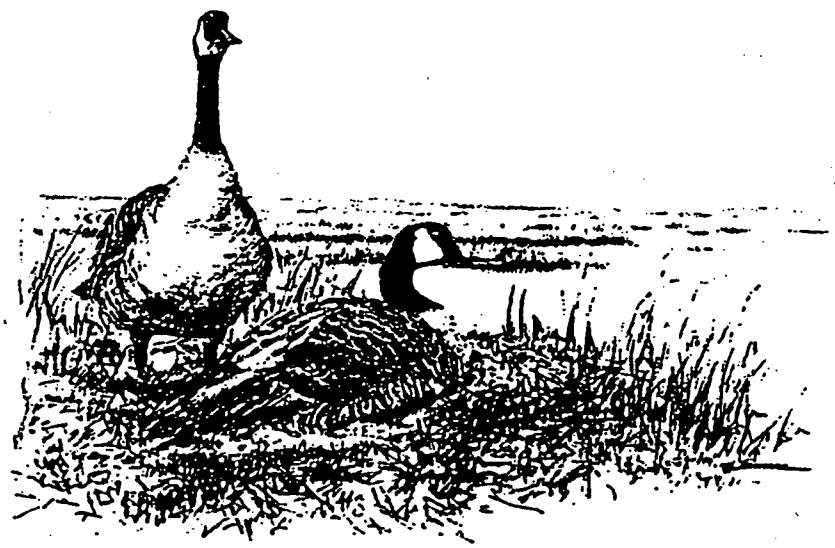
A BREEDING PAIR SURVEY OF CANADA GEESE IN NORTHERN QUEBEC - 1999



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INTRODUCTION

Status of Canada geese (Branta canadensis) in the Atlantic flyway has traditionally been monitored by mid-winter surveys (Hindman and Ferrigno 1990). However, resident (i.e., non-migratory) Canada geese have increased dramatically since the late 1970's throughout the Atlantic flyway. Population estimates of resident Canada geese during the breeding season have tripled since 1989 and now exceed 1,000,000 birds in the mid-Atlantic and northeast states (H. Heusman, Mass. Div. of Fish and Wildl., pers. comm.). Mixing of resident and migrant geese on wintering areas has seriously reduced the value of mid-winter surveys for monitoring these populations. Therefore, emphasis of population monitoring has shifted to surveys on breeding areas, where population affiliation is more obvious.

During the 1960's, aerial surveys identified the Ungava Peninsula in northern Quebec as the primary nesting area for Atlantic flyway Canada geese (Kaczynski and Chamberlain 1968). Malecki and Trost (1990) used a more quantitative approach to estimate the number of breeding pairs throughout the boreal forest and Ungava Peninsula of northern Quebec in 1988. Their findings confirmed that the highest densities were located along the coastal areas of Ungava Bay and Hudson Bay. In 1993, an annual survey was begun in northern Quebec using methods developed by Malecki and Trost (1990) (Bordage and Plante 1993). The objective of this survey is to monitor the status of the migrant population by estimating the number of breeding pairs. This report presents the results of the 1999 breeding grounds survey.

Acknowledgments: The 1999 breeding pair survey was cooperatively funded by the Canadian Wildlife Service (CWS), the U. S. Fish and Wildlife Service (USFWS), and the Atlantic Flyway Council. Jean Rodrigue (CWS) and Bill Harvey (MD DNR) served as observers. Jim Goldsberry (USFWS) served as pilot. The Makivik Corporation , provided logistical support. Others assisting in various phases of the survey included: Carol Peddicord (Wildlife Management Institute), Aliva Tulugak (Povungnituk), Kathryn

Dickson (CWS), Jack Hughes (CWS), Austin Reed (CWS), Michel Melancon (CWS), Jerry Serie (USFWS), Rich Malecki (USFWS), Alan Davenport (USFWS) and Larry Hindman (MD DNR).

STUDY AREA

The 1999 survey was conducted in northern Quebec, approximately north of 51° latitude and west of 67° longitude (Figure 1). The survey is stratified based on Malecki and Trost's (1990) modification of northern Quebec's ecoregions (Gilbert et al. 1985). The regions have been described by Malecki and Trost (1990) and Bordage and Plante (1993). Three regions comprise the area known as the Ungava Peninsula (Figure 1). Region 1 is comprised of inland tundra, with much of the surface covered by granitic bedrock. Region 2 consists mainly of flat coastal tundra, characterized by low relief and numerous ponds and lakes. Region 3 is taiga, with stunted black spruce and tamarack in protected valleys. Elevations range from 100 - 400m in region 1, 0 - 200 m in region 2, and 100-300m in region 3. The northern tip of the coastal zone from Ivujivik, southeast to about 150 km north of Kangirsuk, was excluded (Figure 1). Exploratory transects flown in 1993 indicated that few geese use this mountainous area.

Region 4, approximately bounded by 51° and 57° latitude, was sampled in 1988, 1993, and 1996. This region, comprised of boreal forest and taiga, has relatively low densities of nesting geese (Malecki and Trost 1990, Bordage and Plante 1993) and little annual variation in goose density (Reed and Hughes 1996). We plan to resample this region periodically.

METHODS

The survey followed the methodology of Malecki and Trost (1990). Aerial transects were flown in a Partenavia twin engine at an altitude of 30 m and a ground speed of approximately 140 km/h. Observers recorded the number of geese observed as singles, pairs, or in groups (3 or more geese) within 200 m of each side of the plane. Transect width was calibrated before the survey began. Observers also recorded

similar information for other waterfowl species. Coordinates for each location were generated using a global positioning system (GPS) and stored on a lap-top computer. Transects were flown using a GPS to assist with navigation.

Transects flown in 1999 were established in 1994 and repeated each year thereafter. Repeating transects allows differences between years to be detected more easily and aids in planning for aviation fuel needs. Total length of transects sampled in each region was determined using variance estimates from the 1993 survey and a target of 10% coefficient of variation (Bordage and Plante 1994). Transects were randomly located within regions until the desired length was reached. All transects were orientated along east-west lines (Figure 1).

The number of indicated breeding pairs on a given transect was the sum of the singles and pairs observed by both observers over the length of the transect. Density of breeding pairs within regions was estimated using quotient estimators while the total population density was estimated using a separate stratified quotient estimator (Cochran 1977). Variances were estimated using the jack-knife procedure (Cochran 1977). The significance of differences in population size between years was assessed with a z-test, using the sum of the sampling variances for the 2 years being compared. The estimates presented in this report are not adjusted for visibility bias and thus represent an index to the population.

Differences in survey timing (see Table 1 and Harvey and Rodrigue 1998) between 1999 and 1998 confounded comparisons to the prior year. Therefore, in several cases we compared the 1999 results to 1997, the most recent year with comparable results.

RESULTS

Habitat Conditions and Spring Phenology

Transects were sampled from June 12-17, similar to survey dates in 1993-98, but later than the

1988 survey (Table 1). Warm temperatures in late April and early May lead to a relatively early snowmelt in 1999 (Hughes and Reed 1999). In coastal habitat, most small ponds were ice-free and snow occurred only in occasional drift areas during the period of this survey. Larger ponds and lakes remained frozen or partly thawed. In coastal areas northwest of Kangirsuk, snow cover was more extensive and most ponds were frozen or partly thawed. Inland areas (Region 1) had little snow but most large ponds and lakes were frozen. Habitat conditions and plant chronology appeared to be similar along the Hudson and Ungava Bay coasts.

Breeding Pair and Total Population Estimates

The distribution of breeding and nonbreeding geese in 1999 was similar to previous years, with the highest densities occurring in the coastal zone, and particularly along the Hudson Bay coast (Tables 2-4). The estimated number of breeding pairs on the Ungava Peninsula (regions 1,2, and 3) increased in 1999 (77,451 pairs) from the 1997 estimate of 63,216 pairs. However, the difference was not statistically significant ($P = 0.187$) (Table 2, Figure 2). The number of indicated pairs increased on 21 transects and decreased on 14 transects compared to 1997. The number of breeding pairs in 1999 was greater than the estimate for 1994 (40,086 pairs), 1995 (29,302 pairs), 1996 (46,058 pairs) and 1998 (42,166) ($P < 0.001$), similar to 1993 (91,307 pairs)($P = 0.363$), but less than 1988 (118,031 pairs) ($P = 0.020$) (Table 2, Figure 2).

In region 1 (inland tundra), the number of breeding pairs in 1999 (32,912 pairs) was greater ($P < 0.05$) than in all years except 1993 , 1997 and 1998 ($P > 0.15$) (Table 3). The 1999 breeding pair estimate (33,546 pairs) for region 2 (coastal tundra) was greater ($P < 0.05$) than estimates for 1994 (20,917 pairs), 1995 (15,705 pairs), and 1998 (19,006 pairs), but less than estimates for 1988 (70,833 pairs) and 1993 (57,122 pairs) ($P < 0.005$) (Table 4). No difference in the number of breeding pairs was detected in region

3 (taiga) between 1999 (10,991 pairs) and any other year of the survey ($P > 0.05$) except 1996 (5,258 pairs, $P = 0.040$) (Table 5).

Nonbreeding geese increased on 22 transects, decreased on 12 transects, and remained the same on 1 transect in 1999 compared to 1997. The total population estimate ((indicated pairs x 2) + non-breeders) was greater in 1999 (428,039 individuals, SE = 72,688) than in all years (1993: 241,407 individuals, SE = 30,599; 1994: 258,332 individuals, SE = 48,504; 1995: 238,706 individuals, SE = 30,568; 1996: 251,094 individuals, SE = 22,038) ($P < 0.009$), except 1988 (348,950 individuals, SE = 69,879, $P = 0.219$), 1997 (392,956 individuals, SE = 52,112, $P = 0.384$) and 1998 (462,414 individuals, SE = 60,580, $P = 0.719$) (Figure 2).

Composition of Indicated Pairs

The number of indicated pairs includes birds recorded as pairs and singles. Single birds are likely to be males associated with an incubating female while pairs include some nesting birds as well as subadult or failed breeders. Therefore, the proportion of indicated pairs observed as singles may provide a more reliable indicator of the proportion of indicated pairs that are actually nesting (see Humburg et al. 1998). The percentage of indicated pairs observed as singles on the Ungava Peninsula was 49% in 1999, similar to the average for 1993-99 (mean = 52%, range = 43-60%) (Figure 3). In 1993, 1995 and 1999, the percentage of indicated pairs observed as singles was similar in the coastal zones (region 2) along Ungava Bay and Hudson Bay (Figure 3). In 4 of 7 years (1994, 1996, 1997, and 1998), the percentage of indicated pairs observed as singles was lower on the Ungava Bay coast than along Hudson Bay (Figure 3).

Comparison of Hudson and Ungava Bay Coasts

During 1993-99, the Hudson Bay coast supported an average of 81% (range = 74-84%) of the breeding pairs estimated for the coastal zone (region 2) and 44% (range = 39-48%) of the breeding pairs

on the Ungava Peninsula. In contrast, the Ungava Bay coast supported an average of 19% (range = 16-26%) of the breeding pairs in the coastal zone (region 2) and 10% (range = 7-16%) of the breeding pairs on the Ungava Peninsula. In 1999, the estimated number of breeding pairs increased 7% along Hudson Bay and decreased 2% on the Ungava Bay coast compared to 1997.

The Hudson Bay coast supported an average of 91% (range = 82-95%) of the nonbreeding geese estimated for the coastal zone and 67% (range = 51-90%) of the nonbreeding geese on the Ungava Peninsula. In contrast, the Ungava Bay coast supported an average of 9% (range = 5-18%) of the nonbreeding geese in the coastal zone (region 2) and 6% (range = 4-11%) of the nonbreeding geese on the Ungava Peninsula. The estimated number of nonbreeding geese in 1999 decreased 2% on the Hudson Bay coast (1997: 155,069 birds, 1999: 146,531) and decreased 12% along Ungava Bay (1997: 13,063 birds, 1999: 11,451) compared to 1997.

The proportion of total geese comprised of breeding pairs varied widely during 1993-99 in the Hudson and Ungava Bay portions of the coastal zone (Figure 6). However, in 6 of 7 years, a greater proportion of total geese were comprised of breeding pairs in the Ungava Bay portion of the coastal zone (Figure 6).

DISCUSSION

Number of Breeding Pairs

The estimated number of Canada goose pairs on the Ungava Peninsula increased 23% between 1997 and 1999. Data from field studies along Hudson and Ungava Bay also indicate slightly higher nest densities in 1999 compared to 1997 (Hughes and Reed 1999). Given the poor gosling production that occurred during the mid-1990s, rapid growth of the breeding population was not expected.

Habitat conditions at the time of the survey appeared to be favorable, although not as advanced as in 1998. Findings from intensive nesting studies indicate clutch sizes were smaller than in the 1998 (a year with an extremely early spring) but larger than 1996 (a year with a relatively late spring) (Hughes and Reed 1999). Unlike previous years, nest predation, mainly by arctic foxes, was much more apparent along the Hudson Bay coast. Rates of nest success decreased from 80-85% in 1997 and 1998 to about 60% in 1999 (Hughes and Reed 1999). Overall, we expect good production in 1999, resulting from a somewhat larger breeding population and above-average clutch sizes, tempered by lower rates of nest success.

Total Population

Although breeding population estimates declined from 1988 until 1995, total population estimates changed little, particularly between 1993 and 1996. However, the total population estimate increased markedly in 1997 (Figure 2). Growth of the total population estimate in recent years probably reflects, in part, the good production years of 1997 and 1998. However, extreme caution should be used when interpreting the estimate of total population size. Total population estimates include breeding pairs, non-breeders (i.e., those not of breeding age), failed breeders, and molt migrants from other areas. This survey is designed to estimate the number of breeding pairs during mid to late incubation. We have little knowledge on which to base an assessment of the total population estimate. Numerous factors including survey timing and the arrival dates of molt migrants from other areas and populations can affect the estimate of total population size. Abraham et al. (1999) recently examined molt migration in the breeding range of the Southern James Bay Population of Canada geese. They cautioned that the presence of molt migrants is likely to bias total population estimates upwards. Therefore, they concluded that estimates of nesting pairs may provide the most reliable information for monitoring trends in breeding ground populations.

Hudson Bay and Ungava Bay Coasts

The coastal habitat bordering Hudson Bay and Ungava Bay is well known for its high density of breeding Canada geese (Malecki and Trost 1990). However, separate estimates of the goose populations associated with each coast illustrate that Hudson Bay supports a much larger breeding population than Ungava Bay. The smaller breeding population along the Ungava Bay coast is primarily a function of less land area (Ungava Bay: 9,700 km^2; Hudson Bay: 33,800 km^2) and a somewhat lower density of breeding pairs. This pattern was evident again in 1999. Furthermore, in 4 of 7 years, the percentage of indicated pairs observed as singles has been higher along Hudson Bay compared to Ungava Bay, indicating that productivity may also vary between these areas (see Humburg et al. 1998).

The distribution of band recoveries is quite different for geese banded on the Hudson Bay and Ungava Bay coasts. While geese from both coasts winter in the Chesapeake Bay region, they appear to have different migration corridors (Figures 7 and 8). Recoveries of geese banded as immatures on both coasts occur all most entirely in the Atlantic Flyway (Figures 7 and 8), demonstrating that nesting birds from both areas are associated with the AP. Recoveries of geese banded along Ungava Bay as adults occurred mainly in the Atlantic Flyway (Figure 8). In contrast, recoveries of geese banded along Hudson Bay as adults are widely distributed through both the Atlantic and Mississippi Flyways (Figure 7). This information suggests the presence of molt migrants from other populations (e.g., Mississippi Valley Population) along the Hudson Bay coast that are not present along Ungava Bay. The difference may be partly a function of banding effort. In the 1960's, groups of nonbreeding geese were marked along Hudson Bay (Malecki and Trost 1990). Most banding along Ungava Bay and recent banding along Hudson Bay has focused on groups containing young (R. A. Malecki, pers. comm.). Overall, 80% of the geese banded on the Hudson Bay coast were adults compared to 57% of the geese banded along Ungava Bay.

Information from our survey is consistent with the distribution of band recoveries that suggests molt migrants from other populations use the Hudson Bay coast but are not present or are less numerous along Ungava Bay. In most years, nonbreeding geese are much more abundant, both numerically, and relative to number of breeding pairs along Hudson Bay (Figures 4 and 5) than on the Ungava Bay coast. Morphological measurements of geese killed by Inuit hunters near Povungnituk on the Hudson Bay coast suggest that resident geese may comprise a substantial portion of the geese harvested in this area. In contrast, preliminary information suggests that few geese shot by Inuit hunters near Kuujjuaq (southern Ungava Bay) are large enough to be considered resident birds (Hughes et al. 1997). At this time, we have no information to indicate that geese utilizing Ungava Bay include large numbers of birds from populations other than the Atlantic Population. Abraham et al. (1999) recommended studies to assess feeding or interference competition between molt migrants and breeding geese. On the Ungava Peninsula, these potential problems are more likely to occur along the Hudson Bay coast.

We recommend that monitoring of productivity and population size should consider the Hudson and Ungava Bay coasts separately. Given the small breeding population associated with Ungava Bay relative to Hudson Bay, the potential for different productivity in some years, and the possibility of different migration (and therefore harvest) patterns, combining both areas may mask important changes, particularly along Ungava Bay. Furthermore, other factors, such as feeding or interference competition between molt migrants and breeding geese (Abraham et al. 1999), may be more important along one coast or the other. It may be necessary to adjust survey coverage to obtain estimates along each coast with an acceptable level of precision.

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Table 1. Dates of Canada goose pair surveys conducted in northern Quebec[1] in 1988 and 1993-99.

Year	Survey Date	Peak Hatch Date - Hudson Bay[2]	Peak Hatch Date - Ungava Bay[2]
1988	23 May - 3 June		
1993	11-21 June		
1994	21 June - 1 July		
1995	18-24 June		
1996	17-25 June	7 July	2 July
1997	21-26 June	29 June	23 June
1998	20-27 June	20 June	22 June
1999	12-17 June	24 June	26 June

[1] In 1988, 1993, and 1996, the boreal forest was surveyed prior to the Ungava Peninsula.
[2] Peak hatching dates on Ungava Peninsula from Reed and Hughes (1996), Reed and Hughes (1997), Hughes and Reed (1998) and Hughes and Reed (1999).

Table 2. Number of Canada goose breeding pairs estimated for the Ungava Peninsula (regions 1,2 and 3) of northern Quebec.

YEAR[a]	TOTAL AREA (km^2)	SURVEYED AREA (km^2)	n[b]	PAIR /km^2 (SE)	TOTAL PAIRS (SE)
1988	222700	575	16	0.53 (0.068)	118031 (15144)
1993	222700	838	35	0.41 (0.056)	91307 (12471)
1994	222700	1214	36	0.18 (0.020)	40086 (4454)
1995	222700	1211	36	0.13 (0.013)	29302 (2967)
1996	222700	1211	36	0.21 (0.023)	46058 (5052)
1997	222700	1239	36	0.28 (0.028)	63216 (6201)
1998	222700	1214	36	0.19 (0.023)	42166 (5009)
1999	222700	1208	35	0.35 (0.040)	77451 (8792)

[a]1988 (Malecki and Trost 1990); 1993 (Bordage and Plante 1993); 1994 (Harvey 1994); 1995 (Harvey and Bourget 1995); 1996 (Harvey and Borget 1996); 1997 (Harvey and Bourget 1997); 1998 (Harvey and Rodrigue 1998); 1999 (this report).

[b] Number of transects.

Table 3. Number of Canada goose breeding pairs estimated for the inland tundra (region 1) on the Ungava Peninsula of northern Quebec.

YEAR[a]	TOTAL AREA (km^2)	SURVEYED AREA (km^2)	n[b]	PAIR /km^2 (SE)	TOTAL PAIRS (SE)
1988	116000	285	6	0.30 (0.084)	35016 (9744)
1993	116000	242	4	0.16 (0.063)	18185 (7308)
1994	116000	458	11	0.09 (0.022)	10633 (2542)
1995	116000	458	11	0.07 (0.014)	8101 (1635)
1996	116000	458	11	0.13 (0.034)	14941 (3956)
1997	116000	458	11	0.19 (0.029)	21772 (3398)
1998	116000	458	11	0.14 (0.033)	16709 (3769)
1999	116000	458	11	0.28 (0.062)	32912 (7223)

[a]1988 (Malecki and Trost 1990); 1993 (Bordage and Plante 1993); 1994 (Harvey 1994); 1995 (Harvey and Bourget 1995); 1996 (Harvey and Borget 1996); 1997 (Harvey and Bourget 1997); 1998 (Harvey and Rodrigue 1998); 1999 (this report).

[b] Number of transects.

Table 4. Number of Canada goose breeding pairs estimated for the coastal tundra (region 2) on the Ungava Peninsula of northern Quebec.

YEAR[a]	TOTAL AREA (km^2)	SURVEYED AREA (km^2)	n[b]	PAIR /km^2 (SE)	TOTAL PAIRS (SE)
1988	43500	119	7	1.63 (0.245)	70833 (10658)
1993	43500	420	25	1.31 (0.166)	57122 (7221)
1994	43500	491	21	0.48 (0.062)	20917 (2692)
1995	43500	488	21	0.36 (0.041)	15705 (1799)
1996	43500	488	21	0.60 (0.067)	25865 (2928)
1997	43500	491	21	0.74 (0.099)	32301 (4298)
1998	43500	491	21	0.44 (0.067)	19006 (2986)
1999	43500	485	20	0.77 (0.099)	33546 (4323)

[a]1988 (Malecki and Trost 1990); 1993 (Bordage and Plante 1993); 1994 (Harvey 1994); 1995 (Harvey and Bourget 1995); 1996 (Harvey and Borget 1996); 1997 (Harvey and Bourget 1997); 1998 (Harvey and Rodrigue 1998); 1999 (this report).

[b] Number of transects.

Table 5. Number of Canada goose breeding pairs estimated for the taiga (region 3) on the Ungava Peninsula of northern Quebec.

YEAR[a]	TOTAL AREA (km^2)	SURVEYED AREA (km^2)	n[b]	PAIR /km^2 (SE)	TOTAL PAIRS (SE)
1988	63200	171	3	0.18 (0.067)	11491 (4253)
1993	63200	176	6	0.26 (0.110)	16432 (6952)
1994	63200	265	4	0.13 (0.038)	8124 (2421)
1995	63200	265	4	0.09 (0.027)	5496 (1702)
1996	63200	265	4	0.08 (0.018)	5258 (1165)
1997	63200	290	4	0.15 (0.046)	9144 (2906)
1998	63200	265	4	0.10 (0.022)	6452 (1402)
1999	63200	265	4	0.17 (0.040)	10991(2537)

[a]1988 (Malecki and Trost 1990); 1993 (Bordage and Plante 1993); 1994 (Harvey 1994); 1995 (Harvey and Bourget 1995); 1996 (Harvey and Borget 1996); 1997 (Harvey and Bourget 1997); 1998 (Harvey and Rodrigue 1998); 1999 (this report).

[b] Number of transects.

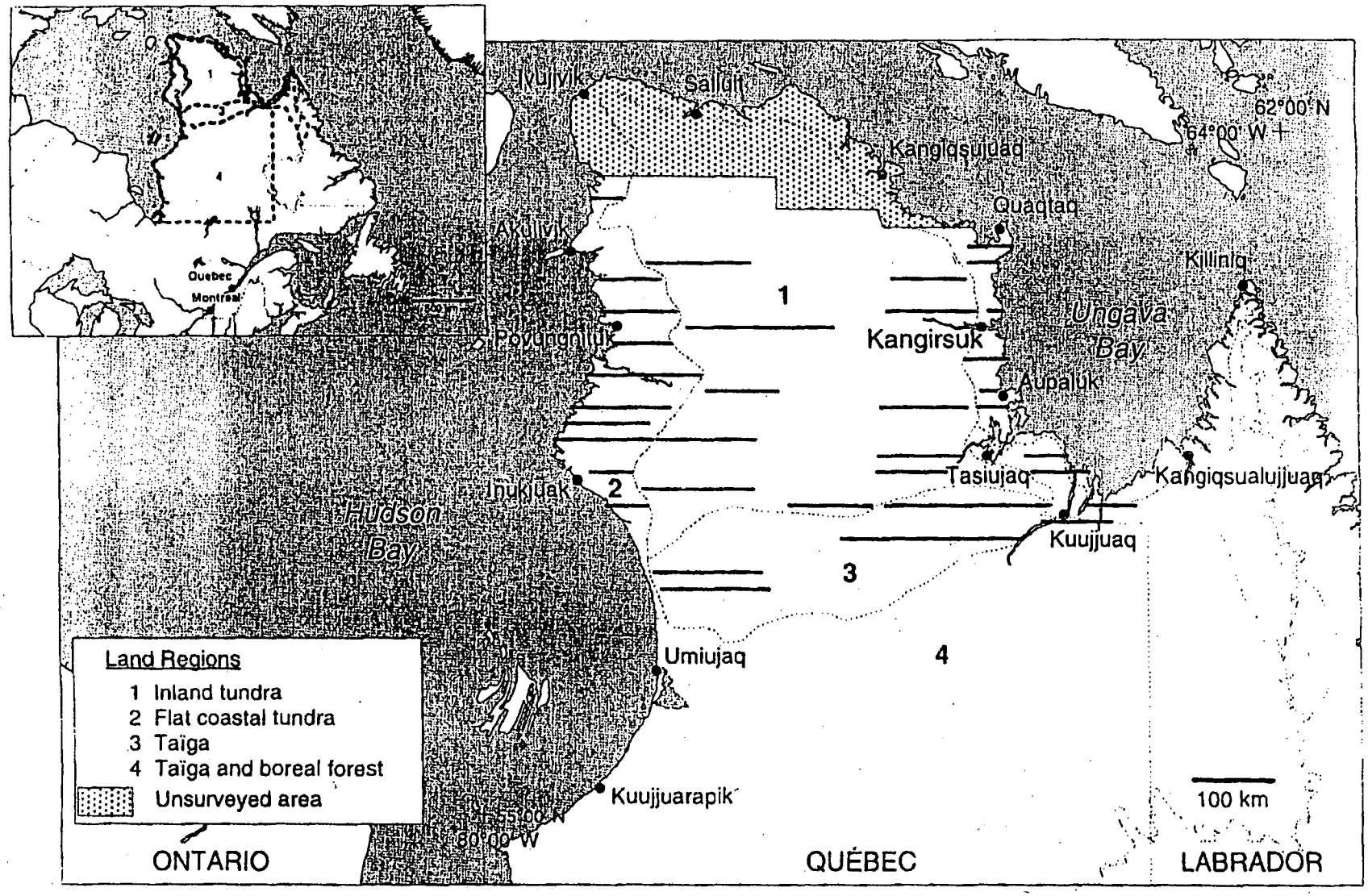

Figure 1. Study area and location of transects for 1999 breeding pair survey in northern Quebec.

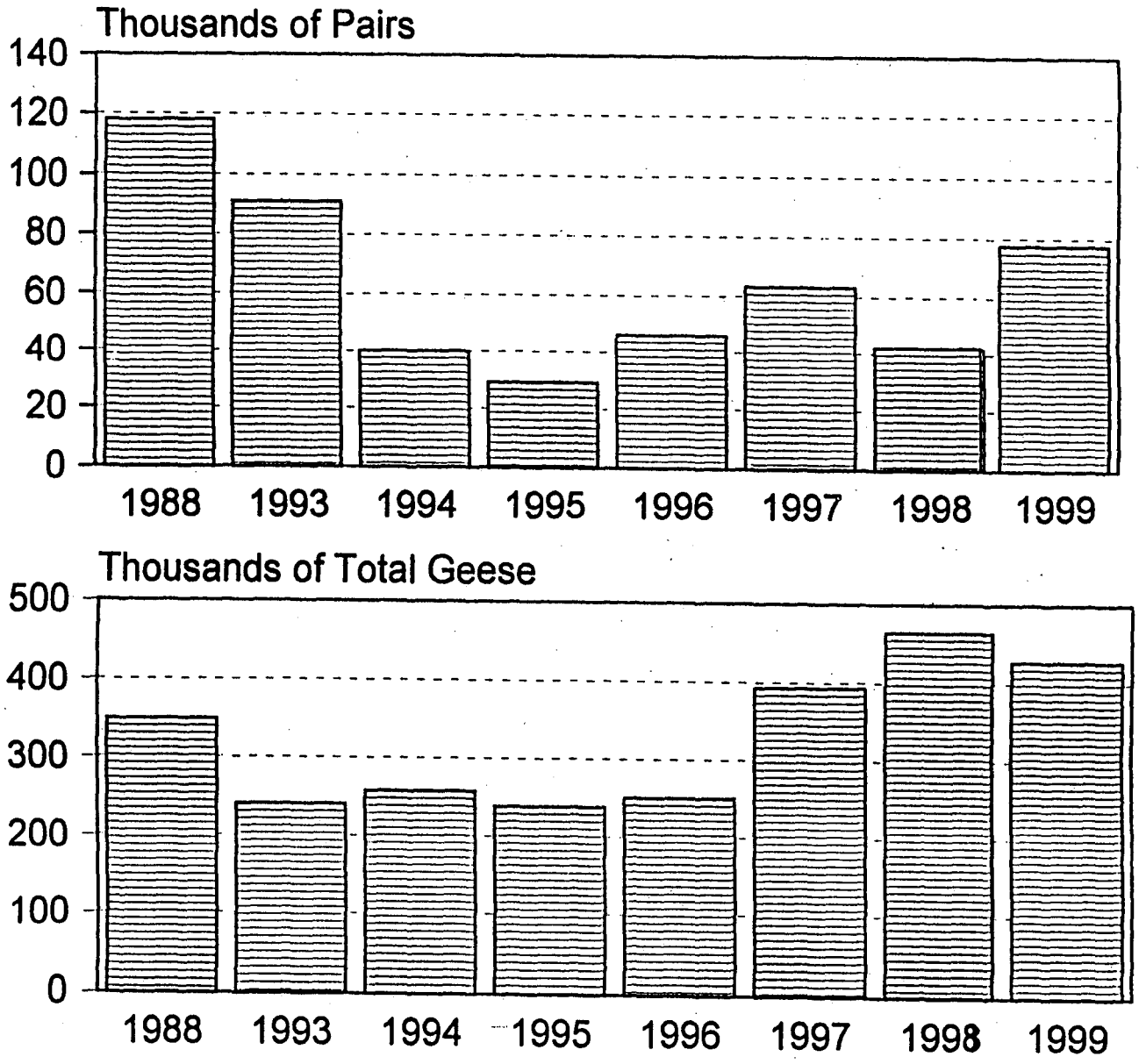

Figure 2. Estimated number of Canada goose breeding pairs and total geese on the Ungava Peninsula of northern Quebec during 1988 and 1993-99.

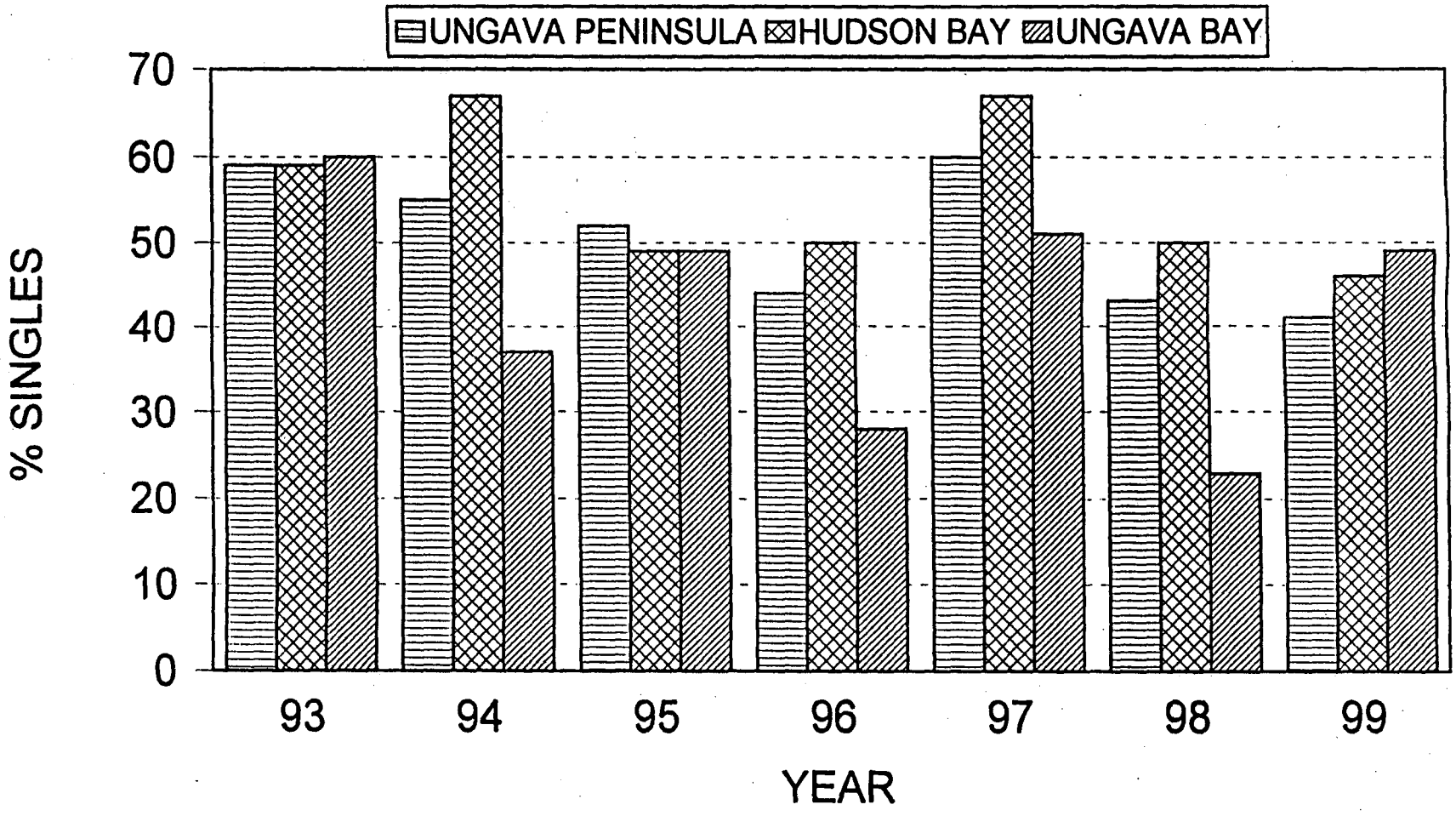

Figure 3. Percent of indicated Canada goose pairs (i.e., singles and pairs) that were observed as singles on the Ungava Peninsula and the coastal zones along Ungava Bay and Hudson Bay in 1993-99.

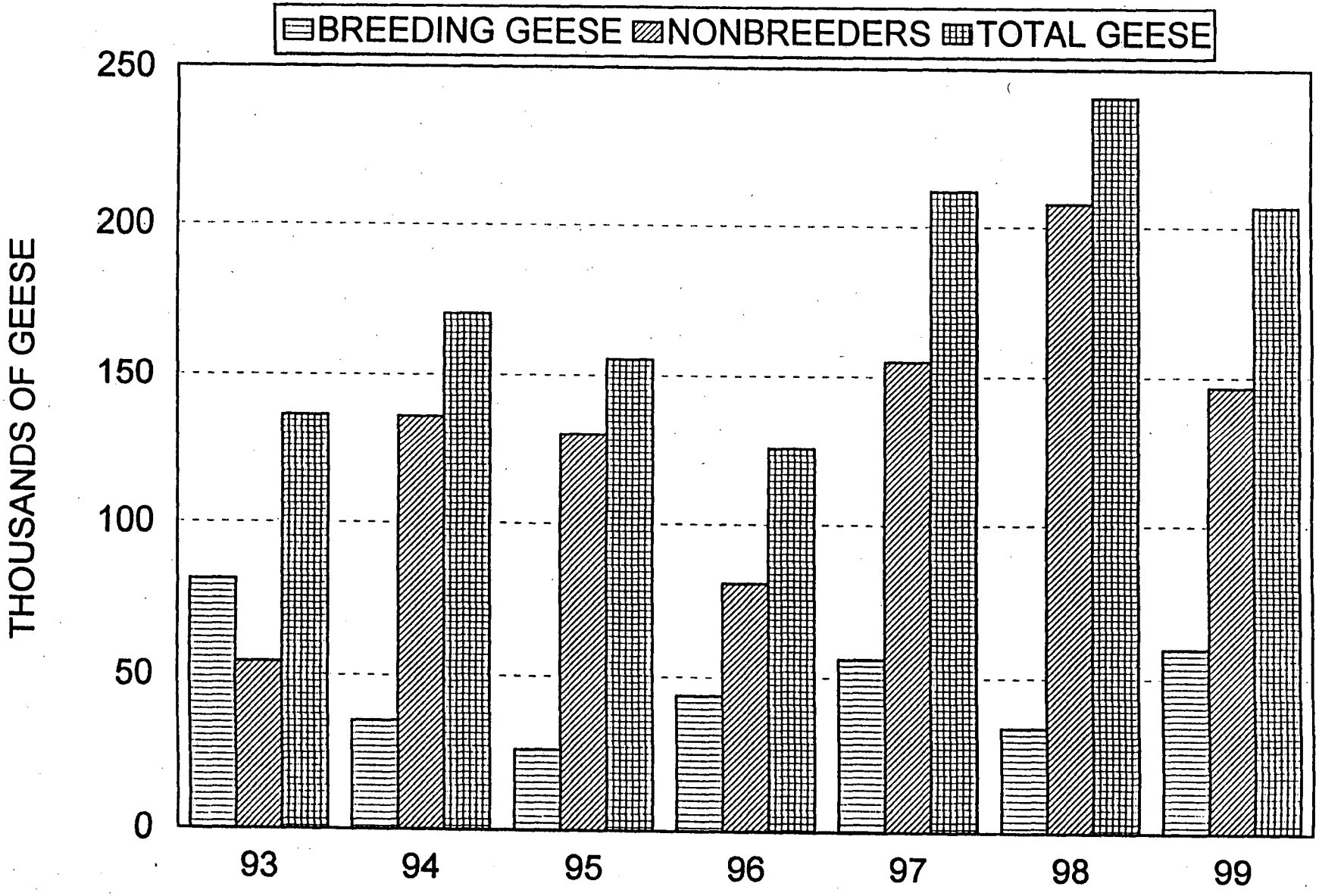

Figure 4. Estimated number of Canada goose breeding pairs, nonbreeding geese, and total geese in the coastal zone along Hudson Bay in 1993-99.

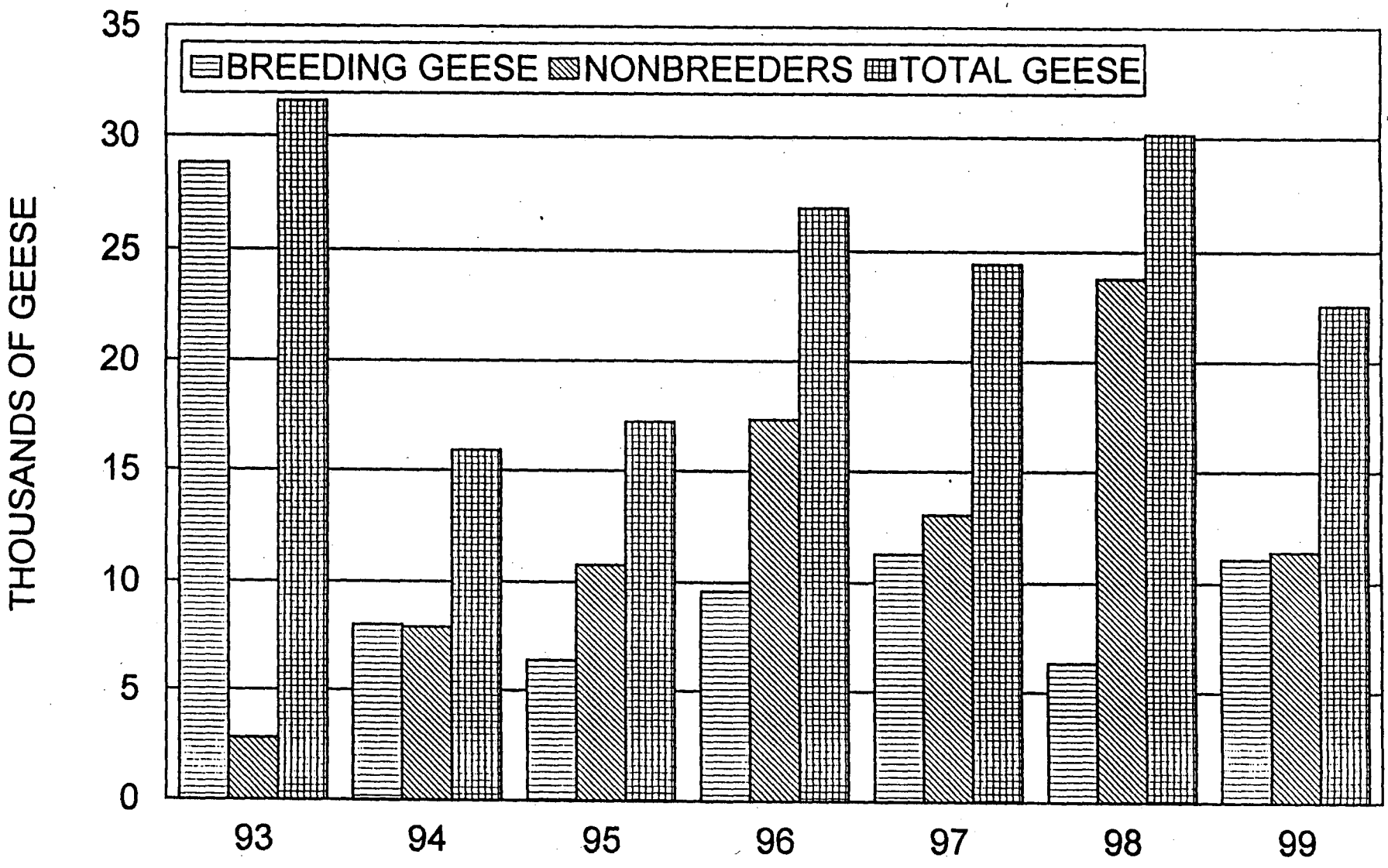

Figure 5. Estimated number of Canada goose breeding pairs, nonbreeding geese, and total geese in the coastal zone along Ungava Bay in 1993-99.

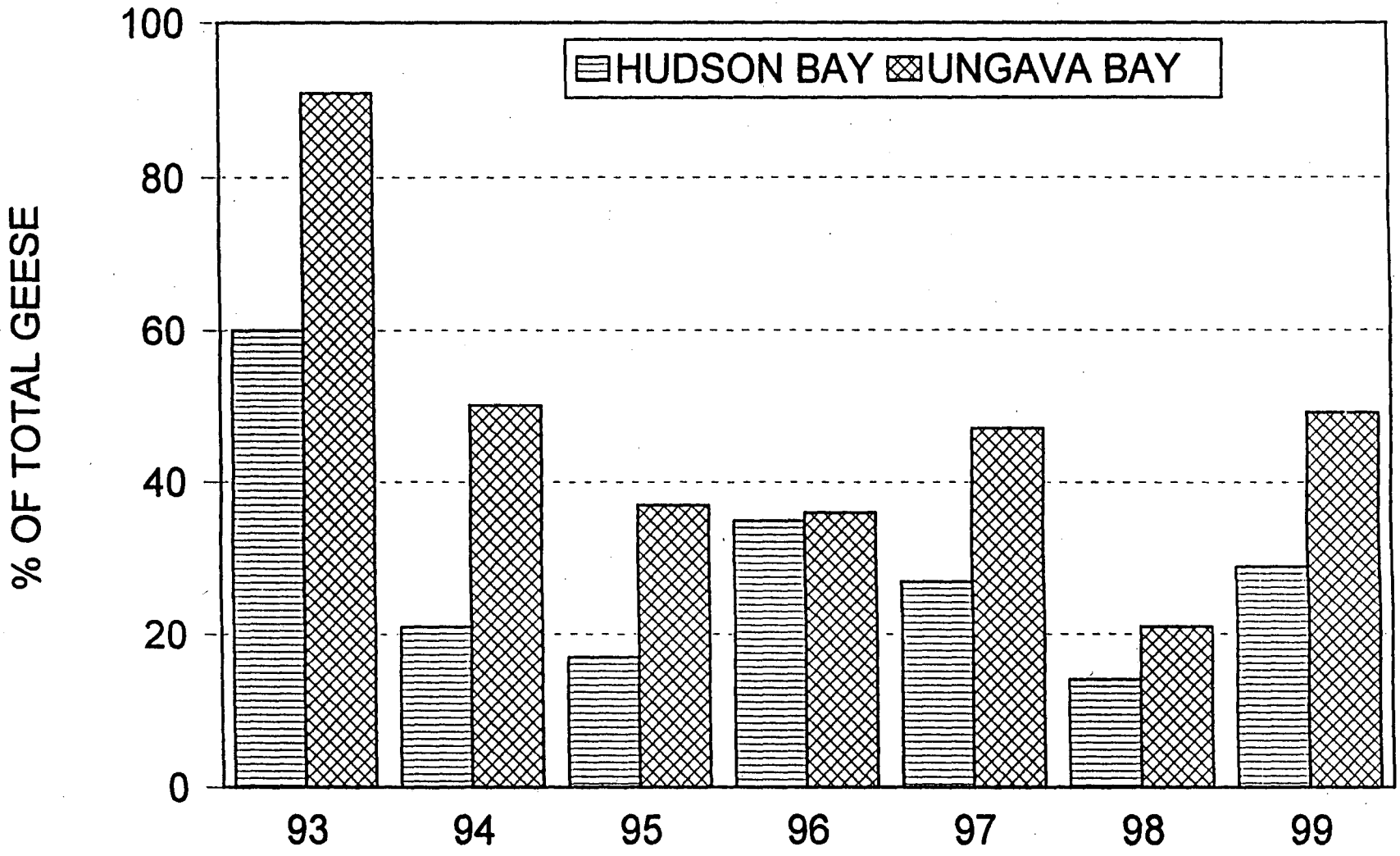

Figure 6. Percent of total Canada geese estimated for the coastal zones along Ungava Bay and Hudson Bay that were breeding pairs in 1993-99.

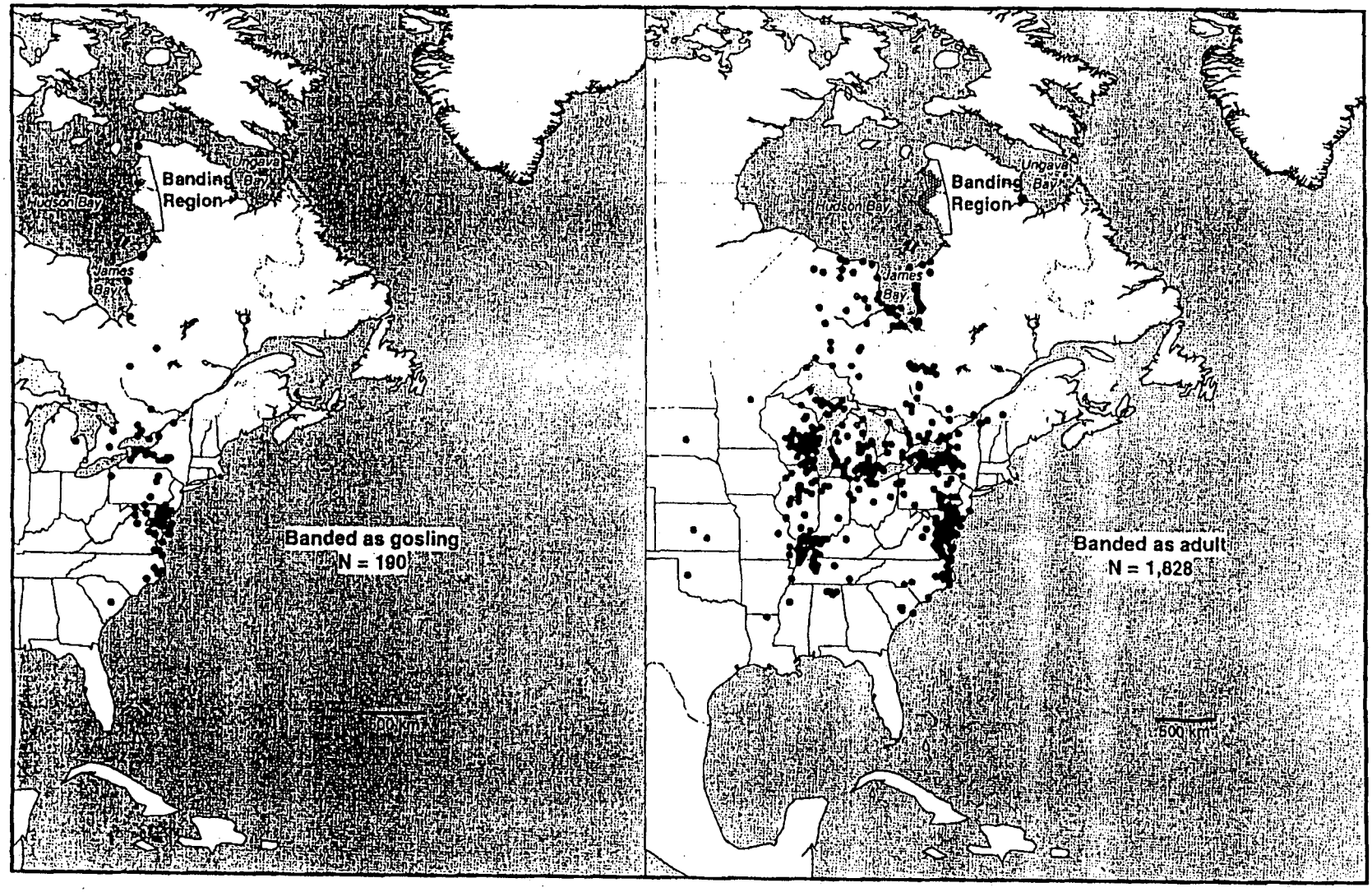

Figure 7. Distribution of recoveries for Canada geese banded as goslings (map on left) and adults (map on right) on the Hudson Bay coast.

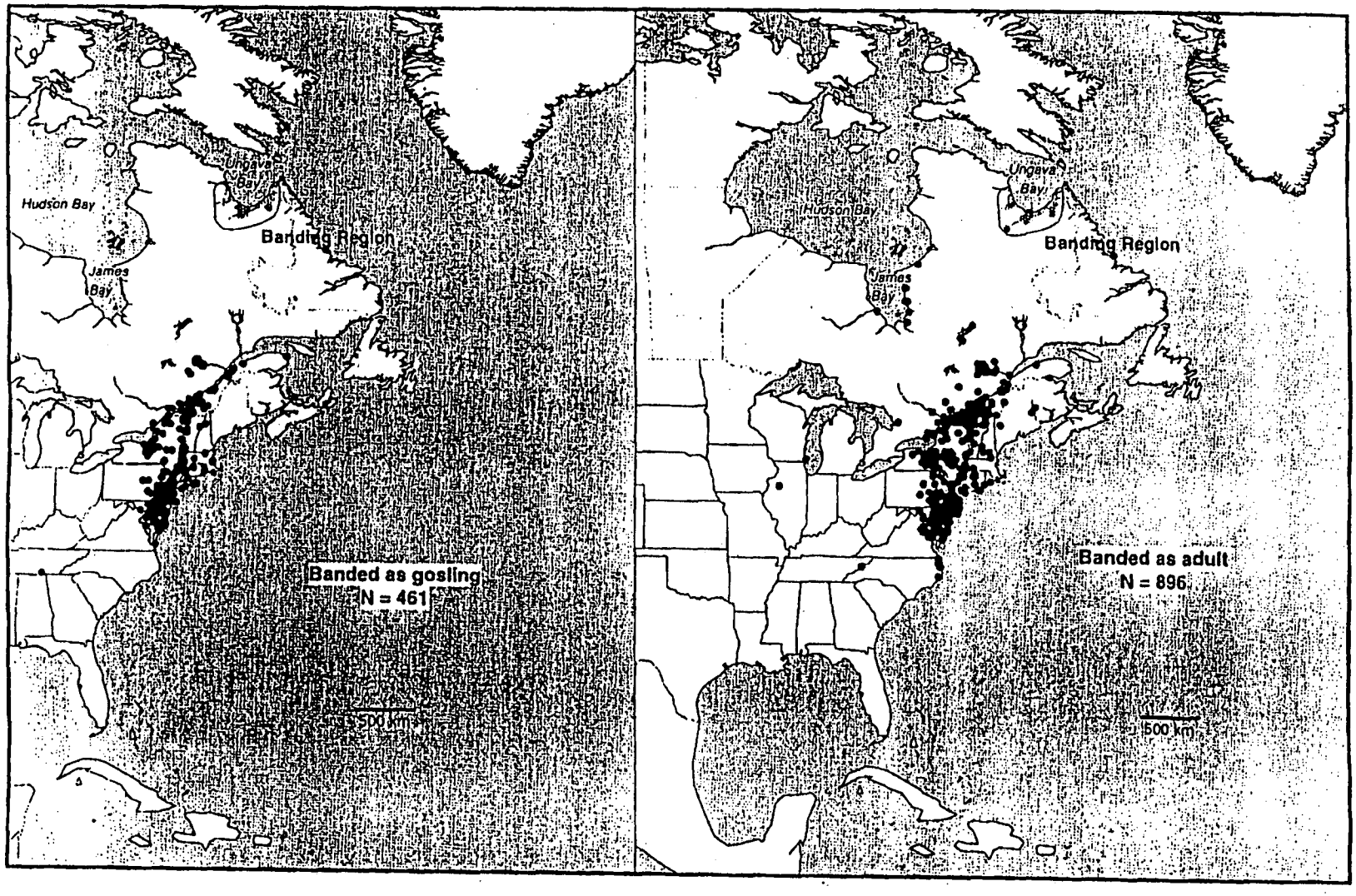

Figure 8. Distribution of recoveries for Canada geese banded as goslings (map on left) and adults (map on right) on the Ungava Bay coast.