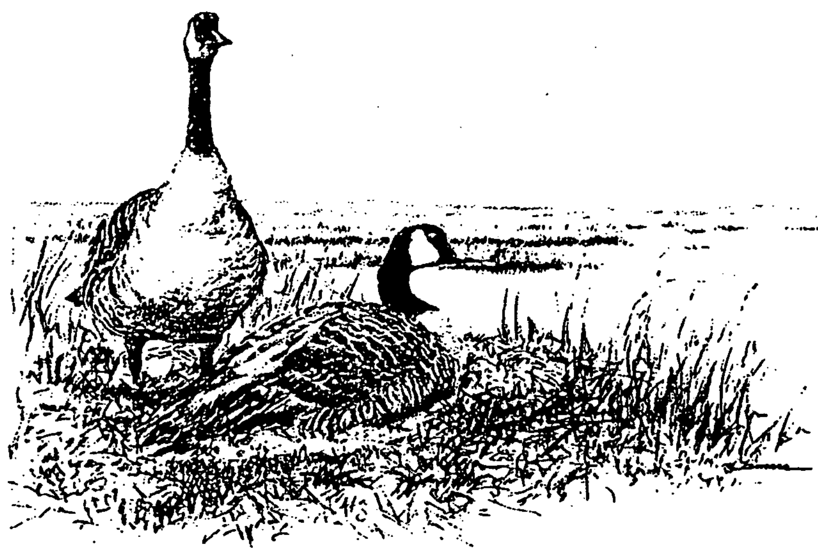
A BREEDING PAIR SURVEY OF CANADA GEESE IN NORTHERN QUEBEC - 2001



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INTRODUCTION

Status of Canada geese (Branta canadensis) in the Atlantic flyway was traditionally 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 2001 breeding grounds survey.

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STUDY AREA

The 2001 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 - 400 m in region 1, 0 - 200 m in region 2, and 100-300 m 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.

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. We occasionally observed multiple pairs of geese in close association (< 10-15 m apart). We classified these geese as grouped birds, since they were unlikely to be associated with a territory. 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. Transect width was calibrated before the survey began.

Transects flown in 2001 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.

RESULTS

Habitat Conditions and Spring Phenology

Transects were surveyed from June 11-23. These dates are similar to surveys conducted during 1993-2000, but later than the 1988 survey (Table 1). Weather delays and the approach of the peak hatching period prevented us from surveying 3 transects in region 2 and 2 transects in region 1. One pair with a brood was observed in 2001. Warm temperatures in late April and May lead to an early snowmelt in 2001 (Hughes and Reed 2001). Inland areas had little snow and nearly all ponds and lakes were open during the survey. In coastal habitat along Ungava Bay, south of Kangirsuk, all ponds and lakes were ice-free and snow was completely gone. However, northwest of Kangirsuk, snow cover was more extensive and many ponds were partly frozen. Along Hudson Bay, all ponds were free of ice and vegetation growth was advanced.

Breeding Pair and Total Population Estimates

The distribution of breeding and nonbreeding geese in 2001 was similar to previous years, with the highest densities occurring in the coastal zone (Tables 2-4). The estimated number of breeding pairs on the Ungava Peninsula (regions 1,2, and 3) increased in 2001 (146,662 pairs) from the 2000 estimate of 93,230 pairs ($P = 0.005$) (Table 2, Figure 2). The number of indicated pairs increased on 23 transects, decreased on 4 transects and was the same on 1 transect compared to 2000. The estimated number of breeding pairs in 2001 was greater than in all previous years ($P \leq 0.007$), except 1988 ($P = 0.197$) (Table 2, Figure 2).

Nonbreeding geese increased on 13 transects and decreased on 16 transects in 2001 compared to 2000. The total population estimate ((indicated pairs x 2) + non-breeders) was greater in 2001 (636,955 individuals, SE = 84,920) than in all years (1988: 348,950 individuals, SE = 69,879; 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; 1997: 392,956 individuals, SE = 52,112) ($P < 0.014$), except 1998 (462,414 individuals, SE = 60,580, $P = 0.095$), 1999 (428,039 individuals, SE = 72,688, $P = 0.061$) and 2000 (641,671 individuals, SE = 85,735, $P = 0.968$) (Figure 2). <u>(Note: see discussion for interpretation of total population estimates</u>).

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 56% in 2001, above the 1993-2001 average of 51% (range = 43-60%) (Figure 3).

Comparison of Hudson and Ungava Bay Coasts

During 1993-2001, the Hudson Bay coast supported an average of 81% (range = 71-88%) of the breeding pairs estimated for the coastal zone (region 2) and 43% (range = 28-52%) of the breeding pairs on the Ungava Peninsula. In contrast, the Ungava Bay coast supported an average of 19% (range = 12-29%) of the breeding pairs in the coastal zone (region 2) and 10% (range = 7-16%) of the breeding pairs on the Ungava Peninsula. In 2001, the estimated number of breeding pairs increased 199% along Hudson Bay and increased 1% on the Ungava Bay coast compared to 2000.

During 1993-2001, the Hudson Bay coast supported an average of 92% (range = 82-95%) of the nonbreeding geese estimated for the coastal zone and 68% (range = 51-90%) of the nonbreeding geese on the Ungava Peninsula. In contrast, the Ungava Bay coast supported an average of 8% (range = 5-18%) of the nonbreeding geese in the coastal zone (region 2) and 6% (range = 3-11%) of the nonbreeding geese on the Ungava Peninsula. The estimated number of nonbreeding geese in 2001decreased 20% on the Hudson Bay coast (2000: 323,744; 2001:258,570) and increased 16% along Ungava Bay (2000: 15,342; 2001: 17,751) compared to 2000.

In 1993, 1995, 1999, and 2000, the percentage of indicated pairs observed as singles was similar in the coastal zones (region 2) along Ungava Bay and Hudson Bay (Figure 3). However, in 5 of 9 years (1994, 1996, 1997, 1998, and 2001), the percentage of indicated pairs observed as singles was lower on the Ungava Bay coast than along Hudson Bay (Figure 3).

DISCUSSION

Number of Breeding Pairs

The estimated number of Canada goose pairs on the Ungava Peninsula increased 57% between 2000 and 2001. An increase in the density of breeding pairs was expected this year, as the young produced in 1997 (a good production year) and 1998 (a very good production year) begin to enter the breeding population. The increase was particularly large along the Hudson Bay coast, where pair densities were nearly triple the level observed in 2000. In 2000, June snowstorms along the Hudson Bay coast combined with a late spring to cause low rates of nesting and large-scale nest abandonment (Hughes and Reed 2000). The late storms did not affect the Ungava Bay coast. Many pairs had failed and entered molting flocks by the time our survey was conducted along Hudson Bay in 2000. Therefore, in 2001, new breeding pairs from both the 1997 and 1998 year classes were likely being observed on our survey for the first time in the Hudson Bay area.

Overall, the percent of indicated pairs observed as singles (a better measure of the pairs actually nesting) in 2001 was among the highest recorded since 1993, suggesting that many of the pairs we observed were attending nests. This finding is consistent with the warm spring weather that lead to early nest initiation. Furthermore, high nest densities, average clutch sizes and high nest success on Hudson Bay and Ungava Bay study plots also suggest excellent gosling production (J. Hughes, pers. comm.). The combination of high pair densities and excellent productivity should lead to a large fall flight and continued growth of the AP.

Total Population

The total population estimate for 2001 was similar to the previous year (Figure 2), probably reflecting the low recruitment that occurred in 2000. Likewise, growth of the total population estimate in recent years probably reflects, in part, the good production years of 1997-1999. 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. Flocks of geese moving north (likely molt migrants) were very abundant along the Hudson Bay coast while we were conducting the survey this year. 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. Factors including survey timing and the arrival dates of molt migrants from other areas and populations can dramatically 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 in most years. Furthermore, in 5 of 9 years, the percentage of indicated pairs observed as singles has been higher along Hudson Bay compared to Ungava Bay (in the other years, the percentage was similar between the 2 areas), indicating that average 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 4 and 5). Recoveries of geese banded as immatures on both coasts occur all most entirely in the Atlantic Flyway (Figures 4 and 5), 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 5). In contrast, recoveries of geese banded along Hudson Bay as adults are widely distributed through both the Atlantic and Mississippi Flyways (Figure 4). 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 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 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 1993-2001.

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
2000	14-27 June	30 June	30 June
2001	11-23 June	24 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), Hughes and Reed (1999), Hughes and Reed (2000), J. Hughes (pers. comm.).

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 (km²)	SURVEYED AREA (km²)	n[b]	PAIR /km² (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)
2000	222700	1107	34	0.42 (0.044)	93230 (9850)
2001	222700	1029	31	0.66 (0.073)	146662 (16185)

[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 (Harvey and Rodrigue 1999); 2000 (Harvey and Rodrigue 2000); (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 (km²)	SURVEYED AREA (km²)	n[b]	PAIR /km² (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)
2000	116000	458	11	0.25 (0.034)	28608 (3986)
2001	116000	361	9	0.46 (0.075)	52961 (8651)

[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 (Harvey and Rodrigue 1999); 2000 (Harvey and Rodrigue 2000) 2001(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)
2000	43500	488	21	0.88 (0.132)	38369 (5735)
2001	43500	404	18	1.77 (0.293)	76974 (12762)

[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 (Harvey and Rodrigue 1999); 2000 (Harvey and Rodrigue 2000); 2001 (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)
2000	63200	161	2	0.42 (0.110)	26252 (6946)
2001	63200	265	4	0.27 (0.078)	16726 (4922)

[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 (Harvey and Rodrigue 1999); 2000 (Harvey and Rodrigue 2000; 2001 (this report).

[b] Number of transects.

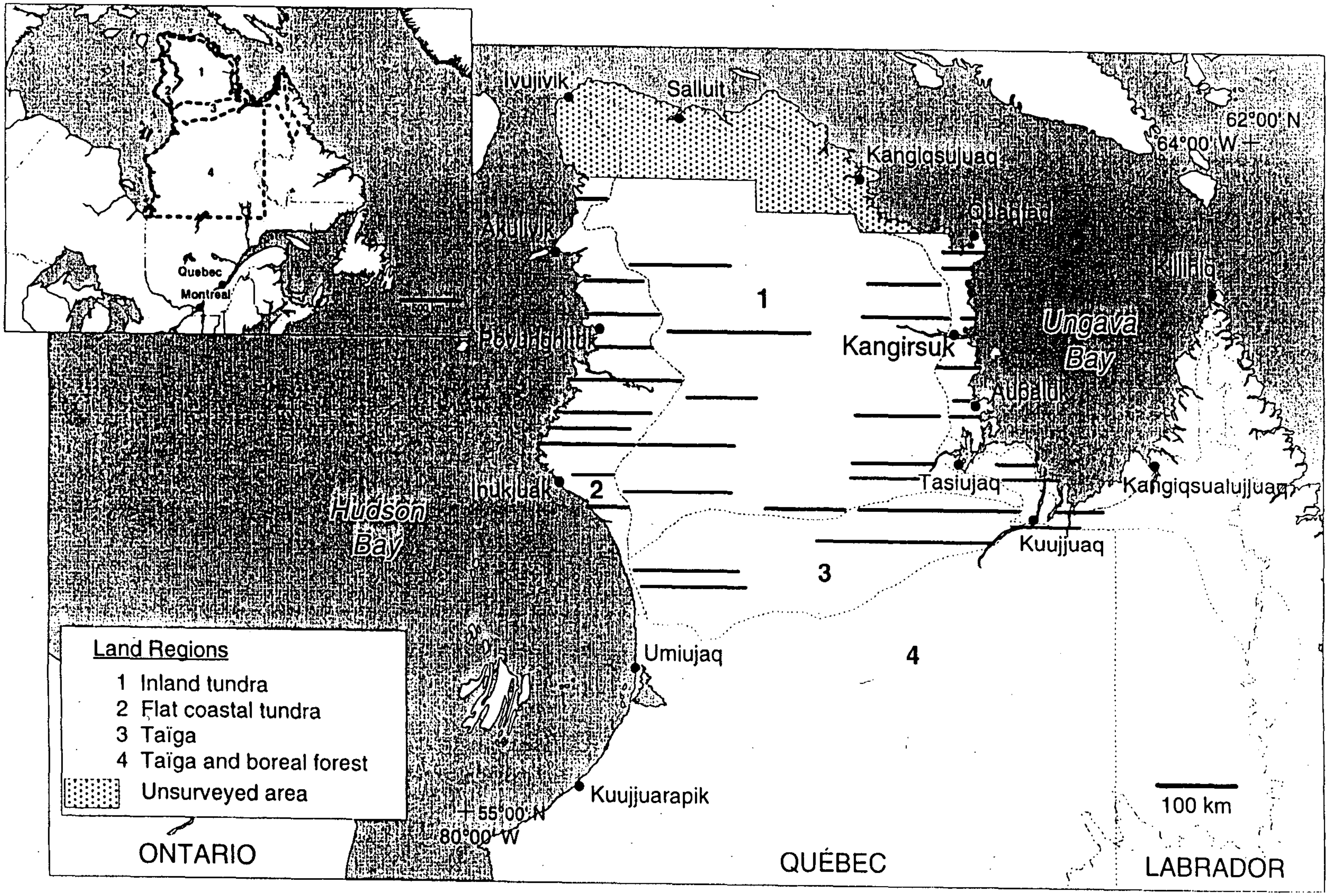

Figure 1. Study area and location of transects for 2001 breeding pair survey in northern Quebec.

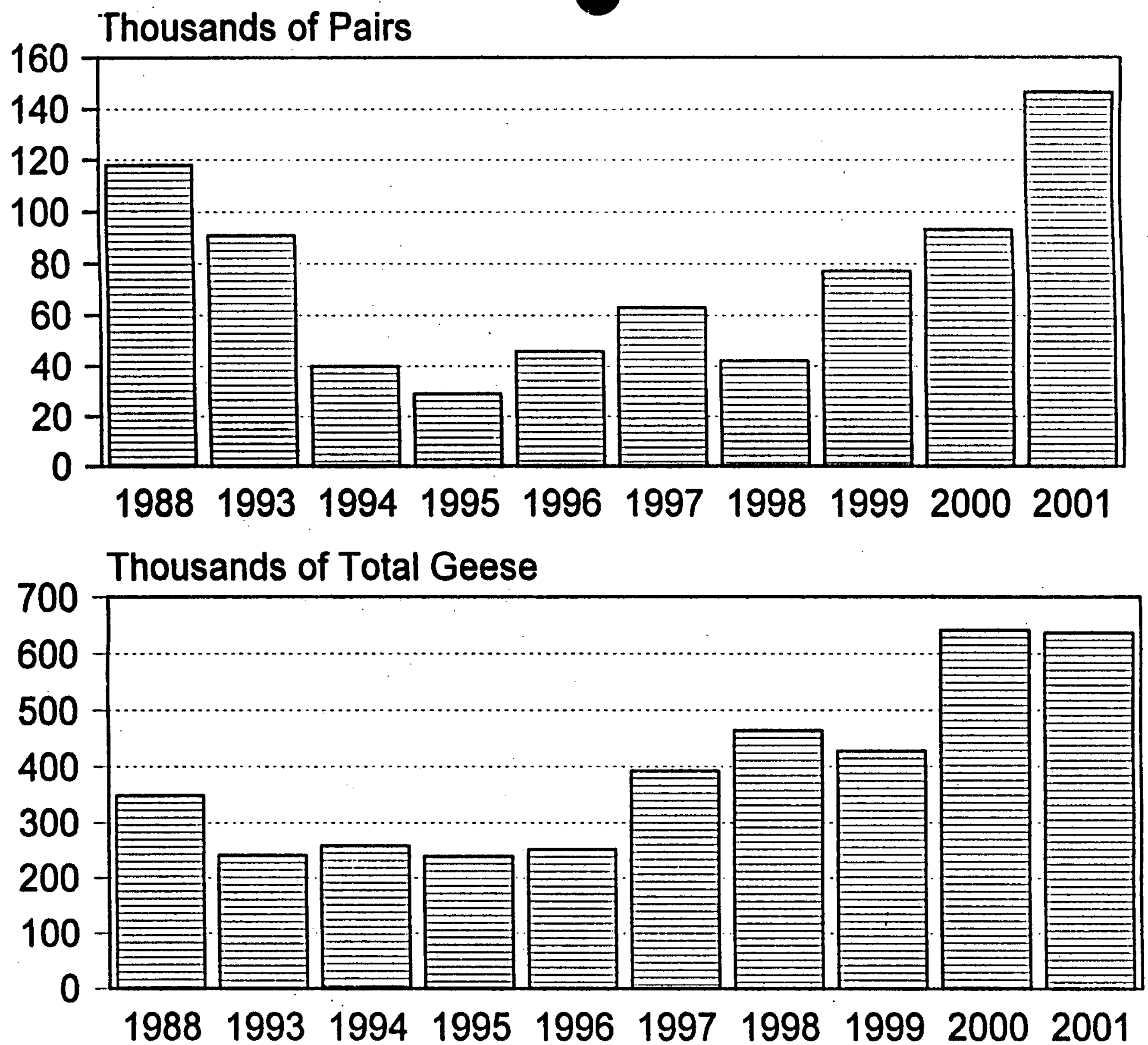

Figure 2. Estimated number of Canada goose breeding pairs and total geese on the Ungava Peninsula of northern Quebec during 1988 and 1993-2001.

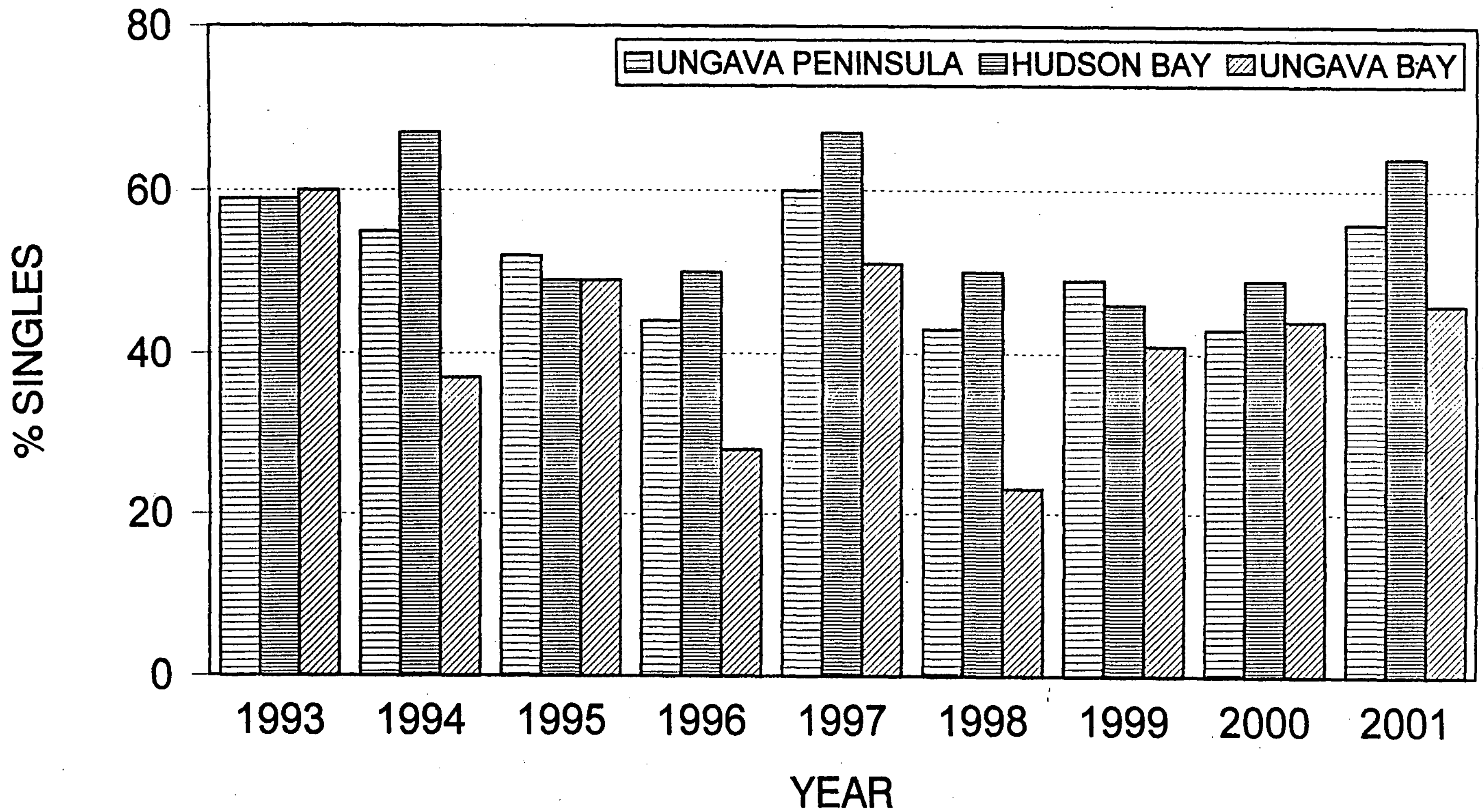

Figure 3. Percent of indicated Canada goose pairs (i.e., singles and pairs) that were observed as singles on the Ungava Peninsula and the coastal zones along Ungava Bay and Hudson Bay in 1993-2001.

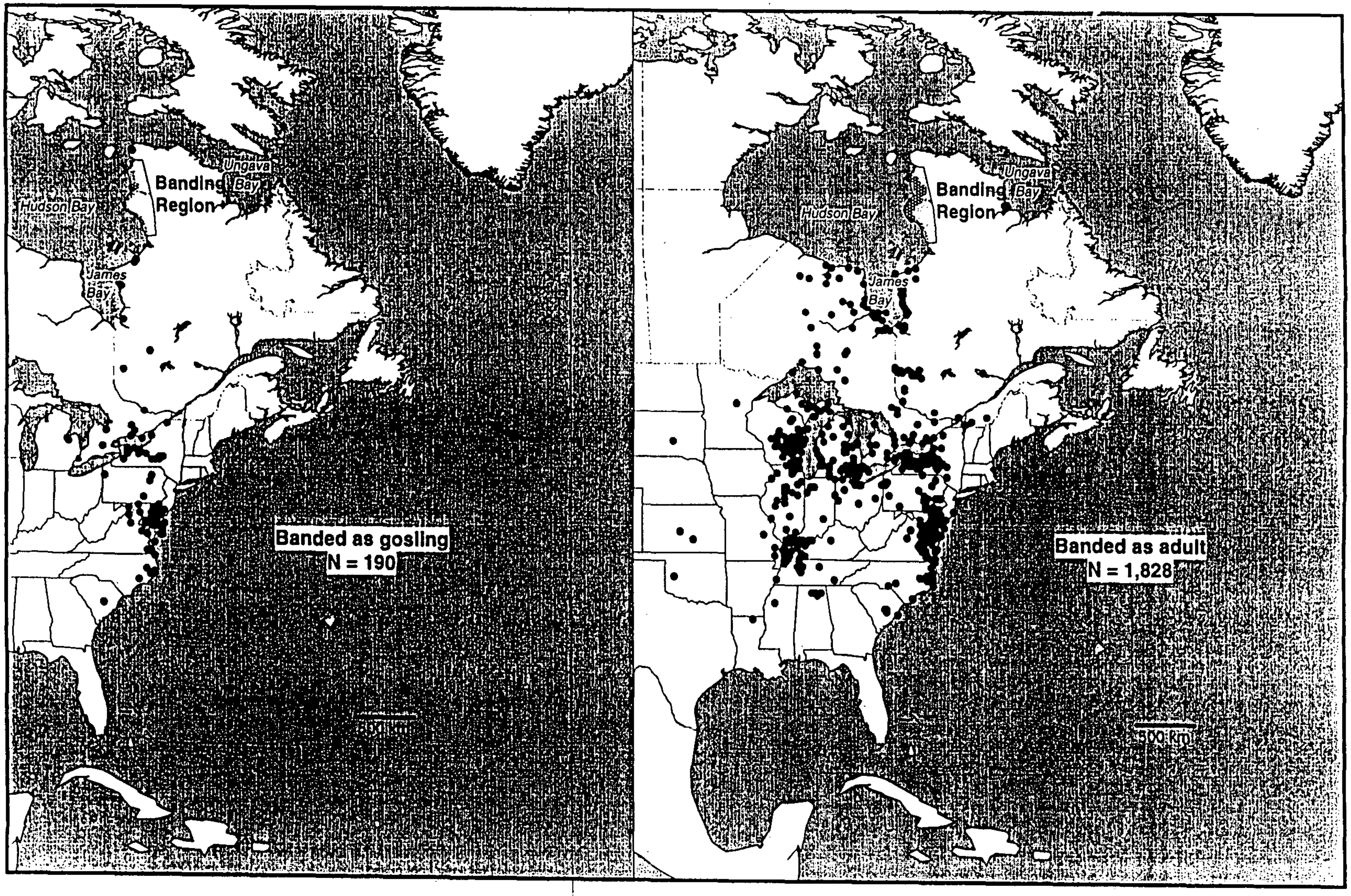

Figure 4. Distribution of recoveries for Canada geese banded as goslings (map on left) and adults (map on right) on the Hudson Bay coast.

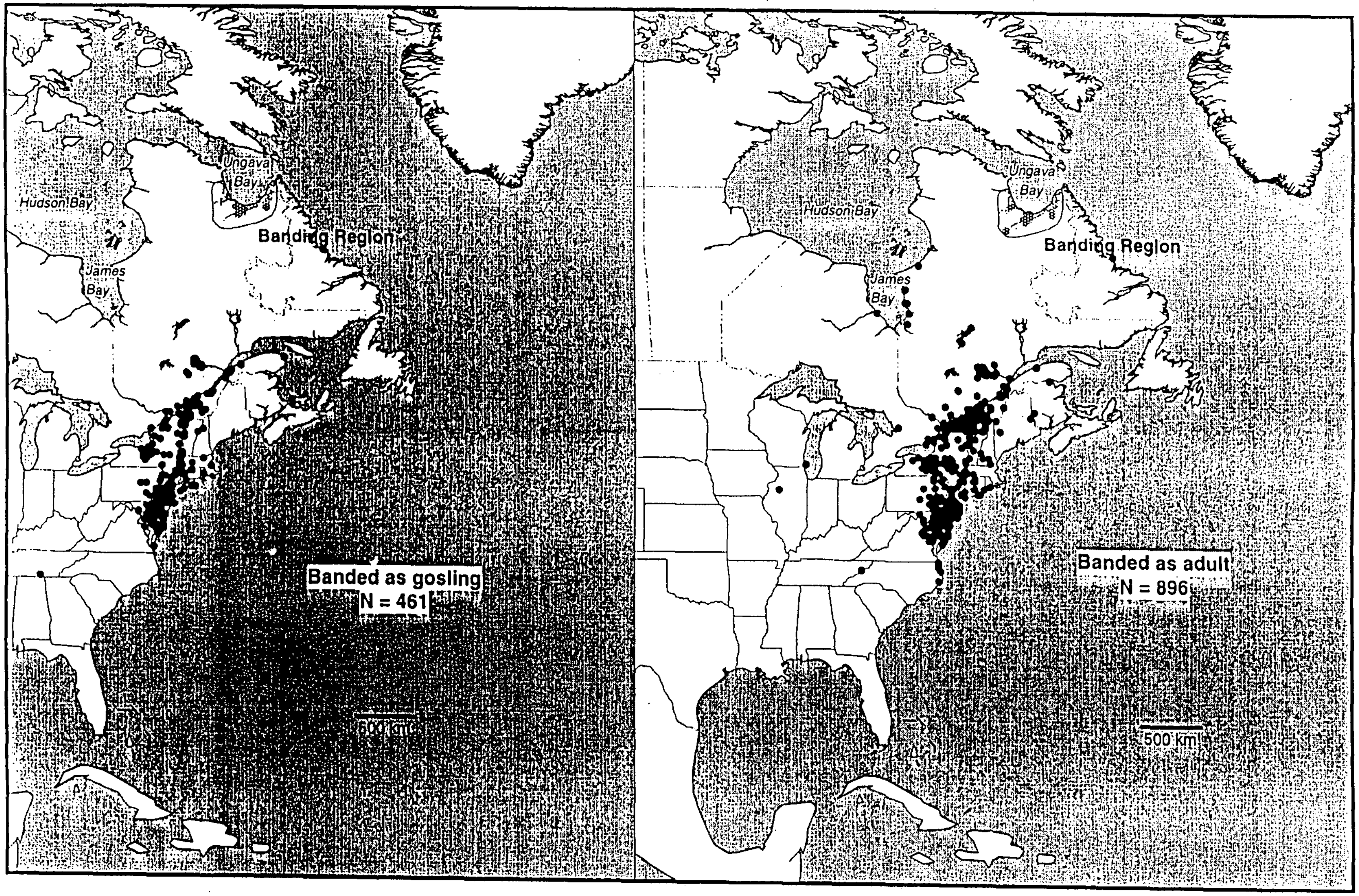

Figure 5. Distribution of recoveries for Canada geese banded as goslings (map on left) and adults (map on right) on the Ungava Bay coast.