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The Numbers and Distribution of Greater Snow Geese on Bylot Island and near Jungersen Bay, Baffin Island, in 1988 and 1983

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ABSTRACT. We conducted aerial photographic surveys of greater snow geese on portions of Bylot Island and northern Baffin Island during August 1988 to determine whether changes had occurred since a similar survey in 1983. On the 1600 km^2 south plain of Bylot Island, using a quadrat system and stratified random sampling, we estimated a population of 26 300 breeding adults, 5400 failed- and non-breeding adults, and 41 400 goslings; the breeding component had increased by 58% from the 1983 survey. In a 274 km^2 study area in Jungersen Bay on northern Baffin Island, we conducted total counts and recorded 2555 adult breeders, 546 failed- and non-breeders, and 4127 goslings; the breeding segment had declined by 15% since 1983. The later date of the survey in 1988, relative to that of 1983, is believed to have been the main cause of a more even distribution of broods among strata on Bylot Island and may have contributed to an underestimation of breeding geese at Jungersen Bay. Both survey areas supported high densities of breeding greater snow geese in both years. Bylot Island supported a similar proportion of the entire greater snow goose breeding population in 1988 (13%) and 1983 (15%).

Key words: *Anser caerulescens atlanticus*, Baffin Island, breeding distribution, Bylot Island, Canada, goose surveys, greater snow goose

RÉSUMÉ. En août 1988, nous avons effectué un inventaire heliporté-photographique des Grandes Oies des neiges sur une partie des îles Bylot et Baffin afin de déterminer s'il y avait eu des changements d'effectifs depuis 1983. Nous avons employé un système de quadrats et un échantillonnage aléatoire stratifié sur une surface de 1600 km^2 de la plaine sud de l'île Bylot; une estimation de 26 300 adultes nicheurs, 5400 adultes non-nicheurs, et 41 400 oisons fut obtenue. Le nombre d'adultes nicheurs avait augmenté de 58% depuis 1983. Dans une aire d'étude de 274 km^2 à Jungersen Bay dans la partie nord de l'île Baffin, nous avons dénombré 2555 adultes nicheurs, 546 adultes non-nicheurs, et 4127 oisons; le nombre d'adultes nicheurs avait diminué de 15% depuis 1983. La date plus tardive de l'inventaire de 1988, en comparaison avec celui de 1983, semblait être la cause d'une répartition plus égale des couvées d'oies parmi les différents strates à l'île Bylot, et a peut être conduit à une sous-estimation à Jungersen Bay. Les deux régions ont supporté des densités élevées de couvées de Grandes Oies des neiges durant les deux années. L'île Bylot a servi de lieu de nidification à une proportion similaire de la population totale de reproducteurs en 1988 (13%) et en 1983 (15%).

Mots clés: aire de nidification, *Anser caerulescens atlanticus*, Canada, Grande Oie des neiges, île Baffin, île Bylot, inventaire d'oies

Traduit par l'auteur senior.

INTRODUCTION

Spring surveys at a staging haunt on the St. Lawrence estuary showed a dramatic increase in the greater snow goose (*Anser caerulescens atlanticus*) population from the mid-1970s to 1988 (Gauvin and Reed, 1987; Reed, 1990). For the past decade the increasingly larger flocks have created concern over the likelihood of the geese overgrazing the tidal marshes they inhabit while staging in southern Quebec and while wintering along the mid-Atlantic coast of the United States (Anon., 1981). Their intensive grazing has had some potentially harmful effects on some of those marshes (Smith and Odum, 1981; Smith, 1983; Giroux and Bédard, 1987), though at one important marsh the geese maintained grazing pressure at or below carrying capacity by dispersing to other sites (Reed, 1989). Overgrazing could have even greater effects on the arctic breeding and moulting areas where the vegetation is characteristically sparser and subjected to harsher growing conditions (Giroux *et al.*, 1984). High densities of lesser snow geese (*A. c. caerulescens*) have caused extensive change to the vegetation of freshwater and brackish marshes in the subarctic coastal lowlands of west Hudson Bay (Kerbes *et al.*, 1990). It is therefore important to learn whether the increase in the overall population of greater snow geese is leading to parallel increases in goose density at important breeding colonies. In this report we present the results of a goose survey conducted in August 1988 on Bylot Island, the most important nesting area for this stock of geese (Lemieux, 1959; Anon., 1981) and which has been used since at least the 1930s (White and Lewis, 1937), and a portion of adjacent Baffin Island, Northwest Territories. The results are compared with a similar survey conducted there in 1983 (Reed and Chagnon, 1987).

STUDY AREAS AND METHODS

The studies were conducted on Bylot Island and near Jungersen Bay on northern Baffin Island (Fig. 1). On Bylot Island our survey covered the 1600 km^2 south plain (Fig. 2), an undulating area characterized by various herbaceous plant associations and wet sedge meadows, glacial streams, and numerous shallow ponds. It represents a closed breeding area, being surrounded by precipitous mountains and open sea. At Jungersen Bay we surveyed a 274 km^2 area of the delta and low-lying valley of the Jungersen River (Fig. 3), which is dominated by wet sedge meadows interspersed with pools with moss-graminoid margins; a salt marsh is also present in the delta. Those features render the Jungersen study area the most suitable brood-rearing habitat near southern Admiralty Inlet; it is, however, partially surrounded by vast expanses of less suitable habitat (few sedge meadows, many barren outcrops, ponds with rocky shorelines). More detailed descriptions of the study areas can be found in Lemieux (1959), Drury (1962), Zoltai *et al.* (1983), Giroux *et al.* (1984), and Reed and Chagnon (1987).

Our surveys were conducted during the brood-rearing period when all successful breeders and goslings, and many

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nonbreeders, were flightless (the term nonbreeder is used to include both geese that did not attempt to breed and those that may have attempted but failed, because it is not possible to distinguish between them in flocks of moulting geese). A Bell 206b helicopter was flown at 50-150 m above ground level with one observer navigating and recording and another photographing each flock. A 35 mm camera equipped with a 70-200 mm zoom lens and colour transparency film (ISO 200) were used. Geese were later counted directly from the colour slides using a binocular microscope. Adult geese and goslings were counted separately.

For the Bylot Island survey we recognized the same habitat stratification (Fig. 2A) used in 1983 (Reed and Chagnon, 1987), and the same survey grid of 400 2×2 km blocks. Seventy-one blocks fell within the dense stratum, 134 within the moderate-density stratum, and 195 within the sparse stratum. Using the optimal allocation method (Cochran, 1977:96), we chose a new stratified random sample of 83 blocks (21% coverage), 34, 28, and 21 in the dense, moderate, and sparse strata respectively. The blocks were surveyed on 7 and 8 August 1988 (compared to 30 July – 3 August 1983), recording all flocks present in each block. In Jungersen Bay we conducted total counts in two adjacent areas (Fig. 3) on 10 August 1988 (compared to 2 August 1983). We also conducted ground observations on goose behaviour and brood size while camped on Bylot Island from 6 to 12 August 1988.

Most groups encountered during the aerial surveys were tightly bunched, multi-family crèches, often accompanied by nonbreeding adult-plumaged geese (Fig. 4). To determine the number of parents among the adult-plumaged geese, we divided the number of goslings in each plot or sector by the mean brood size, determined from ground observations, and multiplied by 2 (2 parents per family); the remaining adult-plumaged geese were assumed to be nonbreeders. The significance of differences in the estimated numbers of geese between years was tested with the Z statistic, hypothesizing equality between years and assuming an approximately normal distribution.

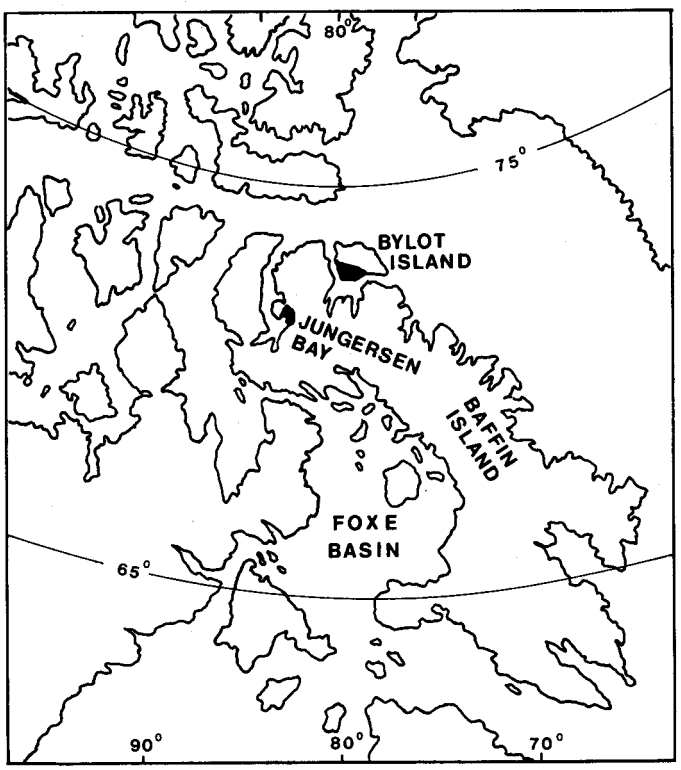

FIG. 1. Map of northern Baffin Island and Bylot Island showing location of study areas.

RESULTS

Bylot Island

In 1988 we estimated a population of 73 100 snow geese, of which 41 400 were goslings (Table 1). The 31 700 adult-plumaged geese were composed of 26 300 parents (based on a mean brood size of 3.15 goslings: Table 2) and 5400 nonbreeders.

There were more parents and goslings in 1988 than in 1983 ($Z = 1.86$, $P = 0.06$ for parents; $Z = 1.83$, $P = 0.07$ for goslings) but fewer nonbreeders ($Z = -2.44$, $P = 0.01$: Table 1). The density of geese in 1988 varied from an average of 340 geese per plot in the dense stratum to 131 in the sparse stratum (Table 3), showing a much narrower range of variation ($Z = 2.26$, $P = 0.02$) than in 1983 (413 to 21 geese per plot). Overall, we estimated a density of 8.2 broods/km^2 in 1988, compared to 5.2/km^2 in 1983 (Table 4). The spatial distribution of sparse, moderate, and high densities of breeding adults was generally similar in both years (Figs. 2B,C).

There were 11 adult and 6 gosling blue-phase snow geese in the survey sample, which represented 0.09% of the total

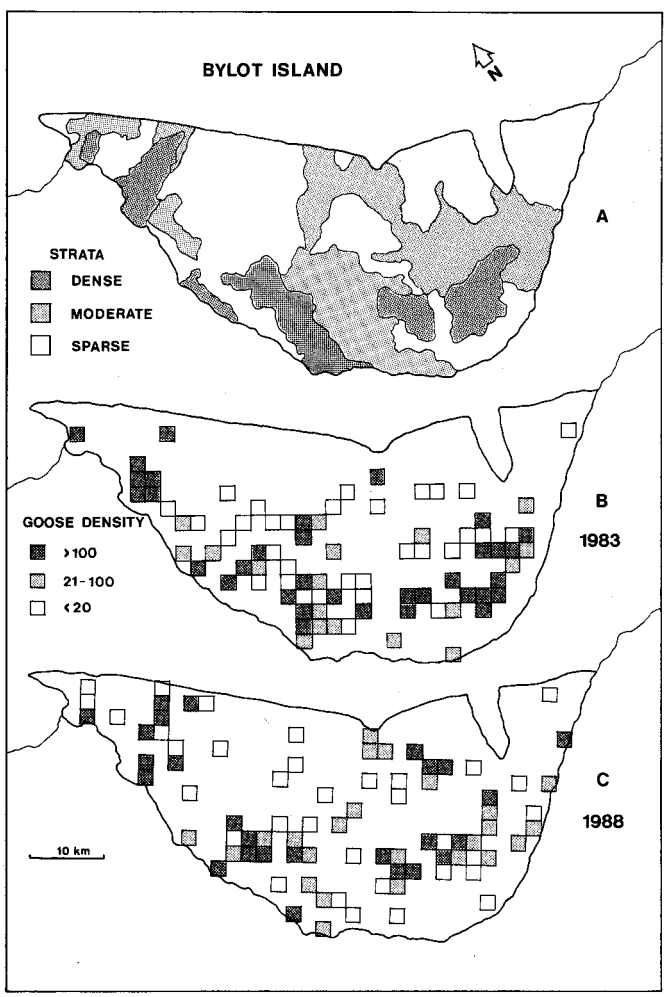

FIG. 2. Maps of the south plain of Bylot Island showing the stratification used in the survey (A) and densities of breeding adult snow geese (numbers of individual parents per survey plot) recorded in 1983 (B) and 1988 (C).

population, identical to the proportion recorded in 1983 (which was mistakenly reported as 0.2% by Reed and Chagnon [1987]).

Jungersen Bay

The photographic count in the lower Jungersen study area showed a population of 4776 geese, of which 2743 (57.4%) were goslings. Of the 2033 adult-plumaged geese, 1698 (SE = 142) were parents (based on a mean brood size of 3.23), and the remaining 335 (SE = 142) were nonbreeders. The estimated 849 (SE = 71) broods represented a 31% decline from 1983 ($Z = -4.95$, $P < 0.001$); brood densities were 5.7 broods/km^2 in 1988 and 8.3 in 1983 (Table 4).

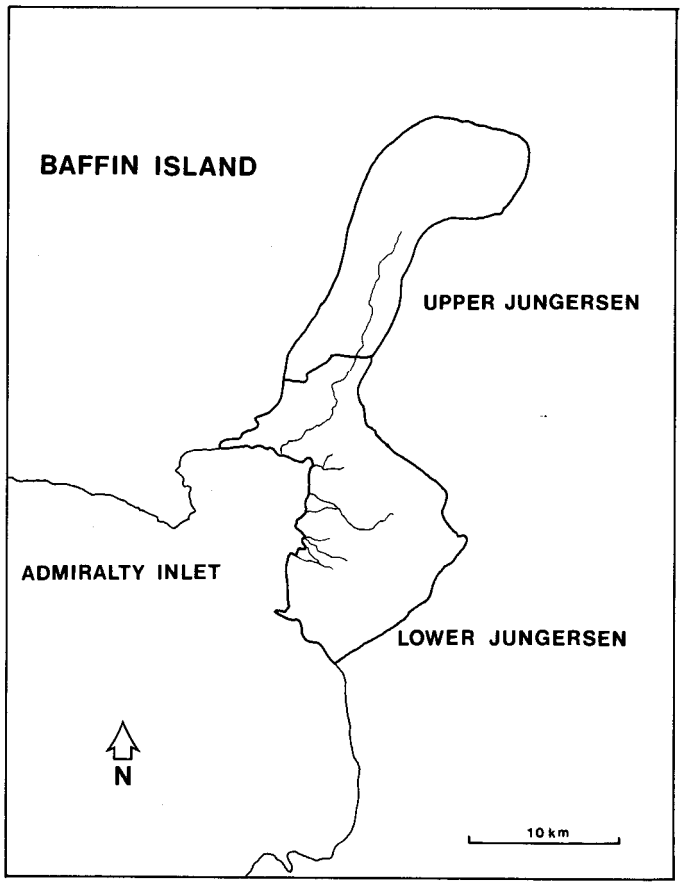

FIG. 3. Map of Jungersen Bay showing upper and lower survey sectors.

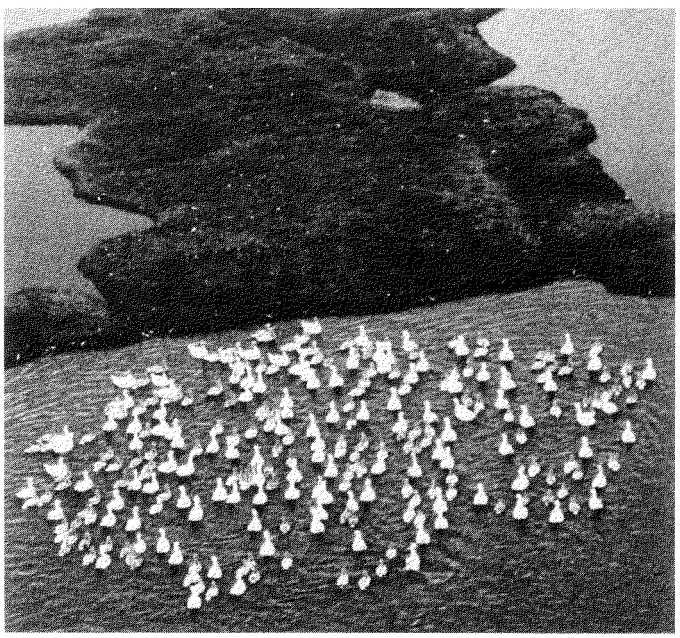

FIG. 4. Photograph of a crèche of greater snow geese on Bylot Island, August 1988. Goslings are recognizable by their smaller size and greyish colouration.

TABLE 1. Estimated numbers of greater snow geese on the south plain of Bylot Island during August 1983 and 1988

	1983[1]	SE	1988	SE
Breeding adults (parents)	16 600	1 520	26 300	4 990
Goslings	26 500	2 320	41 400	7 810
Failed and non-breeding adults	8 900	1 062	5 400	950
Total geese	52 000	4 308	73 100	13 676

[1]Based on a recount of the 1983 raw data, which revealed the need for minor corrections in 5 of the 83 plots; this has resulted in estimates slightly different from those published in Reed and Chagnon (1987).

TABLE 2. Greater snow goose brood sizes on Bylot Island and near Jungersen Bay, 1983 and 1988

Number of goslings	Bylot 1983	Bylot 1988	Jungersen 1988
1	14	14	3
2	30	68	4
3	50	86	2
4	53	63	11
5	17	30	2
6	0	4	0
7	1	0	0
Number of broods	165	265	22
Mean brood size	3.20	3.15	3.23
Standard Error	0.089	0.069	0.270

TABLE 3. Densities of greater snow geese on Bylot Island, 1983 and 1988

	Mean number of geese/plot[1]			
Stratum	1983	SE	1988	SE
Dense	413	39.2	340	37.5
Moderate	139	21.5	174	46.2
Sparse	21	8.1	131	59.3

[1]Adults and goslings combined per 2×2 km plots.

TABLE 4. Estimated densities of greater snow goose broods on Bylot Island and at Jungersen Bay, 1983 and 1988

	Mean number of broods/km^2			
	1983	SE	1988	SE
Bylot Island (estimated values)				
Dense strata	16.4	1.6	14.9	1.7
Moderate strata	5.6	0.9	7.8	2.1
Sparse strata	0.8	0.3	6.1	2.8
Total south plain	5.2	0.5	8.2	1.6
Baffin Island (from total counts in two survey sectors)				
Lower Jungersen Bay	8.3	0.2[1]	5.7	0.5
Upper Jungersen Bay	2.1	0.2	3.4	0.3
Total Jungersen Bay	5.5	0.2	4.7	0.3

[1]The Standard Errors listed for Jungersen Bay reflect the variance associated with the mean brood size that was used to transform the total counts of geese into brood units (see Methods and Table 2).

In the upper Jungersen study area we recorded 2452 geese, of which 1384 (56.4%) were goslings. Of the 1068 adult-plumaged geese, 857 (SE = 72) were parents and 211 (SE = 72) were nonbreeders. The estimated 429 broods represented a significant increase from 1983 (Z = 3.44, P = <0.001); brood densities were 3.4 broods/km^2 in 1988 and 2.1 in 1983 (Table 4).

In 1988, the two Jungersen Bay study areas supported 15% fewer broods than in 1983 (Z = 2.44, P = 0.015).

Fifty-four blue-phase snow geese (22 adults, 32 goslings) were recorded in the two study areas, which represents 0.75% of the total population. Comparison with 1983 can only be made for the lower Jungersen study area, where blue-phase geese increased from 0.29% in 1983 to 0.88% in 1988.

DISCUSSION

On Bylot Island, the breeding component of the adult population increased from 16 600 in 1983 to 26 300 in 1988. Over the same time period, the entire greater snow goose population, as measured by photographic censuses during spring when the geese concentrate in the St. Lawrence estuary (Gauvin and Reed, 1987; Reed, 1990; P. Dupuis and A. Reed, unpubl.), increased from 185 000 to 363 800, and the breeding component (mature adults) from an estimated 112 300 to 205 100 (Table 5). There was no significant difference between the proportion of the potential breeding population that bred on Bylot Island in 1988 (13%) and 1983 (15%) (Z = 0.70, P > 0.05).

TABLE 5. Structure of the greater snow goose population during the springs of 1983 and 1988 as determined by population modeling (Gauvin and Reed, 1987; Reed, 1990) applied to survey data from the St. Lawrence estuary

Year	Total geese	Mature adults	Yearlings	2-year-olds	Total pre-breeders[1]
1983	185 000	112 300	48 900	23 800	72 700
1988	363 800	205 100	153 400	5 300	158 700

[1]Yearlings + 2-year-olds.

The increase of breeding geese on Bylot Island between 1983 and 1988 did not occur uniformly among the strata (Table 4). We observed in the dense stratum a small, non-significant decrease in numbers of breeding adults (Z = –0.66, P = 0.51), in the moderate stratum a small, non-significant increase (Z = 0.956, P = 0.34), and in the sparse stratum a large, significant increase (Z = 1.89, P = 0.06). Much of the change can therefore be attributed to increased density in habitats assumed to be of poorer quality. Several factors could have caused those changes. It is possible that the best areas (dense stratum) were fully occupied at 15-16 broods/km^2 in both years, forcing more broods into less favourable habitat during 1988. If such a factor is operating, it has not yet led to overuse, because we saw no evidence of damage to vegetation as reported by Kerbes *et al.* (1990) in the Hudson Bay Lowlands. A more likely factor is the phenological stage at which the survey was conducted; through the combined effects of a later survey date and an earlier breeding year in 1988, goslings were ≥ 3/4 grown compared to ≤ 1/2 grown in 1983. Older broods, because of their greater mobility and changing food requirements, probably range more widely, increasing the likelihood of them being recorded in those habitats that we considered poorer. Another interrelated factor relates to predatory pressure from arctic foxes (*Alopex lagopus*), which could restrict brood distribution to the vicinity of ponds and other wet areas that serve as escape cover (and which are characteristic of many of the areas we classified as most suitable); in 1988 the population of arctic fox appeared lower and the goslings were larger at the time of the survey, which may have allowed many broods to disperse more widely than in 1983.

A 39% decrease in the number of nonbreeders was recorded on Bylot Island between 1983 and 1988 (Table 1). The age structure of the overall population (Table 5) would have predicted the contrary because there were many more geese of prebreeding age (yearlings and 2-year-olds) in 1988. This contradiction can probably be attributed to the exodus of an unknown but variable proportion of the nonbreeding population, either prior to the moult (as reported for lesser snow geese by Abraham [1980]) or soon after the moult (Giroux *et al.*, 1984). By the time of our 1988 survey, proportionately more nonbreeders had probably left our study area than in 1983, when the survey was conducted earlier.

In the Jungersen Bay study area we recorded a decrease in breeding geese from 1983. Data from survey sectors as small as these are less likely to reflect general population change as accurately as those from our survey area on Bylot Island, which holds the largest breeding group known. Spring conditions (snow cover, flooding) probably cause annual local shifts in nesting distribution, which would have a greater influence on counts of breeding geese in smaller areas. Also, because of the phenologically later date of the 1988 survey, some of the geese that nested in our plots might have dispersed to adjacent unsurveyed areas before the count was conducted. A longer run of carefully scheduled surveys would be required to allow a reliable appraisal of population change in the Jungersen area. The important inference to be made at this time is that the area supported relatively high densities of brood-rearing greater snow geese in 1983 and 1988 (this study), as well as in 1981 (Giroux *et al.*, 1984).

The proportion of blue-phase geese was low (0.09%) on Bylot Island in both 1983 and 1988. In Jungersen Bay in 1988 the proportion was significantly higher than on Bylot Island (Chi^2 = 84.4, D.F. = 1, P < 0.001), and it had increased from 1983. This may reflect increased mixing in Jungersen Bay with the nominate subspecies, the lesser snow goose, whose range now overlaps with that of greater snow geese in nearby Foxe Basin (Reed *et al.*, 1980; Boyd, 1989). Lesser snow goose populations in Foxe Basin generally have 40-60% blue-phase individuals (Kerbes, 1975; Reed *et al.*, 1987).

We recommend that future surveys be conducted in late July, when the goslings are about half-grown, so as to minimize any possible effects of gosling age on choice of strata; in doing so a broader range of density would be expected among strata with reduced variance within strata, resulting in more accurate estimates. That would also ensure the inclusion of most nonbreeders and failed breeders, which would still be flightless.

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