Distribution and abundance of breeding and moulting Brant on Banks Island, Northwest Territories, 1992–1994

Richard C. Cotter[1] and James E. Hines[2]

[1] *Canadian Wildlife Service, Environmental Stewardship Branch, Environment Canada, 1141 Route de l'Église, P.O. Box 10100, Sainte-Foy, QC G1V 4H5 (present address: 620 Chemin Craig, St-Sylvestre, QC G0S 3C0)*
[2] *Canadian Wildlife Service, Environmental Stewardship Branch, Environment Canada, Suite 301, 5204–50th Avenue, Yellowknife, NT X1A 1E2*

Abstract

Aerial surveys were conducted over most (28 414 km^2) of southern Banks Island, Northwest Territories, to determine the distribution and abundance of breeding and non-breeding Brant *Branta bernicla*. In 1992–1993, we estimated that there was an average population of 8745 ± 1115 (standard error) adult Brant on the study area. Taking into account the low densities of Brant that existed in unsurveyed parts of the island, we estimated that at least 10 000 adults were present. Brant were found nesting throughout the study area, including the interior of the island, where earlier observers had not recorded them. The greatest numbers (6455 ± 1007) and densities (0.52/km^2) of Brant were found on the western lowlands. Both numbers and densities were considerably lower in the interior and eastern parts of the island. We estimated that there were 116 nesting colonies present on the study region and possibly as many as 130 colonies on all of Banks Island during 1993 (a good nesting year). The total population in the two areas (the western lowlands and the interior/eastern parts of the island) surveyed in both 1992 and 1993 remained stable. However, the proportion of Brant observed in nesting colonies increased from 6% to 32% between 1992 and 1993, the proportion occurring as dispersed pairs declined from 40% to 22%, and the proportion occurring in flocks of non-breeders decreased from 54% to 47%. These changes can probably be attributed to the much earlier spring in 1993. In 1992 and 1993, brood surveys were conducted in a 252-km^2 area in the western lowlands. The number of broods observed was small; although brood and gosling densities appeared to be higher in 1993 (0.20 broods/km^2, 0.34 goslings/km^2) than in 1992 (0.07 broods/km^2, 0.20 goslings/km^2), the differences were not statistically significant ($P > 0.05$). Approximately 2300 Brant moulted within the study area in 1992, 1993, and 1994, primarily on lakes located within 20 km of the west coast. During July of each year, between 1100 and 1500 Brant were captured and banded. Many of the same lakes were used by moulting flocks each year. Brant appeared to show high fidelity to the area where they had previously moulted, and most (88%) birds captured two or more times were <5 km distant from their previous capture site. Nonetheless, we captured 196 Brant (i.e., 5% of the total number handled) that had not been banded originally on Banks Island. Origins of these birds included the mainland of the Northwest Territories 300 km southwest of Banks Island, the Yukon–Kuskokwim Delta and North Slope in Alaska, and Wrangel Island in the Russian Federation. Most Brant moulting on the western lowlands of Banks Island were Black Brant *B. b. nigricans*, although 11% of the birds could have been classified as Grey-bellied Brant (or Western High-Arctic Brant), which, although they have no official taxonomic status, are thought to be an endangered and unique subspecies by many biologists.

1. Introduction

The Pacific Flyway Population of Brant *Branta bernicla* is small compared with most other populations of Arctic-nesting geese (U.S. Department of the Interior and Environment Canada 1986). Concerns about long-term declines of this population, composed mostly of the subspecies Black Brant *B. b. nigricans* (Reed et al. 1998), on both breeding and wintering areas have been expressed (Subcommittee on Pacific Brant 1992; Sedinger et al. 1993). Because of their small population size, highly social nature, and widely varying reproductive success and the limited availability of suitable habitat in some locations, Brant are potentially susceptible to catastrophic mortality or reproductive failure caused by pollution, disease, adverse weather, disturbance, and habitat loss.

Brant and other species of waterfowl make up an important part of the subsistence diet of the Inuvialuit (Bromley 1996; Fabijan et al. 1997), who, by means of their final land claim agreement, are guaranteed a preferential right to the allowable harvest of migratory birds in the Western Canadian Arctic. In order to manage waterfowl populations carefully so that significant allowable harvests can be sustained, sound information on a number of population parameters, including distribution, numbers, survival rates, and productivity, is required. This is particularly important with regard to Brant populations, which are small relative to most other goose populations, have relatively low and variable reproductive success, and require high survivorship to maintain themselves (Kirby et al. 1985).

The current numbers and population status of Brant in the Western Canadian Arctic are poorly known, and the information available is very out of date. From 1992 to 1994, we carried out an investigation of Brant on Banks Island, a potentially important breeding area for this species in the

Western Canadian Arctic (Manning et al. 1956; Barry 1960; Subcommittee on Pacific Brant 1992). Our specific objective was to determine the distribution and abundance of nesting and moulting Brant on the island.

2. Study area

Banks Island (60 165 km^2) is situated in the Northwest Territories in the southwestern corner of the Canadian Arctic Archipelago (Fig. 1). The climate of the island is dry and cold. For example, at the community of Sachs Harbour, annual precipitation for the years 1971–2000 averaged 149 mm, and the mean daily temperatures for January and July in those years were −29.3ºC and 6.8ºC, respectively (Environment Canada 2003).

Banks Island comprises three topographic regions: Northern Uplands, Southern Uplands, and Central Lowlands (Vincent 1982). Western and central Banks Island, where we carried out much of our fieldwork, lie primarily within the Central Lowlands, a low plain occurring largely within 150 m of sea level and characterized by rolling hills, shallow valleys, and alluvial flats (Fyles 1962). The Central Lowlands can be divided into coastal and interior regions, the former encompassing the drainages of many small rivers as well as the lower reaches of four major river systems: the Kellett, Big, Storkerson, and Bernard (Fig. 1). These rivers occupy broad shallow valleys and become highly braided as they near the Beaufort Sea. The wet lowlands adjacent to the rivers are characterized by large tundra polygons and rounded shallow ponds (Fyles 1962). Some common plants of the valley bottoms include mountain avens *Dryas integrifolia*, bistort *Polygonum viviparum*, buttercup *Ranunculus hyperboreus*, horsetail *Equisetum variegatum*, cottongrass *Eriophorum scheuchzeri*, rush *Juncus biglumis*, and several species of louseworts (*Pedicularis* spp.), saxifrages (*Saxifraga* spp.), sedges (*Carex* spp.), and willows (*Salix* spp.) (Porsild 1955). The interior of the Central Lowlands rises 250 m above sea level, and the topography is dominated by a plateau of dry, well-drained, rolling hills and is dissected by a dendritic network of broad, shallow river valleys and gullies (Fyles 1962). Four plant species are ubiquitous on these rolling hills: the sedge-like *Kobresia myosuroides*, mountain avens, cinquefoil *Potentilla rubricaulis*, and Arctic oxytrope *Oxytropis arctica* (Porsild 1955).

Eastern Banks Island lies within the Southern Uplands (Vincent 1982). The area extending from the east coast to approximately 50 km inland is dominated by a plateau of rolling hills, many of which extend to Prince of Wales Strait, where they drop off sharply to the sea. The headwaters of many of the major westward-flowing rivers occur in this region (Fyles 1962). The hills are well drained and dry, and the vegetation is similar to that found in the interior of the Central Lowlands (Porsild 1955).

Based on topography (Fyles 1962; Vincent 1982), the expected distribution of Brant (Manning et al. 1956; Barry 1960), and the potential amount of lowland habitat in the region, we divided the study area into three strata. The East Coast stratum (7000 km^2) was located within the Southern Uplands, and the West Coast stratum (12 436 km^2) and Inland stratum (8978 km^2) were both located in the Central Lowlands. Parts of the Central Lowlands (approximately 6900 km^2) (in particular the northwestern corner of Banks Island), the Northern Uplands (20 500 km^2), and the extreme southern part of Banks Island (4300 km^2) were not included in our study area (Fig. 1). There was little lowland habitat there (Fyles 1962; Vincent 1982), and these areas were expected to support very low densities of Brant.

3. Methods

3.1 Aerial survey of Brant

A helicopter transect survey of nesting and non-breeding Brant was conducted in the West Coast stratum from 16 to 22 June in 1992 and from 11 to 24 June in 1993. The Inland stratum was surveyed from 26 to 28 June in 1992 and from 25 to 27 June in 1993. Surveys were carried out in the East Coast stratum only in 1993 (from 29 June to 1 July). Transects in the West Coast stratum (n = 50) were aligned east–west and were spaced every 5 km, whereas transects in the Inland stratum (n = 16) ran north–south and were 10 km apart. Transects in the East Coast stratum (n = 14) were also spaced at 10-km intervals, but were aligned east–west. All transects were 50 km in length and were divided into 2-km segments. A global positioning system was used to navigate along the transects and to determine the starting point of each segment. Observations were made from a float-equipped Bell 206B helicopter flying at a height of 45 m above ground and at a ground speed of approximately 80 km/h. Observations of Brant within 200 m of the transect centre line were recorded on audio tape and later transcribed onto data forms. For each sighting, the transect and segment numbers were recorded, as were group sizes and whether pairs were solitary or associated with colonies.

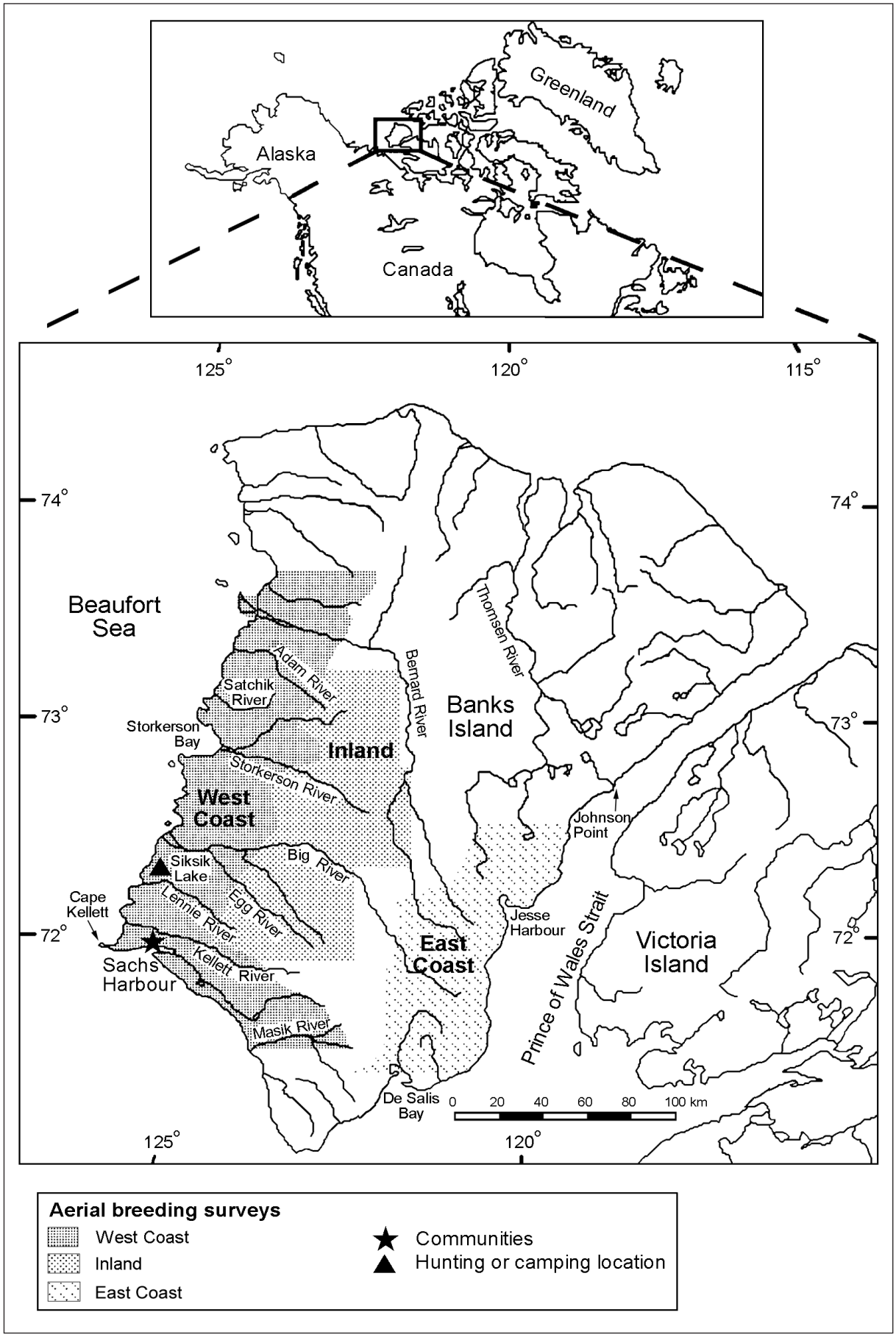
Female Brant are difficult to spot from the air if they are on nests, so any observation of a lone Brant was interpreted as a pair in calculating population estimates (Dzubin 1969; U.S. Department of the Interior and Environment Canada 1987). Three or more Brant observed together were classified as a group (i.e., probable non-breeders). To calculate the minimum number of birds present in a stratum, we multiplied the number of pairs by two and added that number to the number of grouped birds.

Minimum population estimates, later adjusted for visibility, and densities (± standard errors) were calculated for each stratum using the method recommended by Jolly (1969) for equal-sized sample units. Population estimates and densities for both years were averaged to calculate the mean number of Brant in each stratum. The standard error (SE) of the mean population estimate for each stratum was calculated as follows:

$$SE = \frac{\sqrt{VAR_{1992} + VAR_{1993}}}{2}$$

where VAR_{1992} and VAR_{1993} are the variances for the population size in 1992 and 1993, respectively. The minimum population size for the entire study region was the sum of estimates for the individual strata. The standard error (SE) of the minimum population estimate was calculated as follows:

Figure 1
Location of strata for aerial breeding survey of Brant on Banks Island, Northwest Territories, 1992–1993



$$SE = \sqrt{VAR_{WC} + VAR_{IL} + VAR_{EC}}$$

where VAR_{WC}, VAR_{IL}, and VAR_{EC} are the variances for the minimum population size of the West Coast, Inland, and East Coast strata, respectively.

In order to compensate for Brant missed during the surveys, a visibility correction factor was applied to the breeding pair and population estimates. Hines et al. (2000) recommended a minimum visibility correction factor of 1.5 for dark geese from the Western Canadian Arctic. From the air, Brant are similar in appearance to other dark geese and difficult to spot. We believe that a visibility correction factor of 1.5 should produce conservative population estimates under most conditions.

Potential between-year differences in the proportion of the Brant population made up of dispersed pairs, colonial pairs, and flocked birds were evaluated using 2 × 2 contingency tables, and annual changes in Brant numbers in a given stratum were assessed by a Wilcoxon two-sample test (Sokal and Rohlf 1981). The significance level was set at $\alpha = 0.05$ for all statistical tests.

3.2 Aerial survey of Brant broods

Aerial surveys of Brant broods were conducted from 3 to 5 August in 1992 and on 28 July in 1993, following methods similar to those used for the breeding pair surveys. Due to budgetary and logistic constraints, brood surveys were conducted only in the part of the Big River Valley where breeding pair densities were relatively high. Ten transects, each 14 km in length and divided into 2-km segments, were surveyed in a 252-km^2 area that extended 40 km inland from the coast (Fig. 2). We recorded the number of adults, broods, and goslings observed on each transect segment. As broods of Brant tend to amalgamate as they get older (Reed et al. 1998), the number of individual broods in such groups was calculated by dividing the number of adults present by two. Population estimates (± standard errors) for the 252-km^2 survey area were calculated for adults, broods, and young following the method recommended by Jolly (1969) for equal-sized sampling units. Annual changes in Brant brood densities were assessed by a Wilcoxon two-sample test (Sokal and Rohlf 1981).

3.3 Moulting Brant

As part of a banding and marking program, we searched by helicopter for moulting adult Brant on most lakes and large ponds in the West Coast stratum between the Kellett River and the Satchik River (Fig. 1). The region searched extended up to 40 km in from the coast and made up about 30% of the West Coast stratum. Counts of the flightless non-breeders or failed breeders were carried out from 24 to 31 July in 1992, from 13 to 26 July in 1993, and from 12 to 18 July in 1994. The flightless Brant had moulted their remiges and could be readily captured by helicopter drives (Timm and Bromley 1976; Maltby 1977). Each captured Brant was fitted with a standard numbered metal band on one leg and a uniquely coded plastic band on the other leg. The age, sex, and belly colour of each Brant were recorded. Belly colour, which is useful in identifying Brant from different populations, was classified using a Munsell soil colour chart (sheet 10YR; see Boyd and Maltby 1979).

4. Results

4.1 Breeding survey

Although Brant were observed throughout the study area, the overall population densities of pairs, non-breeding Brant, and total Brant were considerably higher in the West Coast stratum than in either the Inland stratum or the East Coast stratum (Table 1). In the West Coast stratum, Brant were recorded on 75% and 72% of the transects in 1992 and 1993, respectively, whereas in the Inland stratum, they were observed on 50% of the transects in 1992 and 63% of the transects in 1993. In the East Coast stratum, surveyed only in 1993, Brant were recorded on only 21% of the transects. The two highest concentrations of sightings were found within the West Coast stratum, between Sachs Harbour and the Big River (51% and 23% of all sightings in 1992 and 1993, respectively) and between Liot Point (20 km north of Storkerson Bay) and the Adam River (20% and 34% in 1992 and 1993, respectively). Overall, 74% of the Brant on the study area were found in the West Coast stratum, 21% in the Inland stratum, and only 4% in the East Coast stratum.

During the aerial surveys or during general reconnaissance flights, 45 Brant nesting colonies were found in 1992–1993 (Fig. 2). In the strata surveyed in both years, 10 colonies were found in 1992 and 38 were found in 1993. Although colonies were found throughout the area surveyed, most (76%, 34/45) were situated in the West Coast stratum, particularly in the Big River Valley (Fig. 2). Based on the number of colonies found on our transects, we estimated that there were 15 and 116 colonies on the study area in 1992 and 1993, respectively (1993 estimate includes 20 colonies for the East Coast stratum that were not surveyed in 1992).

The mean densities of Brant for the entire study area were 0.31 birds/km^2, 0.08 breeding pairs/km^2, and 0.15 non-breeders/km^2. The estimated total population for the study area was 8745 Brant, including 2273 pairs (52% of the total birds) and 4199 flocked (non-breeding) birds (48% of the total) (Table 1).

There were no significant annual changes in the total numbers of Brant or total numbers of pairs of Brant seen in either the West Coast stratum or the Inland stratum ($P > 0.05$ for all comparisons). Although nearly identical numbers of Brant were counted in 1992 and 1993 in the overall area surveyed in both years (Table 1), the composition of the population in terms of social groupings changed substantially between years (Fig. 3). In 1992, only 6% of the observed Brant occurred in nesting colonies, compared with 32% in 1993 ($P < 0.01$). The increased proportion of Brant that occurred in colonies in 1993 was accompanied by a large decrease (from 40% to 22%) in the proportion of dispersed pairs ($P < 0.01$) and a smaller (but still statistically significant) decrease in the proportion of Brant that occurred in flocks of non-breeders ($P < 0.01$). Lone Brant (as opposed to sightings of two birds) made up a much greater proportion of the "indicated pairs" in 1993 (55%, n = 40) than in 1992

Figure 2
Location of Brant nesting colonies, banding locations of moulting Brant, and transects for aerial brood survey of Brant on Banks Island, Northwest Territories, 1992–1994

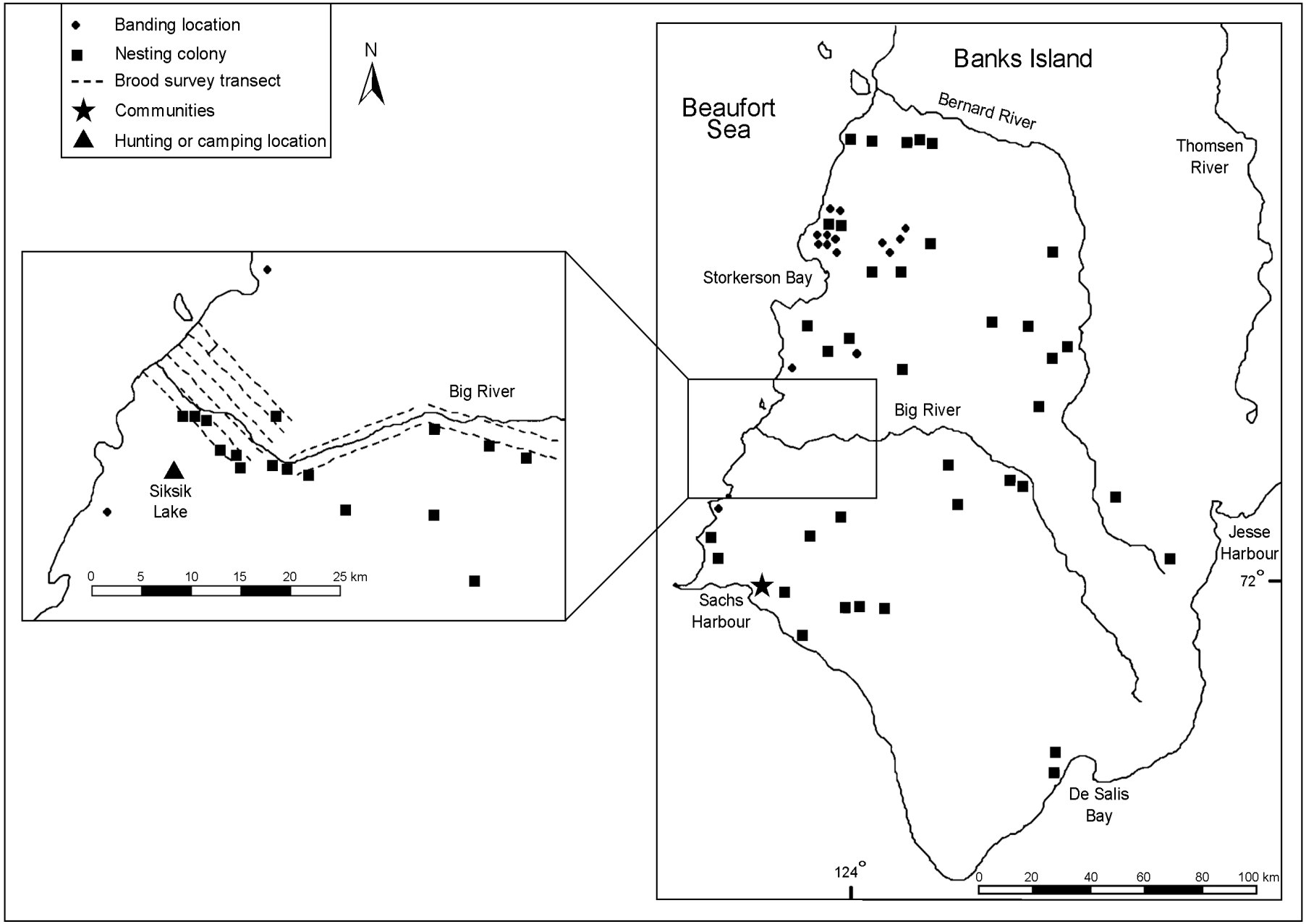


Table 1
Population estimate and density of indicated breeding pairs, flocks of non-breeders, and total indicated Brant in the three survey strata on Banks Island, 1992–1993

Stratum	Year	Number of dispersed pairs	Number of colonial pairs	Total number of pairs	Pair density (numbers/km^2)	Number of non-breeders in flocks	Total number of birds	Total density of birds (numbers/km^2)
West Coast	1992	1007 (± 162)	174 (± 118)	1181 (± 227)	0.095	2263 (± 656)	4625 (± 918)	0.372
	1993	348 (± 75)	746 (± 342)	1094 (± 349)	0.088	1791 (± 489)	3979 (± 978)	0.320
	Average (no VCF[a])	678 (± 89)	460 (± 181)	1138 (± 208)	0.092	2027 (± 409)	4303 (± 671)	0.347
	Average (adjusted by VCF)	1017 (± 134)	690 (± 272)	1707 (± 312)	0.138	3041 (± 614)	6455 (± 1007)	0.521
Inland	1992	112 (± 64)	0	112 (± 64)	0.012	729 (± 303)	953 (± 295)	0.105
	1993	253 (± 90)	140 (± 138)	393 (± 150)	0.044	814 (± 351)	1600 (± 498)	0.179
	Average (no VCF)	183 (± 55)	70 (± 69)	253 (± 81)	0.028	772 (± 232)	1278 (± 289)	0.142
	Average (adjusted by VCF)	275 (± 83)	105 (± 104)	380 (± 122)	0.042	1158 (± 348)	1918 (± 434)	0.213
West Coast and Inland combined	1992	1119 (± 174)	174 (± 118)	1293 (± 236)	0.060	2992 (± 723)	5578 (± 965)	0.260
	1993	601 (± 117)	886 (± 368)	1487 (± 380)	0.069	2605 (± 602)	5579 (± 1097)	0.260
	Average (no VCF)	860 (± 105)	530 (± 194)	1390 (± 223)	0.065	2799 (± 460)	5579 (± 731)	0.261
	Average (adjusted by VCF)	1290 (± 158)	795 (± 291)	2085 (± 335)	0.098	4199 (± 705)	8369 (± 1097)	0.393
East Coast	1993	75 (± 53)	50 (± 49)	125 (± 68)	0.018	0	250 (± 137)	0.036
	Average (adjusted by VCF)	113 (± 80)	75 (± 74)	188 (± 102)	0.027	0	376 (± 206)	0.054
Entire study area	(adjusted by VCF)	1403 (± 176)	870 (± 300)	2273 (± 350)	0.080	4199 (± 705)	8745 (± 1115)	0.308

[a] Visibility correction factor.

(26%, n = 85) ($P < 0.01$), suggesting that proportionately more of the dispersed pairs were nesting in 1993 than in 1992.

4.2 Brood survey

Only a small number of Brant were observed during the brood surveys (Table 2), which took place about 18–20 days after the peak of hatch in 1992 and 21 days after the peak of hatch in 1993. We saw almost three times as many broods and 1.7 times as many goslings in the survey area in 1993 than in 1992; however, the differences between years were not statistically significant ($P > 0.05$), probably due to the small samples.

4.3 Moulting Brant

On western Banks Island, we saw approximately 2500 flightless adult Brant on 18 lakes in 1992, 2000 on 22 lakes in 1993, and 2300 on 16 lakes in 1994. The mean size of these "moulting" flocks was 140, 85, and 145 in 1992, 1993, and 1994, respectively. We captured and banded 1105 (44%) of the moulting Brant in 1992, 1400 (70%) in 1993, and 1547 (67%) in 1994. Over the three years, Brant were captured on 17 different lakes (Fig. 2). On average, 60% of the Brant captured each year (range: 55–68%) were on eight lakes located 15–30 km north of the mouth of the Storkerson River (near the Satchik River) and 5–15 km inland from the coast, 11% were on four lakes located at the same latitude as the previous location but 25 km farther inland, 20% were on three lakes located about halfway between the Big and Storkerson rivers, and 9% were on two lakes situated near the Lennie River. Brant used many of the same lakes for moulting each year: at the seven sites where Brant were captured in 1992, Brant were captured at five and four of the sites in 1993 and 1994, respectively.

In 1992 and 1993, 2423 different Brant were captured. In total, 248 individuals (10% of the Brant marked) were recaptured in 1993 or 1994. Most recaptures (88%) occurred within 5 km of their previous site of capture on the island.

A significant proportion (5%) of the 4052 Brant that we captured were originally banded in locations other than Banks Island. Banding locations of these 196 Brant included the Yukon–Kuskokwim Delta (23%) and North Slope (48%) in Alaska, Wrangel Island in the Russian Federation (2%), and the Anderson River/Liverpool Bay area on the mainland of the Western Canadian Arctic (26%).

Males made up 53%, 54%, and 51% of all Brant captured in 1992, 1993, and 1994, respectively. Belly colour was recorded for most birds captured and ranged from 2 (black) to 7 (light). The mean belly colour was 3.41 (standard deviation [SD] = 1.05, mode 3, n = 990) in 1992, 3.40 (SD = 0.95, mode 3, n = 1399) in 1993, and 3.16 (SD = 0.90, mode 3, n = 1541) in 1994. Most birds appeared to be typical Black Brant, but at least 11% of the Brant had lighter belly scores (>4 on the Munsell soil chart) and, by this criterion, could have been classified as Grey-bellied (or Western High-Arctic) Brant. Grey-bellied Brant, although not officially recognized as a subspecies, appear to be taxonomically distinct and are of special management concern because of their small population size (Reed et al. 1998).

5. Discussion

5.1 Numbers and distribution of adult Brant

Our surveys, which covered 47% of Banks Island, provided an average population estimate of 8745 Brant. Aerial reconnaissance of parts of the island (Cotter, unpubl. data) and ground-based surveys conducted in Aulavik National Park of Canada on northern Banks Island (Henry and Mico 1997) indicate that very low densities of Brant

Figure 3
Composition of the Brant population in the West Coast stratum and Inland stratum on Banks Island, Northwest Territories, 1992 and 1993

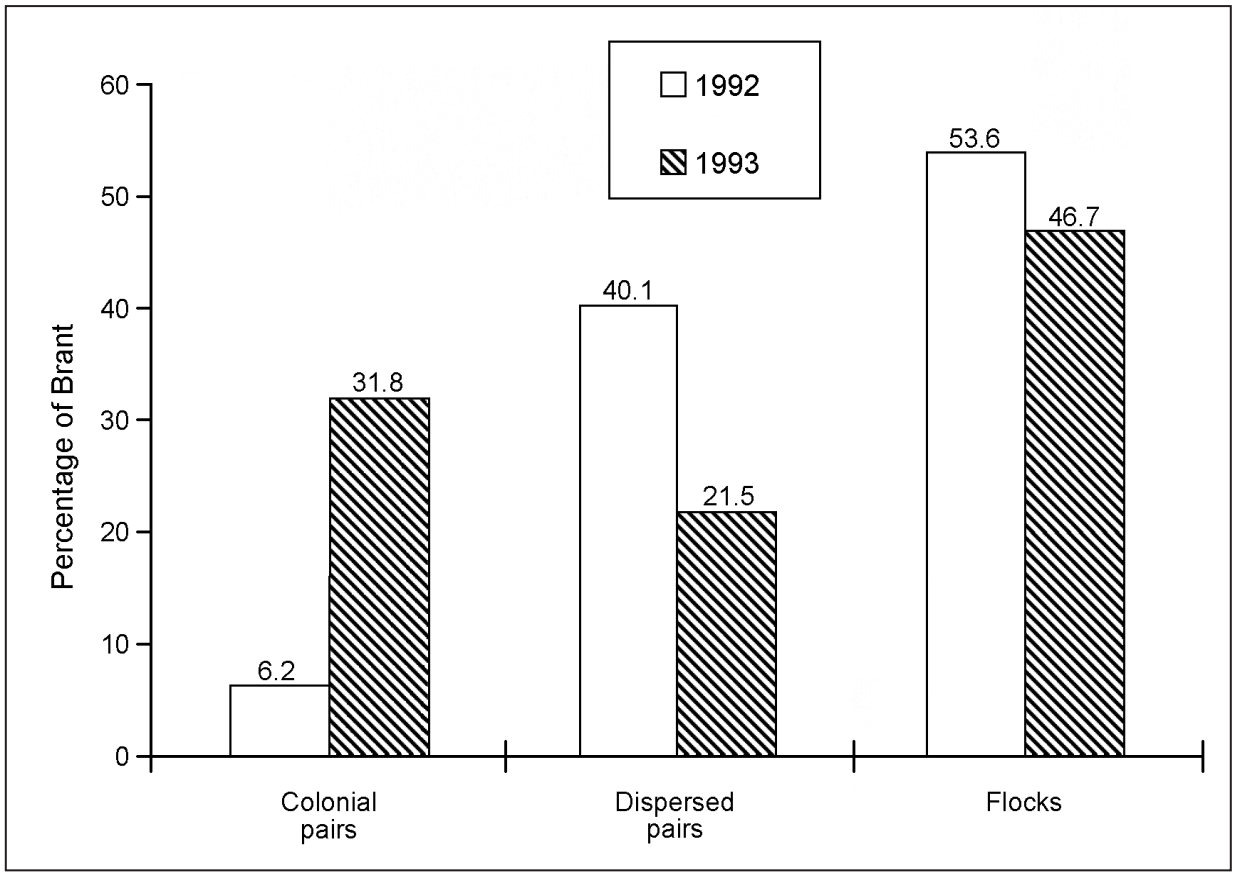


Table 2
Number of individuals sighted, density, and population estimate (± standard error) of adult and young Brant in a 252-km^2 area on western Banks Island, Northwest Territories, during late summer, 1992–1993

	Number observed			Density (number/km^2)			Estimated numbers present		
Year	Adults	Broods	Goslings	Adults	Broods	Goslings	Adults	Broods	Goslings
1992	45	4	11	0.80 ± 0.34	0.07 ± 0.05	0.20 ± 0.12	203 ± 85	18 ± 12	50 ± 30
1993	31	11	19	0.55 ± 0.23	0.20 ± 0.11	0.34 ± 0.18	140 ± 59	50 ± 27	86 ± 44
Average	38	8	15	0.68 ± 0.21	0.13 ± 0.06	0.27 ± 0.11	172 ± 52	34 ± 15	68 ± 27

occur in the unsurveyed part of the island as well. The 31 751-km^2 part of the island that was not surveyed, primarily the Northern and Southern Uplands, was similar in topography and vegetation to the East Coast stratum (Porsild 1955; Fyles 1962; Vincent 1982). If it is assumed that densities of Brant in the unsurveyed area were very low and similar to those in the East Coast stratum (0.05 Brant/km^2), the overall population estimate for the island would increase by approximately 1500 Brant to a total of 10 300 individuals. Assuming an average colony size of 12.8 nests (Cotter and Hines 2001) and 32% of population nesting colonially (Fig. 3), we estimate that there would be approximately 130 colonies present on Banks Island in a "good" nesting year, such as 1993. Observations of pairs during the aerial breeding surveys, as well as the location of nesting colonies, demonstrated that Brant nested throughout the study area, including the interior of Banks Island, where their status had been uncertain: some range maps showed Brant as absent from the interior (Johnsgard 1975; Boyd et al. 1988), whereas others showed Brant to nest throughout the island (Palmer 1976; Godfrey 1986). Nevertheless, Brant were not distributed evenly throughout the study area. The proportion of transects on which Brant were observed and the density of Brant pairs and groups of non-breeders were highest in the West Coast stratum, intermediate in the Inland stratum, and lowest in the East Coast stratum. The most important region on the island is the West Coast stratum, which supported about 6455 Brant, over 60% of the total estimate for all of Banks Island. The higher numbers in the West Coast stratum reflect the greater availability of lowland habitat (particularly the coastal plain, with its numerous lakes and ponds and the presence of nesting islands on many of those lakes and ponds) for breeding, brood rearing, and foraging in this stratum compared with the other two strata.

In the two years of our transect surveys (1992 and 1993), the Pacific Flyway Population numbered about 125 000 individuals in January (from Figure 6 in Reed et al. 1998). Our estimate for Banks Island of 10 300 Brant therefore represented 8% of the Pacific Flyway Population, with the West Coast stratum alone accounting for 5% of the population.

5.2 Annual differences in breeding effort and success

We carried out aerial surveys of Brant on Banks Island during two breeding seasons with highly different spring weather and phenology. Snowmelt during our first year of study, 1992, appeared to be very late on Banks Island (Cotter and Hines 2001) and throughout the circumpolar Arctic in general (Ganter and Boyd 2000). In contrast, Brant nesting dates and snowmelt occurred 8–14 days earlier in 1993 than in 1992 (Cotter and Hines 2001). We estimated that nesting productivity was nearly four times higher in 1993 than in 1992, due primarily to the greater number of Brant nesting in 1993 and secondarily to larger average clutch size and greater nesting success that year (Cotter and Hines 2001). The data from our breeding pair surveys also demonstrated clear differences in reproductive effort between years. The number of colonies, number of nesting birds, and proportion of dispersed pairs that were nesting increased from 1992 to 1993, and the proportion of the population that occurred in flocks of non-breeders declined. Our late-summer brood surveys were restricted to a relatively small part of the study area. We observed nearly 2.8 times as many broods in 1993 as in 1992 and 1.7 times more goslings in 1993 than in 1992. The results from our surveys (reported here) and nesting studies (Cotter and Hines 2001) are consistent with other studies, which show that spring weather is one of the most important factors influencing reproductive success of Brant and other Arctic geese (Barry 1962; Newton 1977; O'Briain et al. 1998; Ganter and Boyd 2000).

5.3 Moulting Brant and their origins

Over 2000 Brant moulted annually on lakes within 20 km of the west coast of Banks Island during 1992–1994. In any given year, over half of these birds moulted on lakes located in a 20-km-diameter area north of Storkerson Bay.

A significant proportion of Brant recaptures in 1993 and 1994 were birds that were originally captured and banded at the Yukon–Kuskokwim Delta in Alaska, on the North Slope of Alaska, or on the mainland of the Inuvialuit Settlement Region to the southwest of Banks Island. A few had been banded on Wrangel Island in the Russian Federation.

It is evident that western Banks Island is an important moulting area for Brant. Other important moulting sites may exist elsewhere on the island. We were able to check two potential locations. Approximately 470 moulting Brant were observed during a reconnaissance flight at Castel Bay on the northern coast of Banks Island on 8 July 1992 (Cotter, unpubl. data). In contrast, no Brant were observed on 27 July 1993 during a reconnaissance flight over Windrum Lagoon, located on De Salis Bay on the southern end of Banks Island (Hines, unpubl. data), which had been identified as a potentially important area for Brant by Kay et al. (this volume).

As noted in Section 4.3, most Brant moulting near the west coast of Banks Island were Black Brant, although a number of the captured birds were similar in belly colour to Grey-bellied (or Western High-Arctic) Brant (see Reed et al. 1998: 4), which nest on the Queen Elizabeth Islands (Boyd and Maltby 1979). The mean belly colour of 3.4 from our study was close to that obtained previously for Black Brant from Banks Island and Alaska (from Figures 2 and 3 in Boyd and Maltby 1979). Each year, however, >10% of the Brant we captured could have been classified as Grey-bellied Brant. The observation that moulting Grey-bellied Brant might occur on Banks Island is of special interest because of the recent numerical decline of this stock of geese from about 20 000 in 1995 to only about 10 000 in 1996–2002 (Canadian Wildlife Service Waterfowl Committee 2003).

6. Conclusions and management implications

With the exception of parts of the mainland of the Inuvialuit Settlement Region (Wiebe Robertson and Hines, Brant paper, this volume) and now Banks Island, recent and accurate population estimates are not available for Brant from the Western Canadian Arctic. We estimated that over 10 000 Brant (approximately 8% of the Pacific Flyway Population) used Banks Island during the breeding seasons of 1992 and 1993. Approximately equal numbers were breeding pairs and non-breeders. The most important area for Brant was the lowland extending from the western coast approximately 50 km inland (lying within Banks Island Migratory Bird Sanctuary No. 1). Over 60% of the Brant were found in the stratum encompassing these lowlands. In addition, an average of 2300 Brant, a significant proportion with origins outside of Banks Island, moulted during July of each year on the western lowlands. Due to the vulnerability of Brant to a variety of factors, as is evidenced by declines in wintering counts in the early 1960s to the late 1970s, careful monitoring of the Brant population is necessary. For Banks Island, better information is needed on the distribution and abundance of breeding and moulting Black Brant (and moulting Grey-bellied Brant) in regions we could not survey. In addition, better information on the breeding effort and success of dispersed (non-colonial) pairs and an inventory of important brood-rearing sites would be useful. Brant share the lowland habitats on Banks Island with an increasing population of Lesser Snow Geese *Anser caerulescens caerulescens* (Kerbes et al. 1999). The impact that this increasing population of Lesser Snow Geese is having on lowland habitats, on which Brant and a number of other species of migratory birds depend, needs to be determined.

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