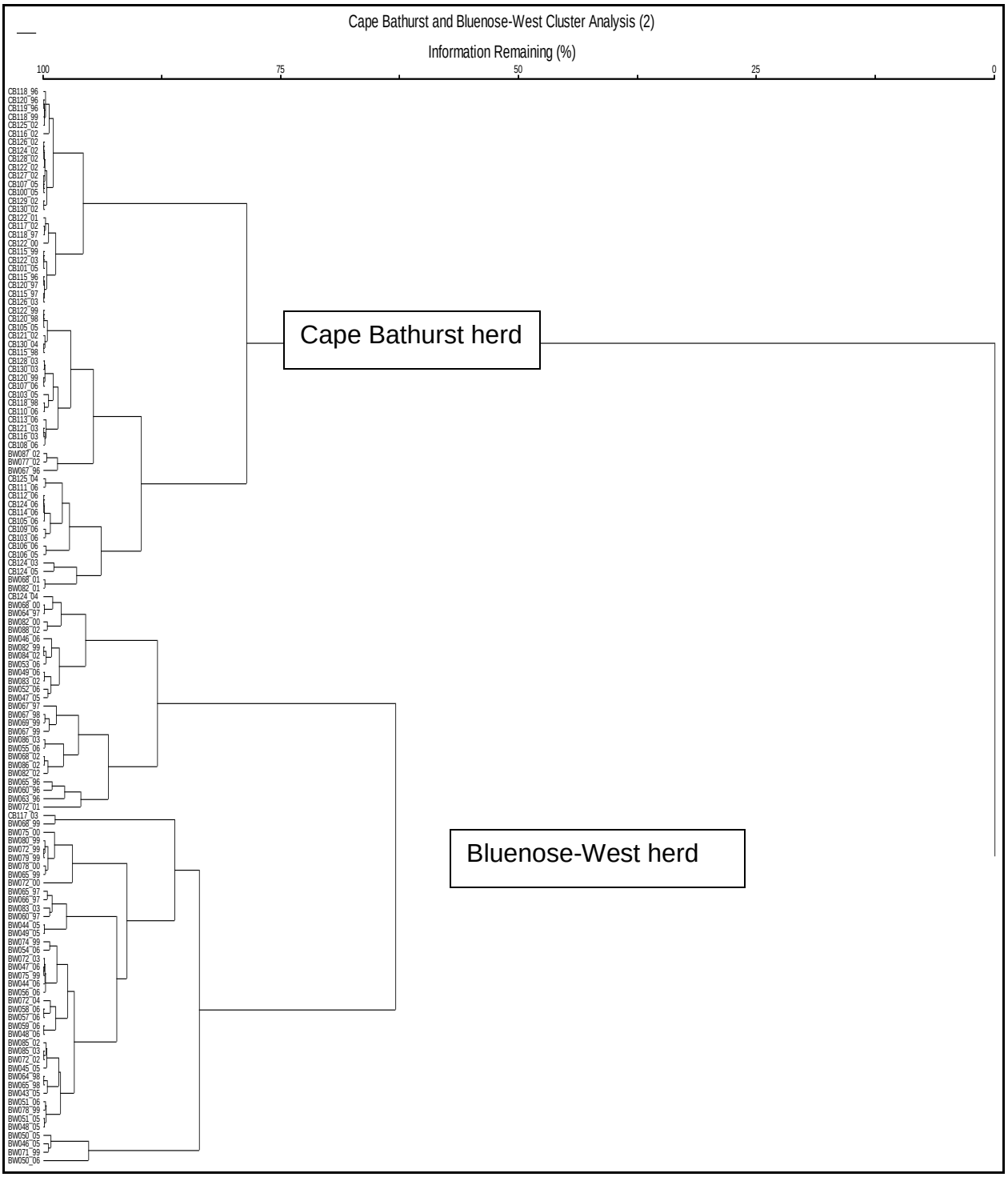

Figure 15. Cluster dendogram based on the Euclidean distance between clusters calculated using Ward's group linkage method for locations obtained during calving (n = 2) and the rut (n = 2) for Cape Bathurst and Bluenose-West caribou. Data were pooled among years for each season.

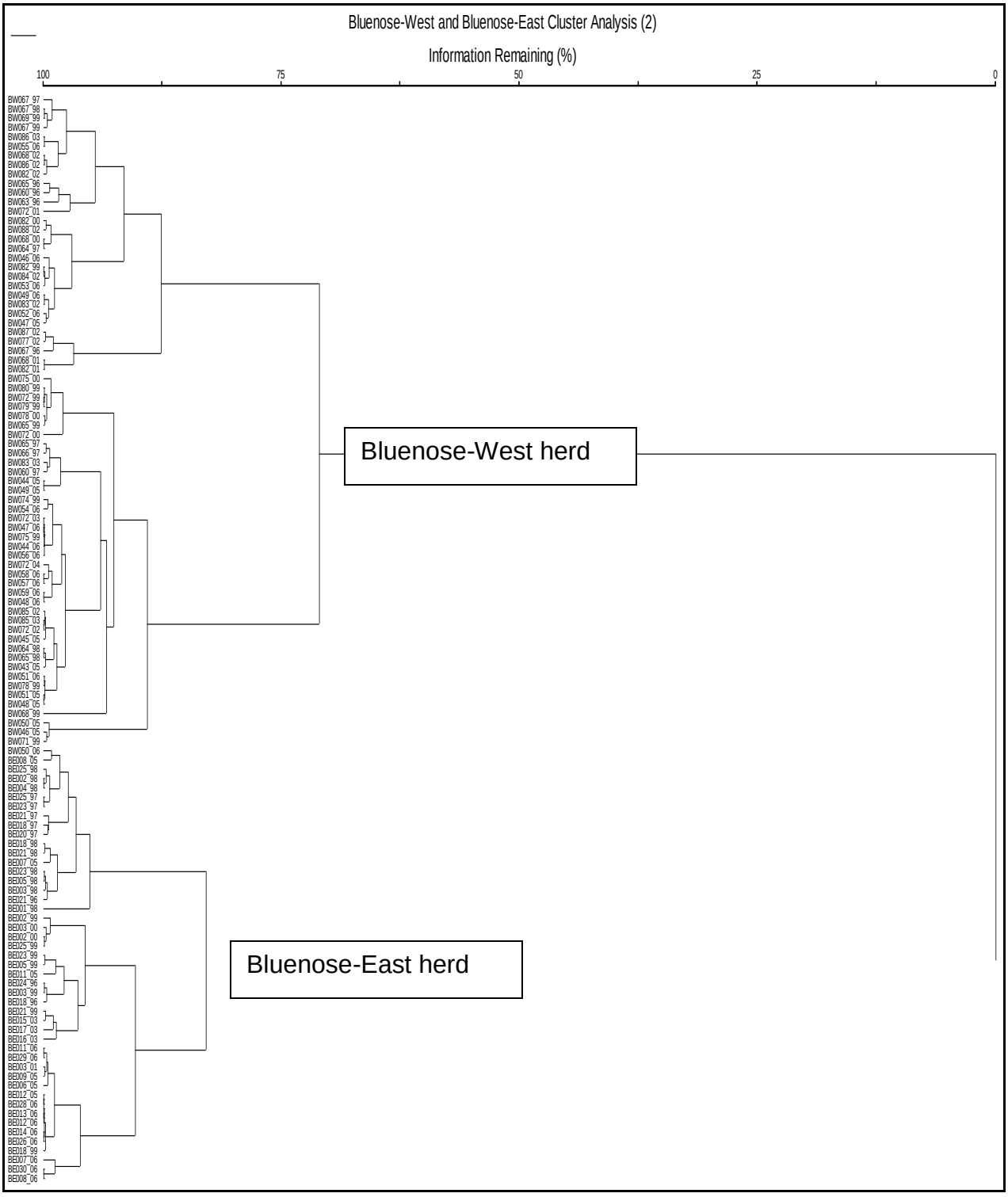

Figure 16. Cluster dendogram based on the Euclidean distance between clusters calculated using Ward's group linkage method for locations obtained during calving (n = 2) and the rut (n = 2) for Bluenose-West and Bluenose-East caribou. Data were pooled among years for each season.

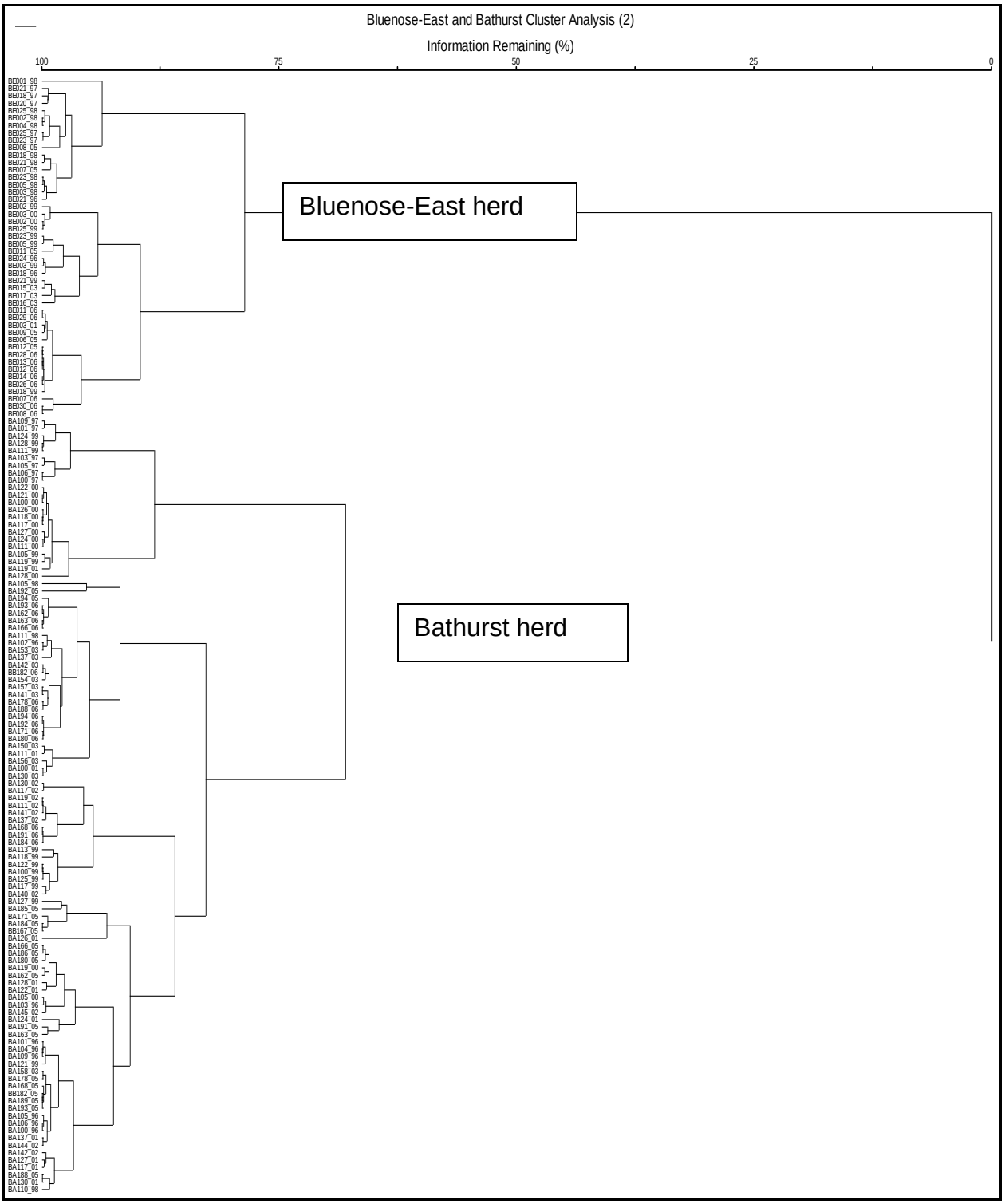

Figure 17. Cluster dendogram based on the Euclidean distance between clusters calculated using Ward's group linkage method for locations obtained during calving (n = 2) and the rut (n = 2) for Bluenose-East and Bathurst caribou. Data were pooled among years for each season.

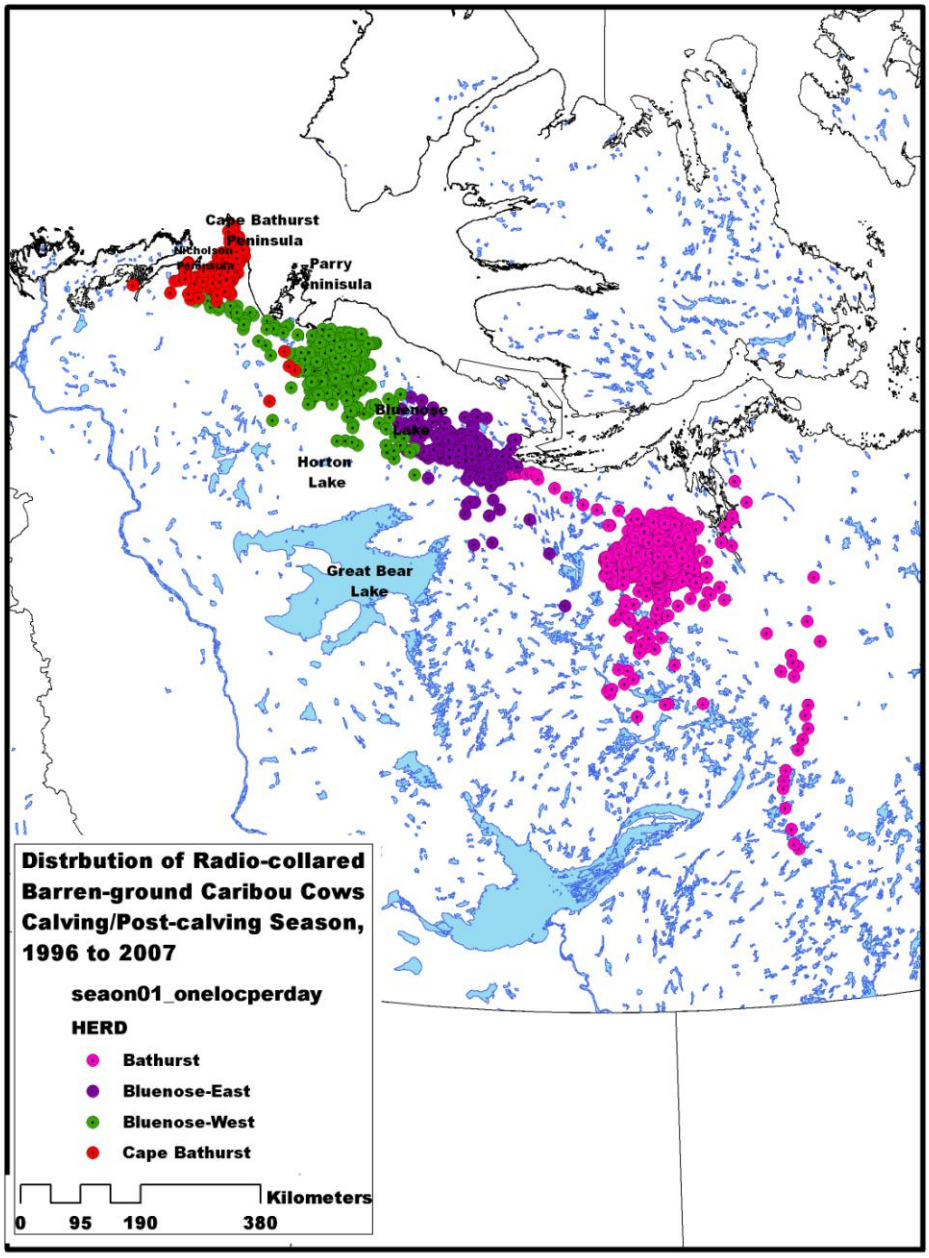

Figure 18. Locations used in multi-response permutation procedure analyses to determine if the distribution of radio-collared cows in the Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst herds were significantly different during the calving/post-calving. One location per day for the days when locations were available was used in the analyses.

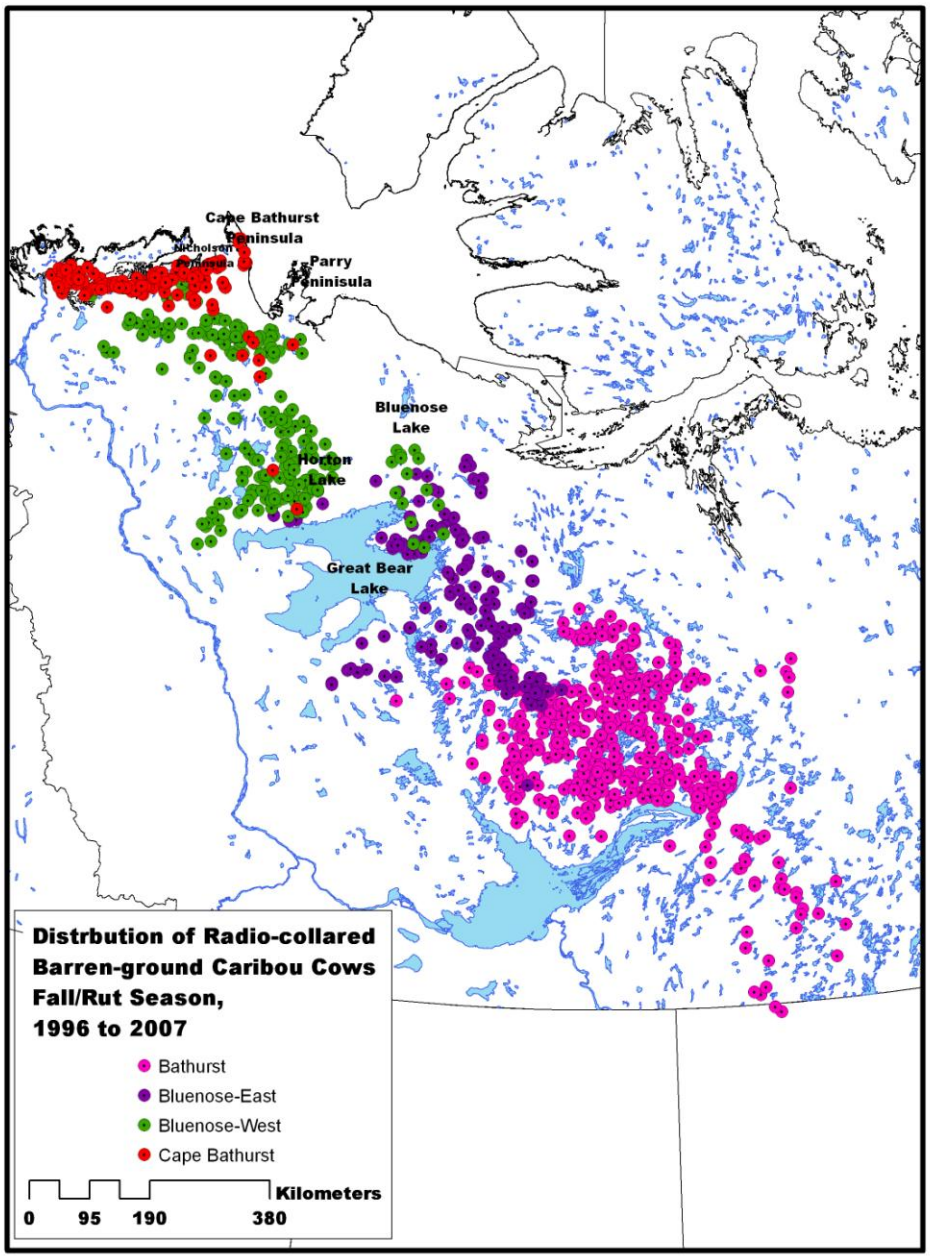

Figure 19. Locations used in multi-response permutation procedure analyses to determine if the distribution of radio-collared cows in the Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst herds were significantly different during the fall/rut period. One location per day for the days when locations were available was used in the analyses.

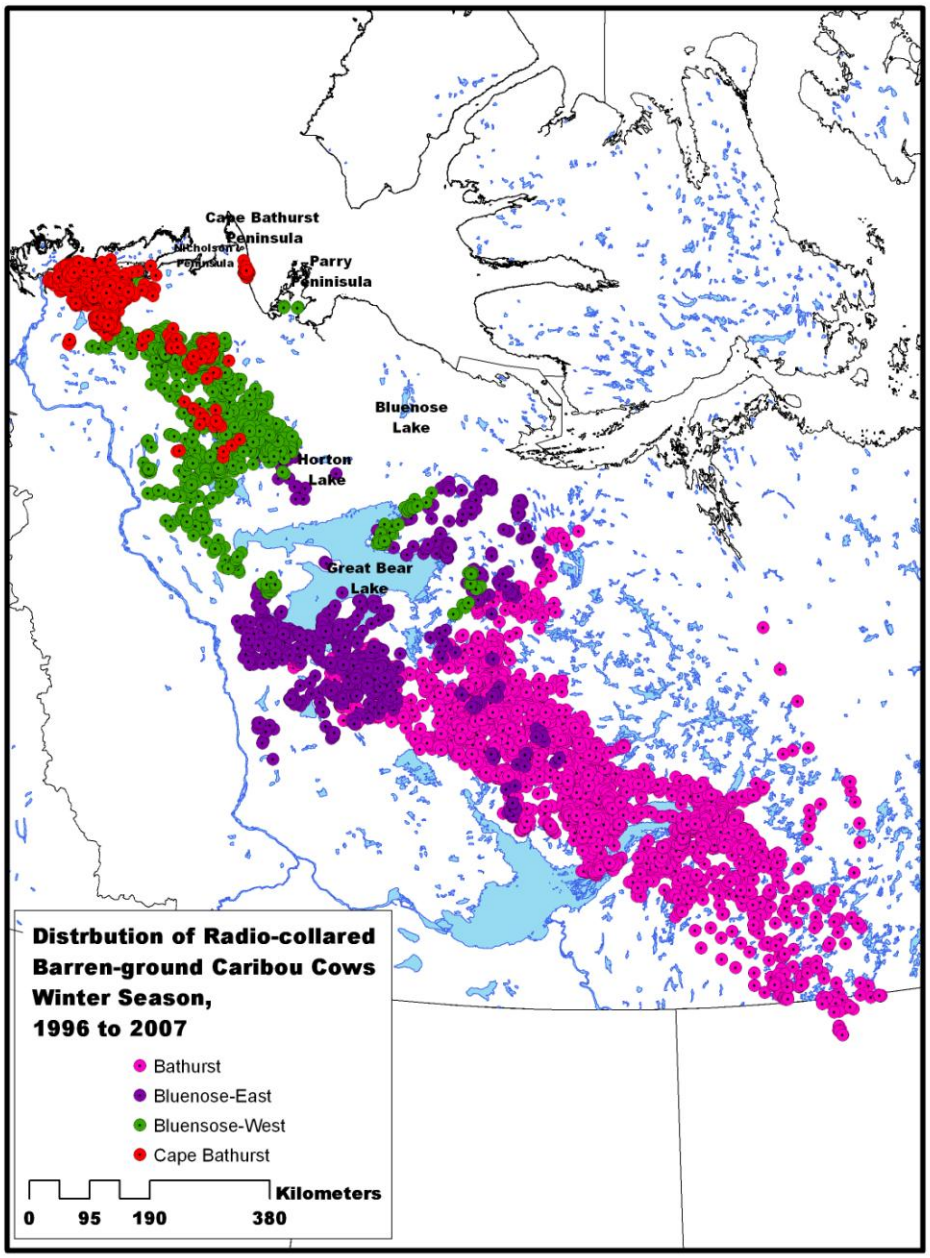

Figure 20. Locations used in multi-response permutation procedure analyses to determine if the distribution of radio-collared cows in the Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst herds were significantly different during the winter period. One location per day for the days when locations were available was used in the analyses.

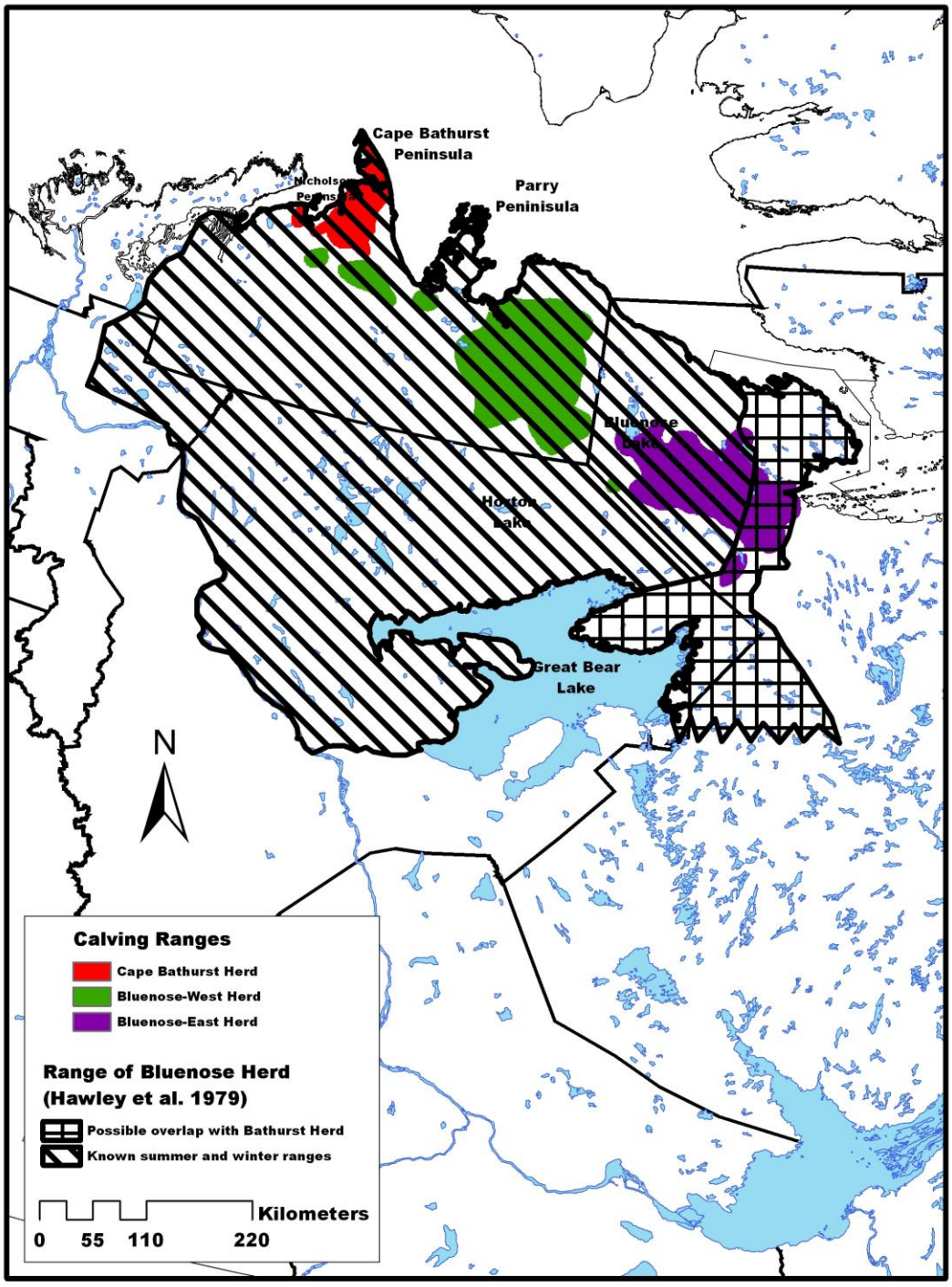

Figure 21. Distribution of calving sites documented during this study in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).

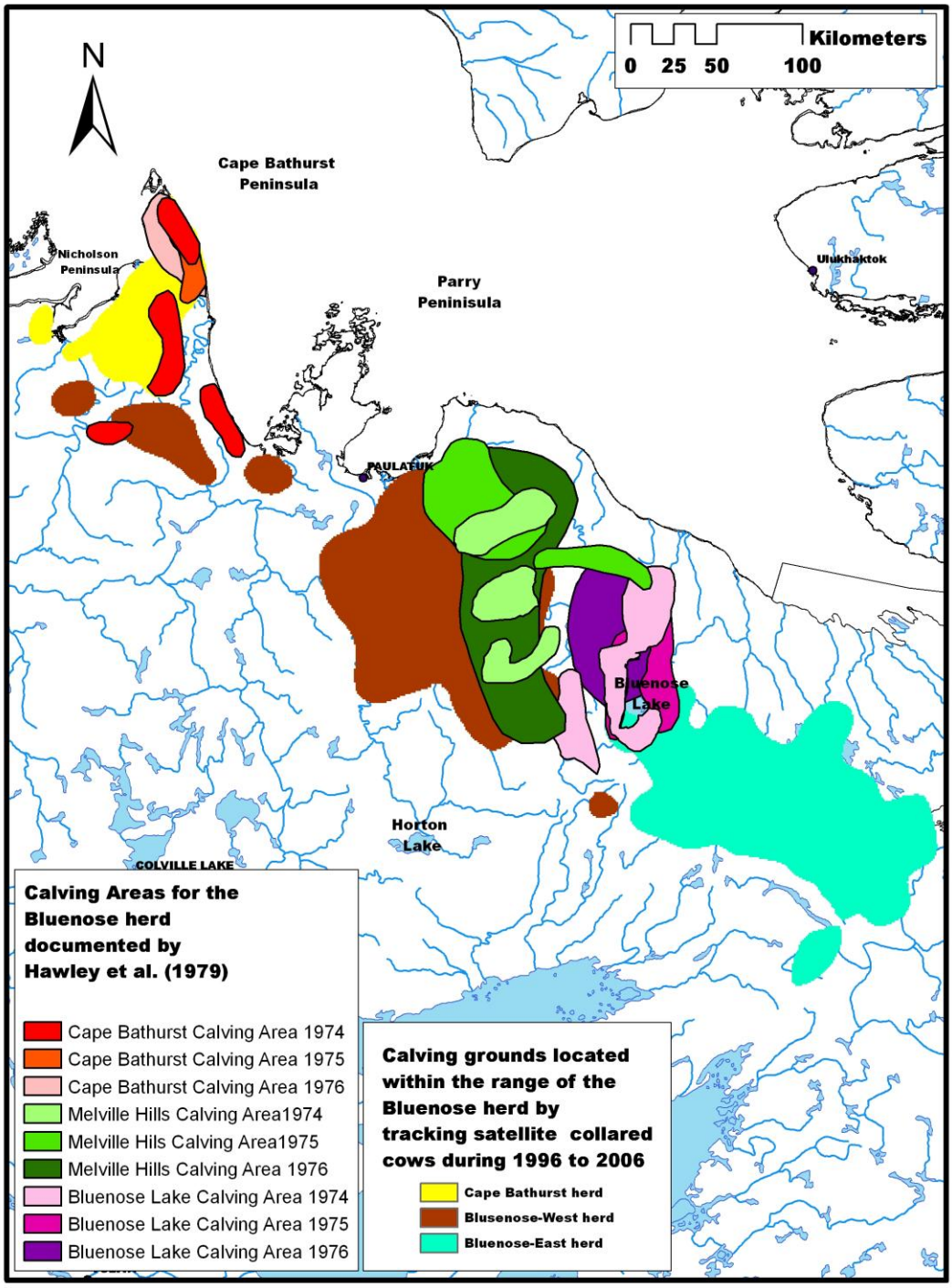

Figure 22. Distribution of calving sites documented during this study in relationship to those described by Hawley *et al.* (1979).

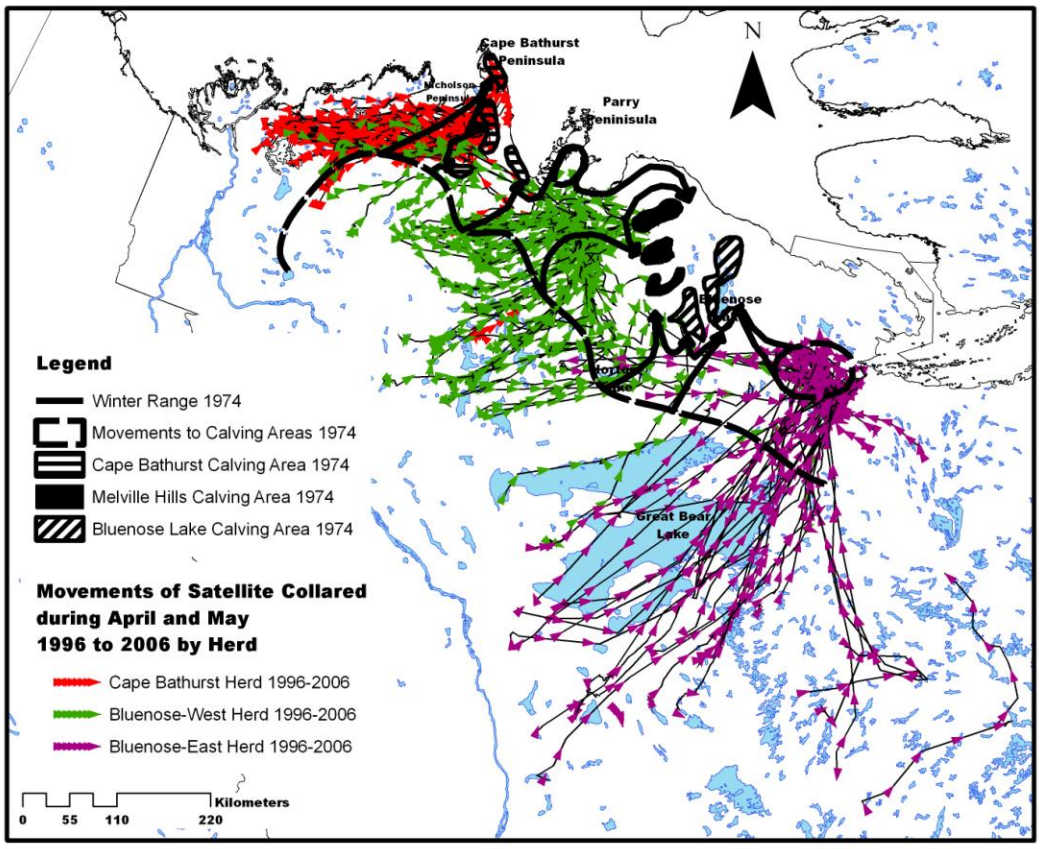

Figure 23. Movement tracks of radio-collared cow caribou on route to calving areas on the Cape Bathurst Peninsula, in the Melville Hills, and near Bluenose Lake (Rae and Richardson Rivers area) in relationship to the migration routes to these calving areas documented by Hawley *et al.* (1979) in 1974.

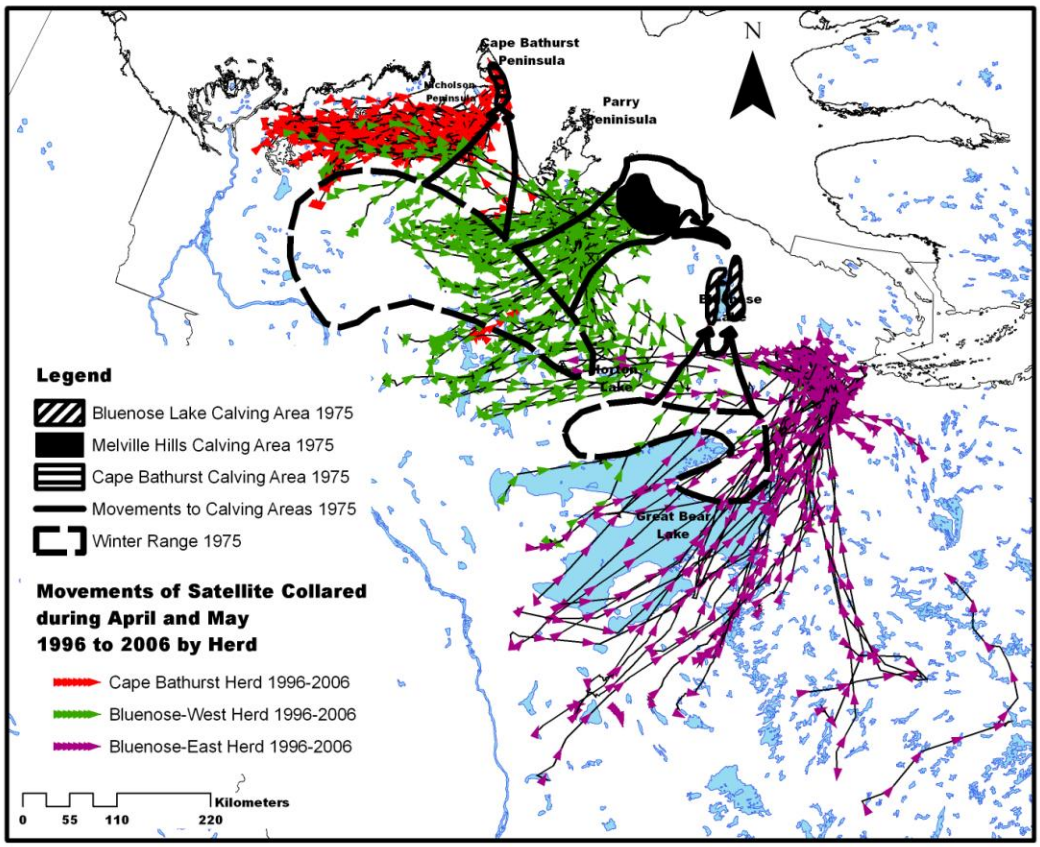

Figure 24. Movement tracks of radio-collared cow caribou on route to calving areas on the Cape Bathurst Peninsula, in the Melville Hills, and near Bluenose Lake (Rae and Richardson Rivers area) in relationship to the migration routes to these calving areas documented by Hawley *et al.* (1979) in 1975.

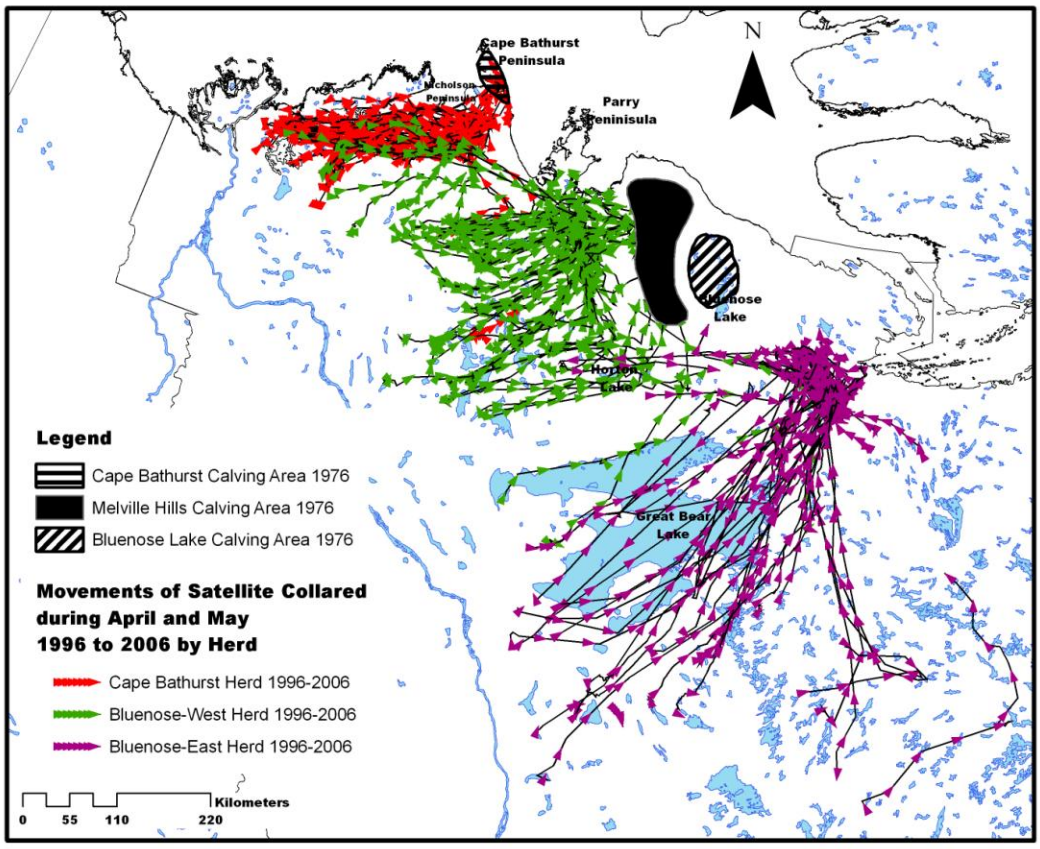

Figure 25. Movement tracks of radio-collared cow caribou on route to calving areas on the Cape Bathurst Peninsula, in the Melville Hills, and near Bluenose Lake (Rae and Richardson Rivers area) in relationship to calving areas documented by Hawley *et al.* (1979) in 1976.

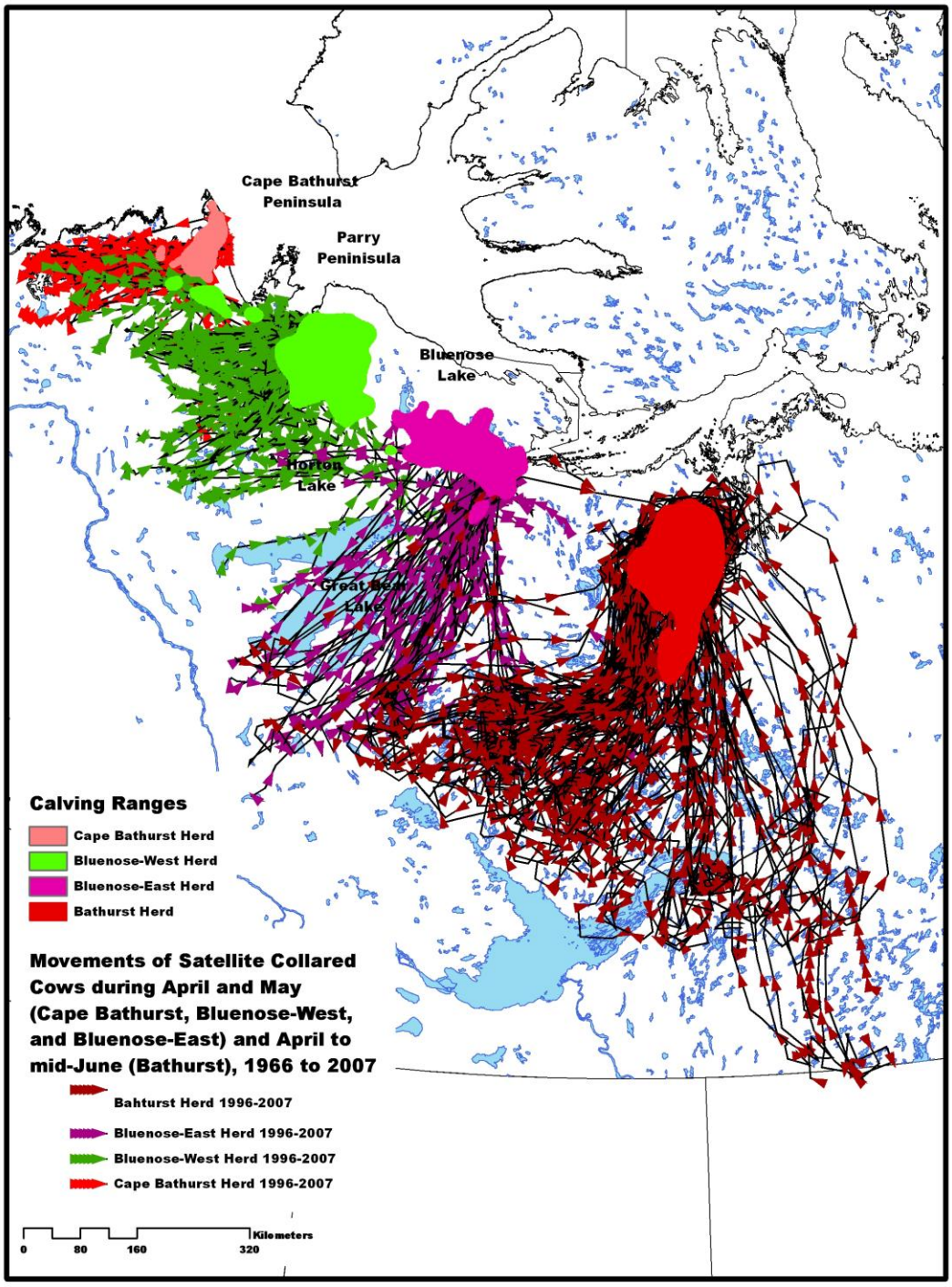

Figure 26. Movements of satellite-collared Cape Bathurst, Bluenose-West, and Bluenose-East cows during April and May 1996–2007 and Bathurst cows during April to 15 June 1996 to 2007 to their respective calving grounds.

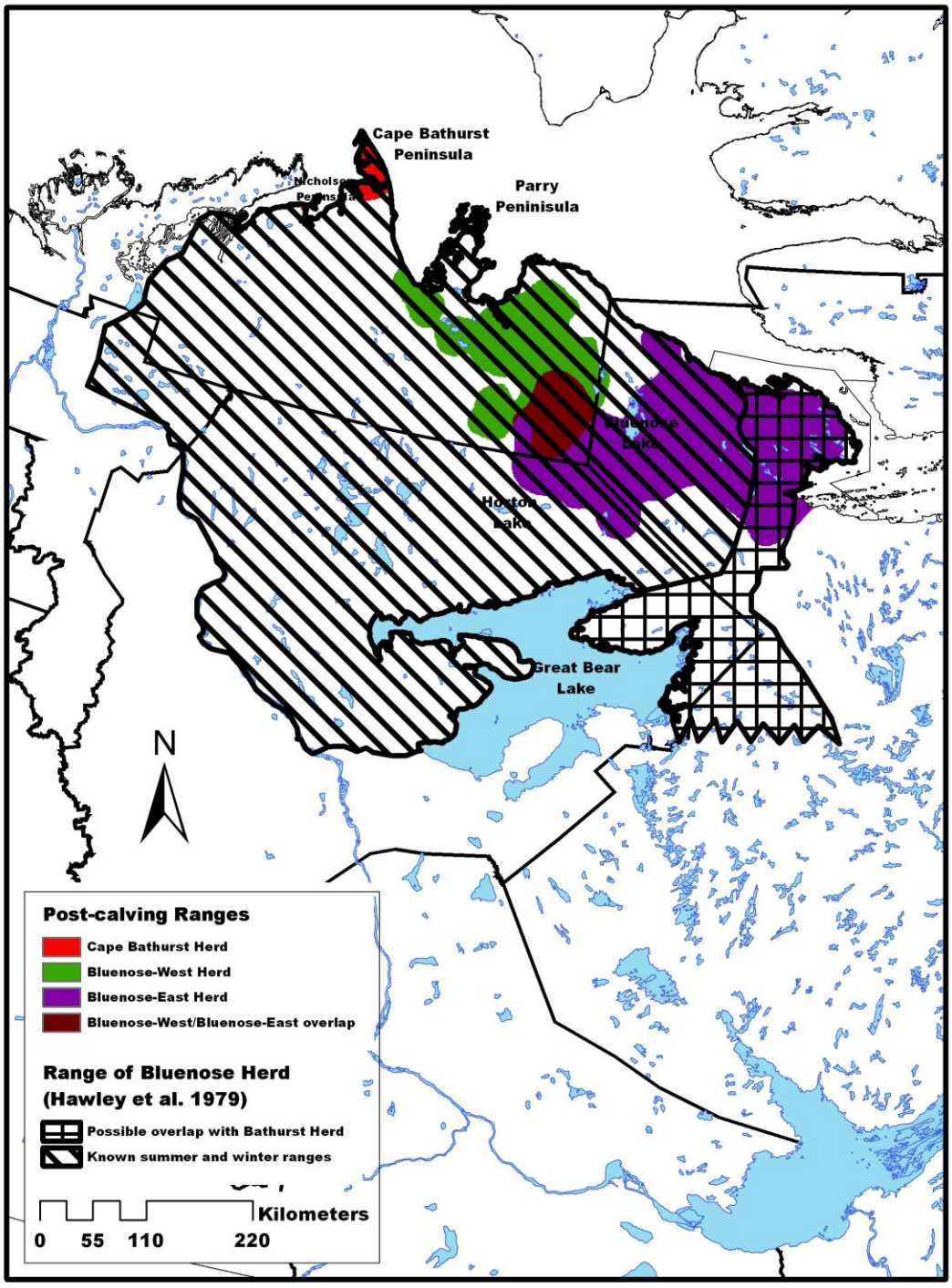

Figure 27. The post-calving (early summer) ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).

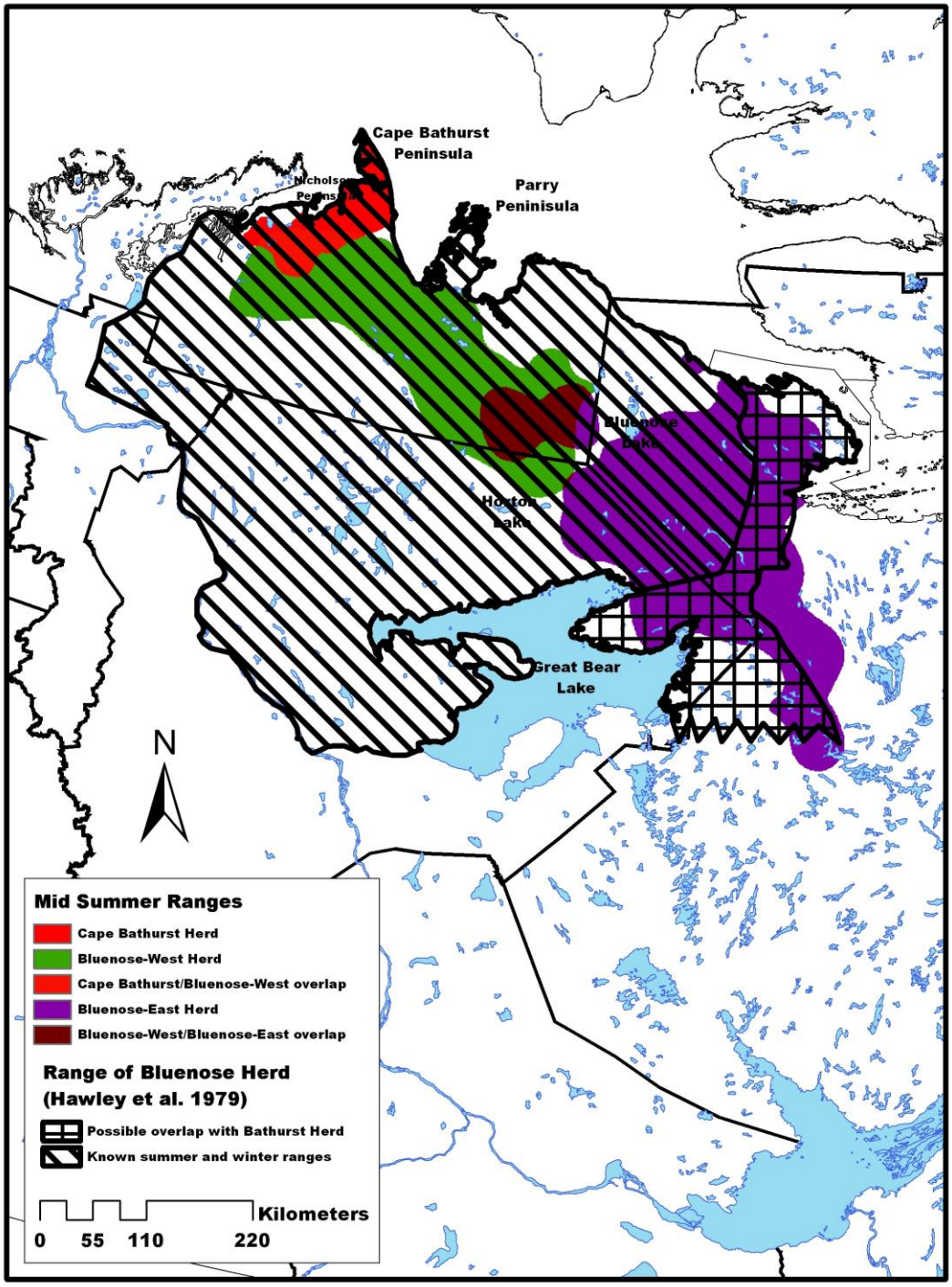

Figure 28. The mid summer ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).

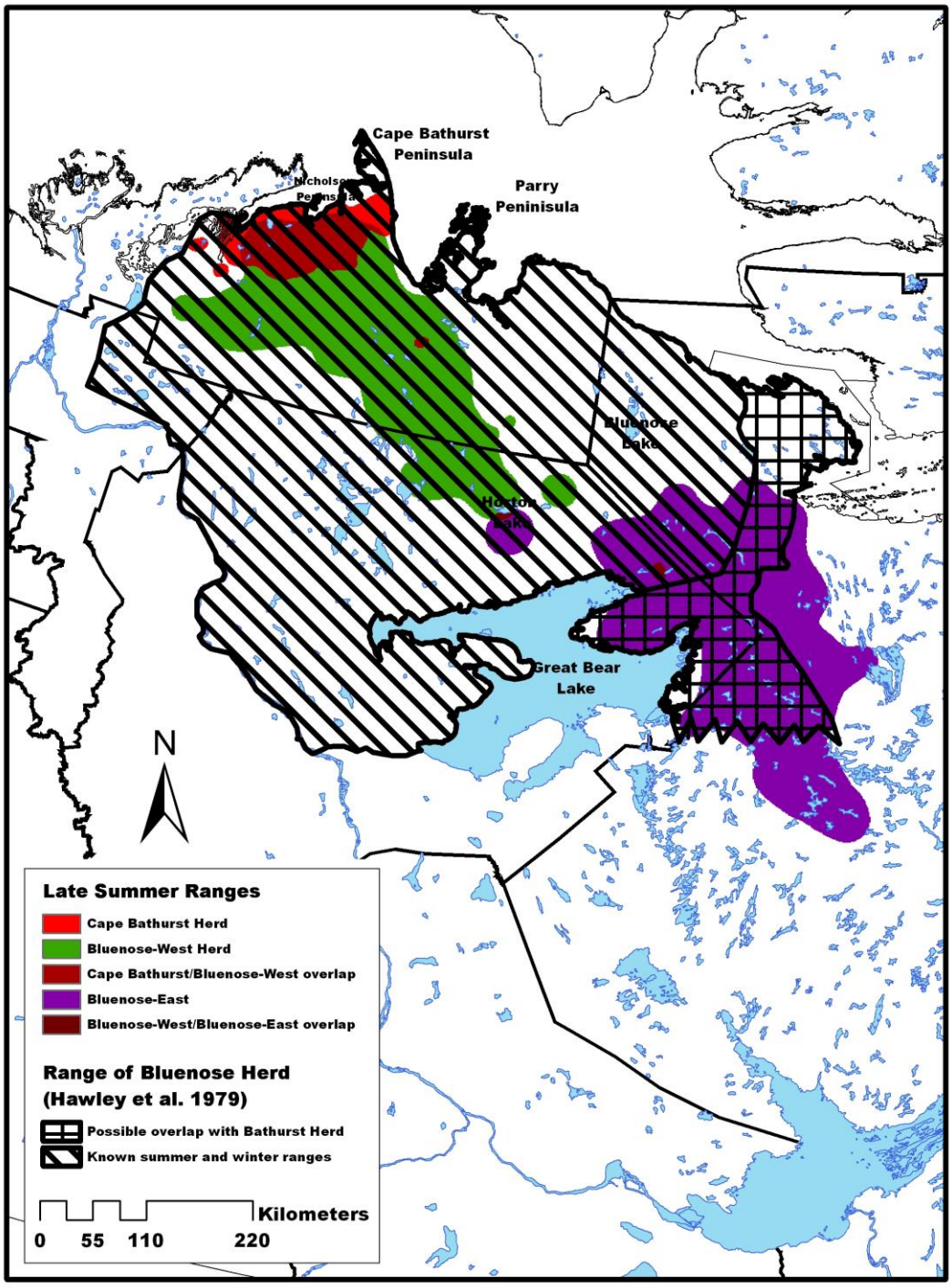

Figure 29. The late summer ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).

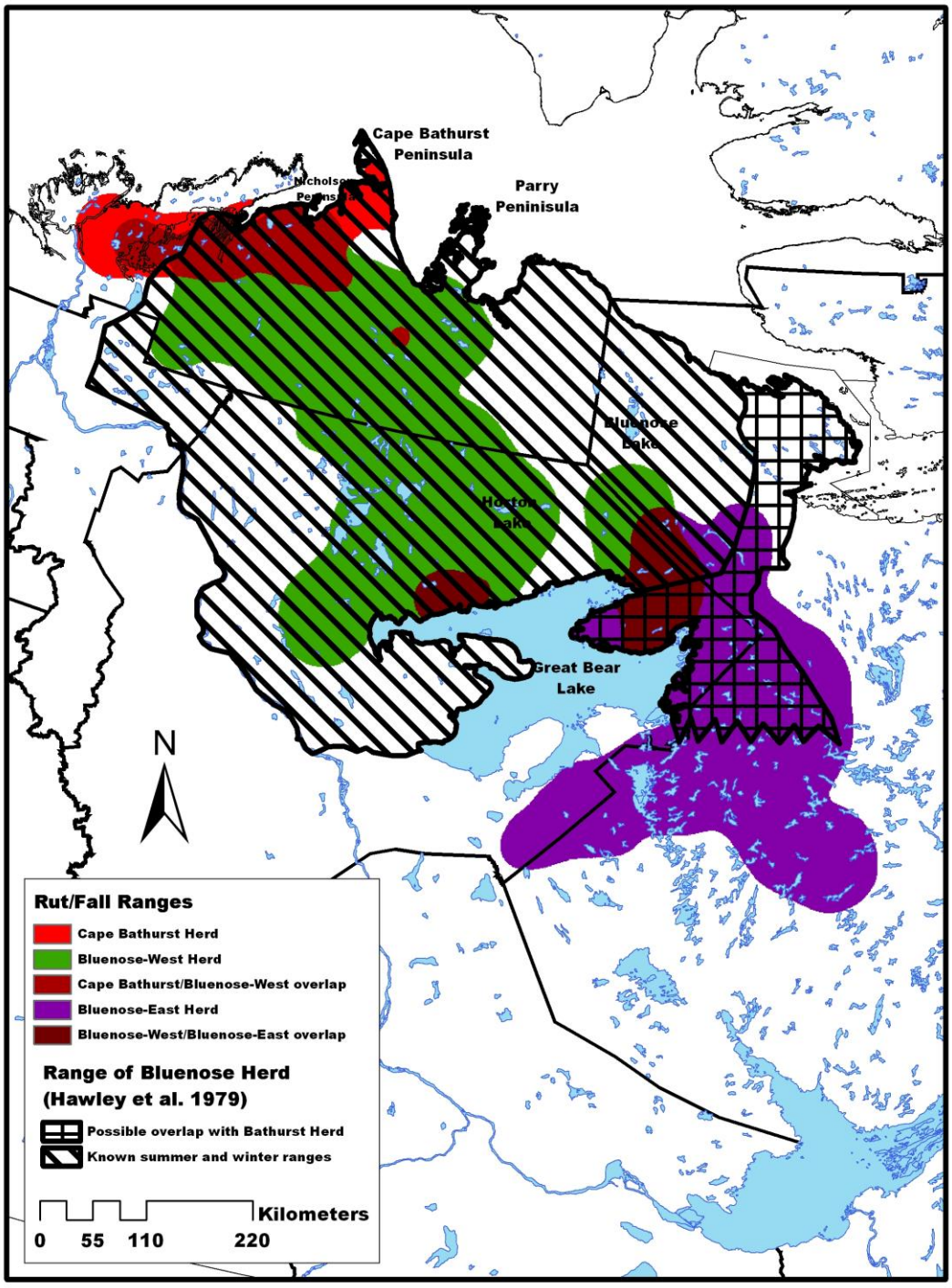

Figure 30. The rut/fall ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).

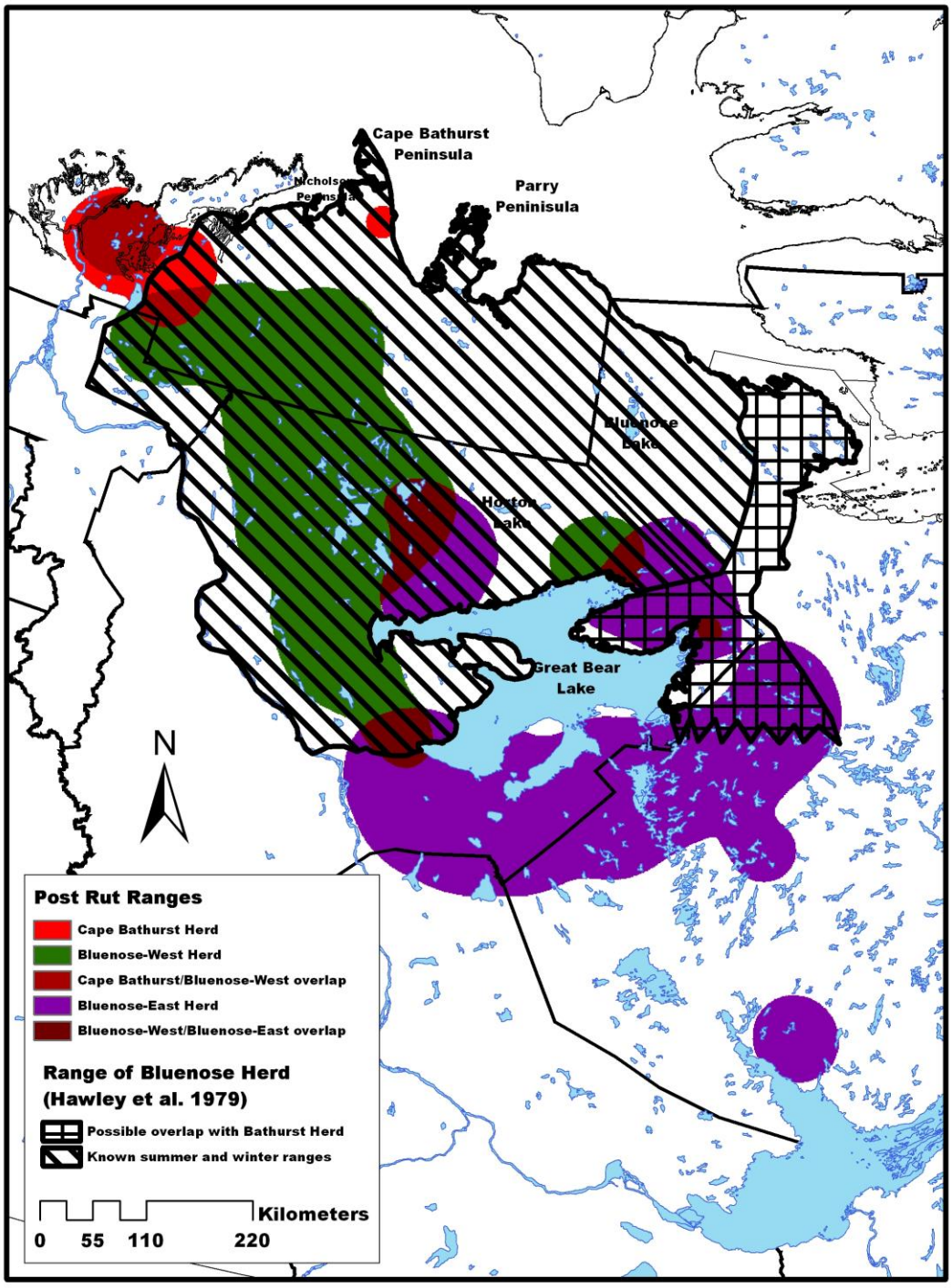

Figure 31. The post-rut ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).

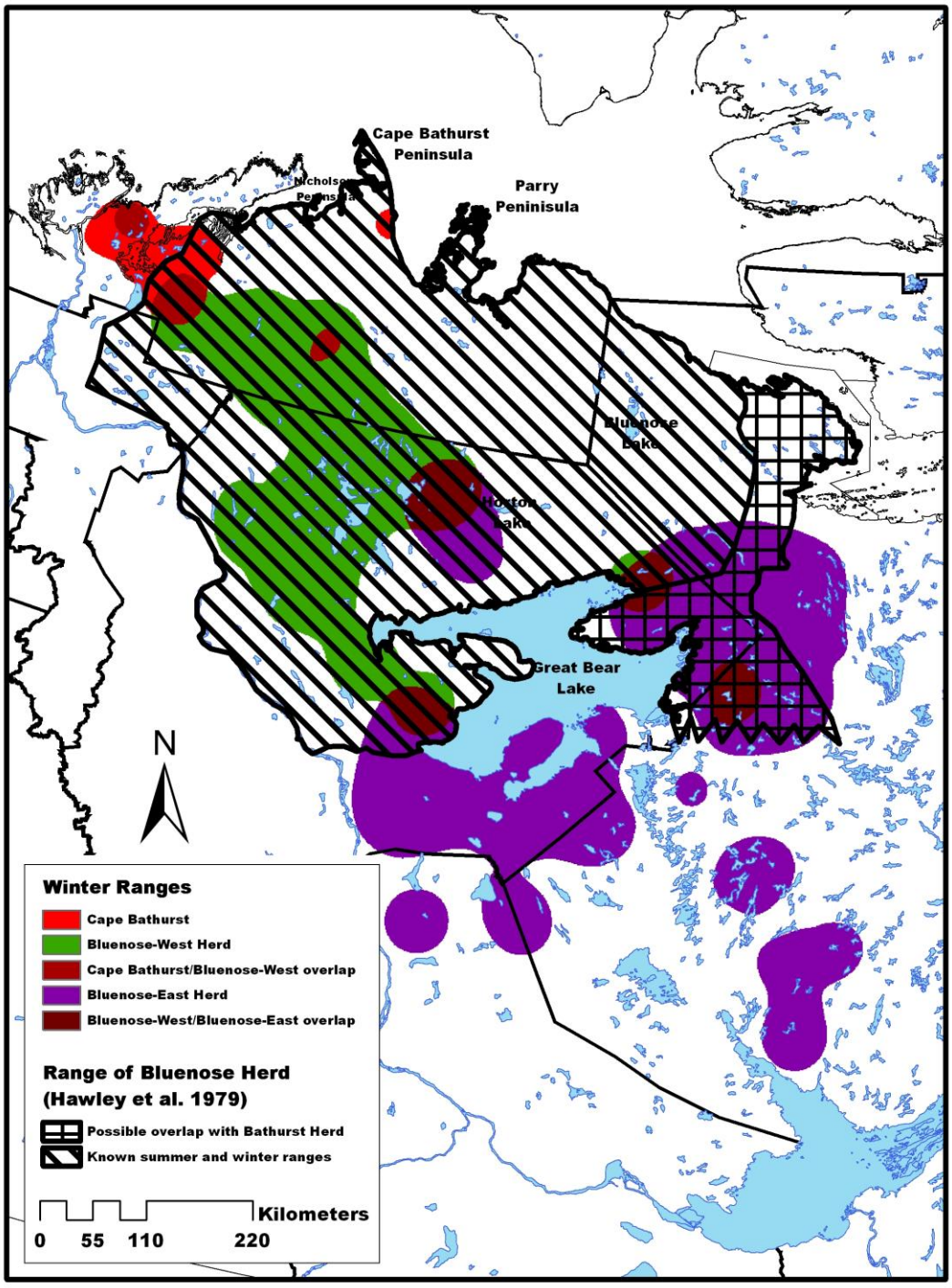

Figure 32. The winter ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).

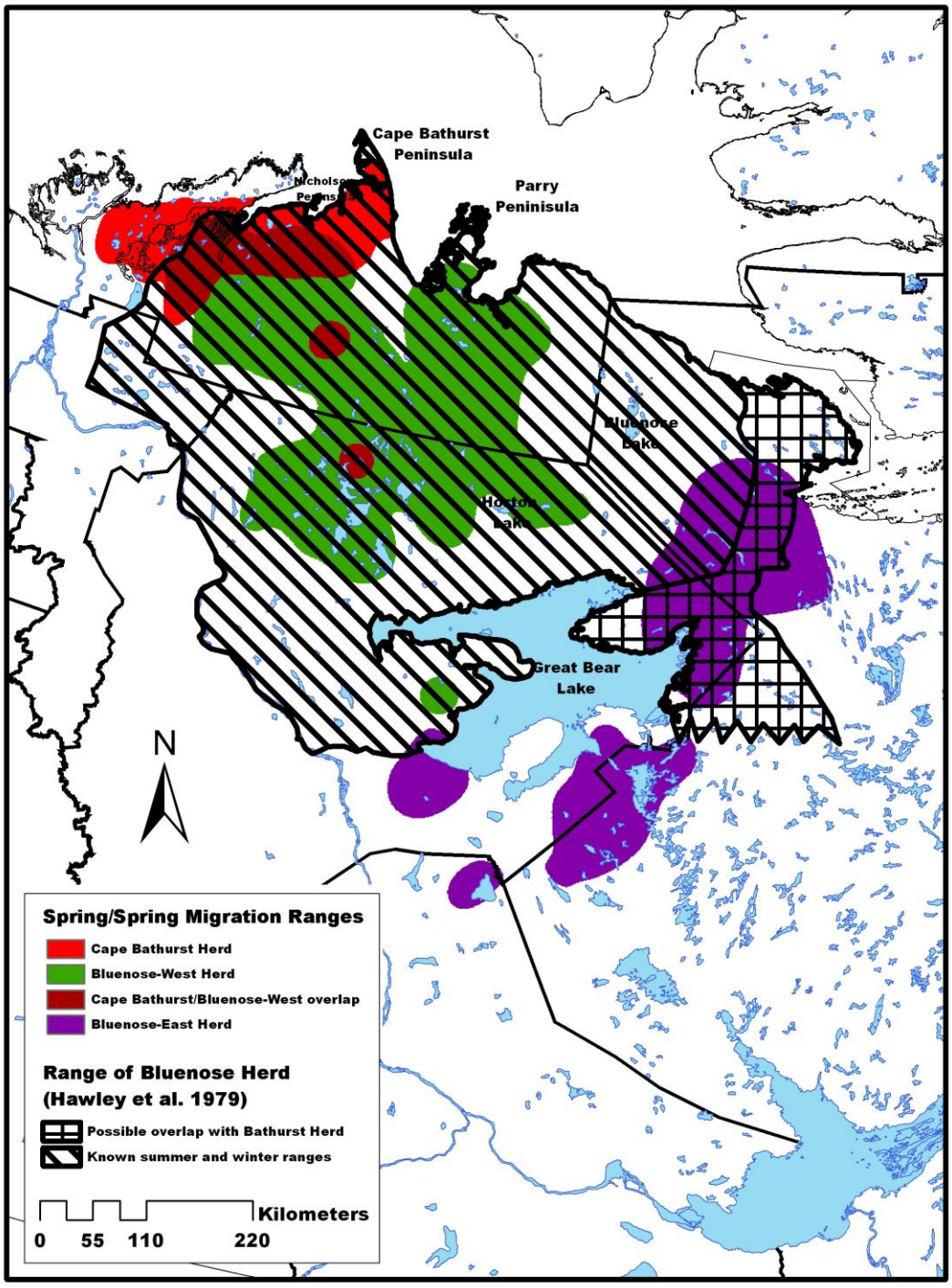

Figure 33. The spring/spring migration ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).

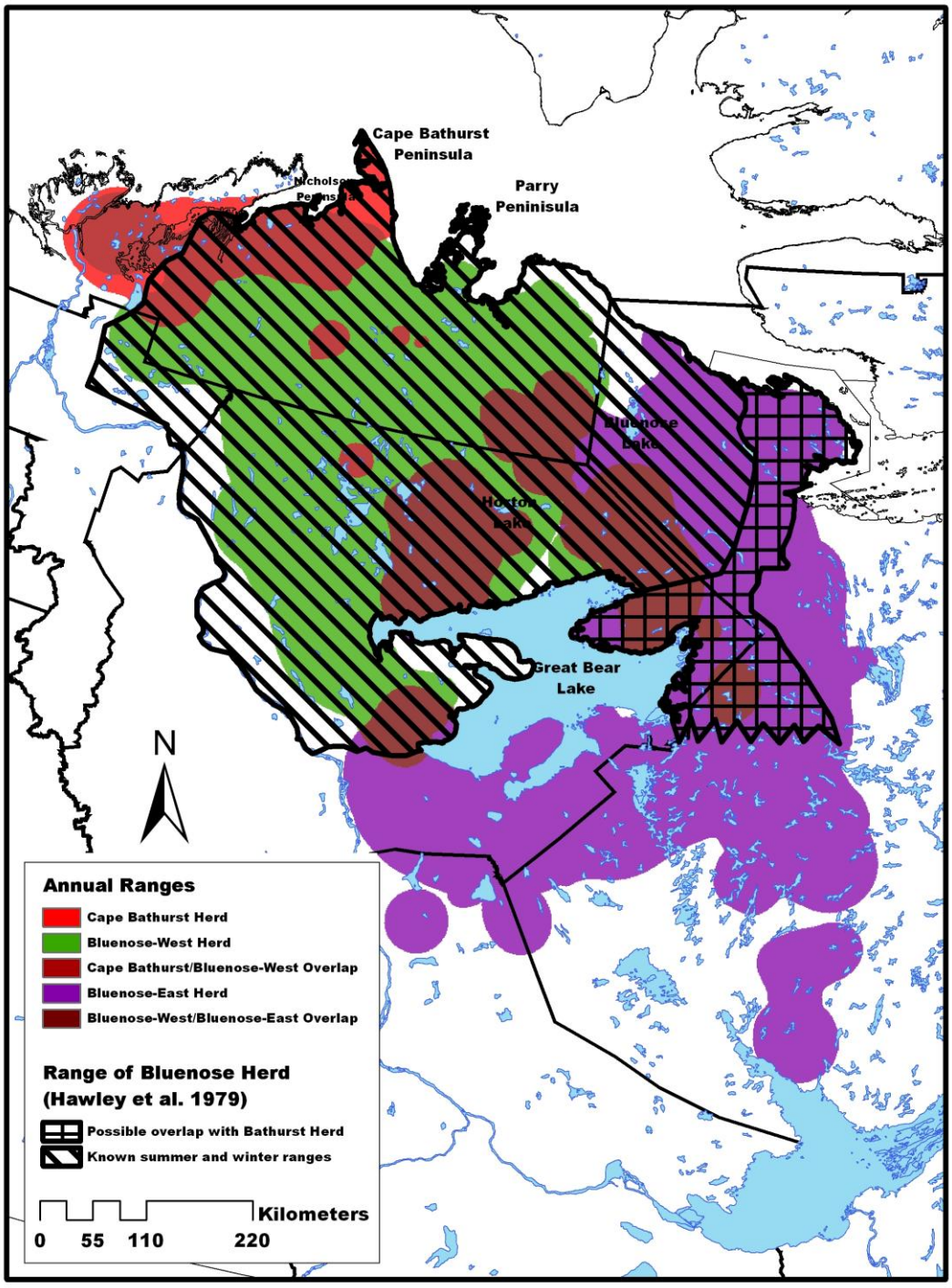

Figure 34. The spring/spring migration ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds in relationship to the range of the Bluenose herd described by Hawley *et al.* (1979).