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Habitat Use by Greater Snow Geese During the Brood-Rearing Period

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ABSTRACT. Observations of habitat use by the Greater Snow Goose (*Anser caerulescens atlanticus*) were conducted at Jungersen Bay, northern Baffin Island, from 27 July - 17 August 1981. Density of geese using the study area was estimated at 425 birds·km^{-2}. The average of 2.8 young per family did not change during our study. Non-breeding geese were first observed in flight on 1 August and were seen regularly until 13 August. Three types of habitat used by geese during the brood-rearing period were distinguished: tidal marshes dominated by *Carex subspathacea* and *Puccinellia phryganodes*; wet moss-covered meadows with up to 5 cm of standing water, dominated by *Carex stans, Dupontia fisheri, Calamagrostis neglecta,* and *Arctagrostis latifolia*; and, around ponds, bands of vegetation 1-2 m wide dominated by *Carex stans*. The three most important species of monocots grazed by geese were *Puccinellia phryganodes, Carex subspathacea,* and *C. stans*. It is unlikely that habitat and food resources are limiting factors for Greater Snow Geese in the High Arctic during the brood-rearing period. We suggest that potential breeding areas for this species be identified and given special protection.

Key words: Greater Snow Goose (*Anser caerulescens atlanticus*), habitat use, brood, Baffin Island, grazing, monocots, wet meadows

RÉSUMÉ. Du 27 juillet au 17 août 1981, nous avons effectué des travaux sur l'utilisation de l'habitat par la Grande Oie Blanche (*Anser caerulescens atlanticus*) à Jungersen Bay au nord de la terre de Baffin. Nous estimons à 425 oiseaux·km^{-2} la population d'oies qui a fréquenté notre aire d'étude. La moyenne de 2.8 jeunes par famille ne changea pas durant notre séjour. Les oies non-nicheuses ont été observées en vol du ler au 13 août. Les oies utilisèrent trois types d'habitat durant la période d'élevage des jeunes: des marécages intertidaux où *Carex subspathacea* et *Puccinellia phryganodes* étaient les principales espèces végétales; des zones très humides ayant jusqu'à 5 cm d'eau à la surface, recouvertes de bryophytes et dominées par *Carex stans, Dupontia fisheri, Calamagrostis neglecta,* et *Arctagrostis latifolia*; et, autour des étangs, des ceintures de végétation (1-2 m de largeur) caractérisées par *Carex stans*. Les trois espèces de monocotyles les plus importantes pour l'alimentation des oies étaient *Puccinellia phryganodes, Carex subspathacea,* et *C. stans*. Il est peu probable que l'habitat et la nourriture soient des facteurs limitants pour la Grande Oie Blanche dans l'Arctique. Nous suggèrons d'identifier les sites propices à cette espèce afin de leur accorder une protection particulière.

Mots clés: Grande Oie Blanche (*Anser caerulescens atlanticus*), utilisation de l'habitat, élevage des jeunes, Terre de Baffin, alimentation, monocotylédones, zones humides

Traduit par les auteurs.

INTRODUCTION

The Greater Snow Goose (*Anser caerulescens atlanticus*), the larger subspecies of the Snow Goose, is a well-differentiated population that breeds in the Canadian High Arctic and winters on the Atlantic Coast of the United States. During its migration, it travels through Québec east of Hudson Bay. The current spring population is estimated at 170 000 birds (Anon., 1981).

Because their numbers have doubled during the last decade (Anon., 1981), it is important to identify and study the habitats used by Greater Snow Geese during all phases of their life cycle. This is especially true for the arctic breeding grounds where the habitat is susceptible to disruption resulting from industrial development such as oil and gas exploration or mining (Babb and Bliss, 1974). There is no other published information available on the habitats used by Greater Snow Geese in the Arctic.

Wildlife managers have recently stressed the importance of assessing the impact of population increases on the food supply at the breeding grounds of this species (Anon., 1981). Before this can be done, it is necessary to know which species of plants the geese consume. Only two published reports are available (Lemieux, 1959; Drury, 1961) that briefly describe the food habits of Greater Snow Geese in the Arctic.

In 1981, we conducted observations on Greater Snow Geese on northern Baffin Island from 27 July - 17 August. The purpose of our work was to describe the habitat used by geese during the brood-rearing period and to identify the major plant species they consume.

STUDY AREA AND METHODS

Observations were conducted at Jungersen Bay (71°40'N, 84°30'W) in the southeast portion of Admiralty Inlet, on northern Baffin Island (Fig. 1). The study area consisted of a 150-km^2 valley traversed by several rivers draining into the inlet. A sedge-moss meadow, as described by Muc and Bliss (1977), represented the dominant plant community of the area. The vascular plant cover was primarily composed of *Carex stans, C. subspathacea, C. membranacea, C. atrofuscus, Arctagrostis latifolia, Eriophorum* spp., *Dupontia fisheri, Calamagrostis neglecta,* and *Salix* spp. Bryophytes were a major component of the wet meadows. Along the coast, a tidal salt marsh was dominated by *Puccinellia phryganodes*.

We divided the northern section of the valley into three study zones based on topographical features (Fig. 1). Within each zone, we counted all adult geese present every day from 1-14 August. Goslings (15-20 days old at the start of the study) could not be accurately counted because of their grey colour and small size. Thirteen surveys were carried out from an

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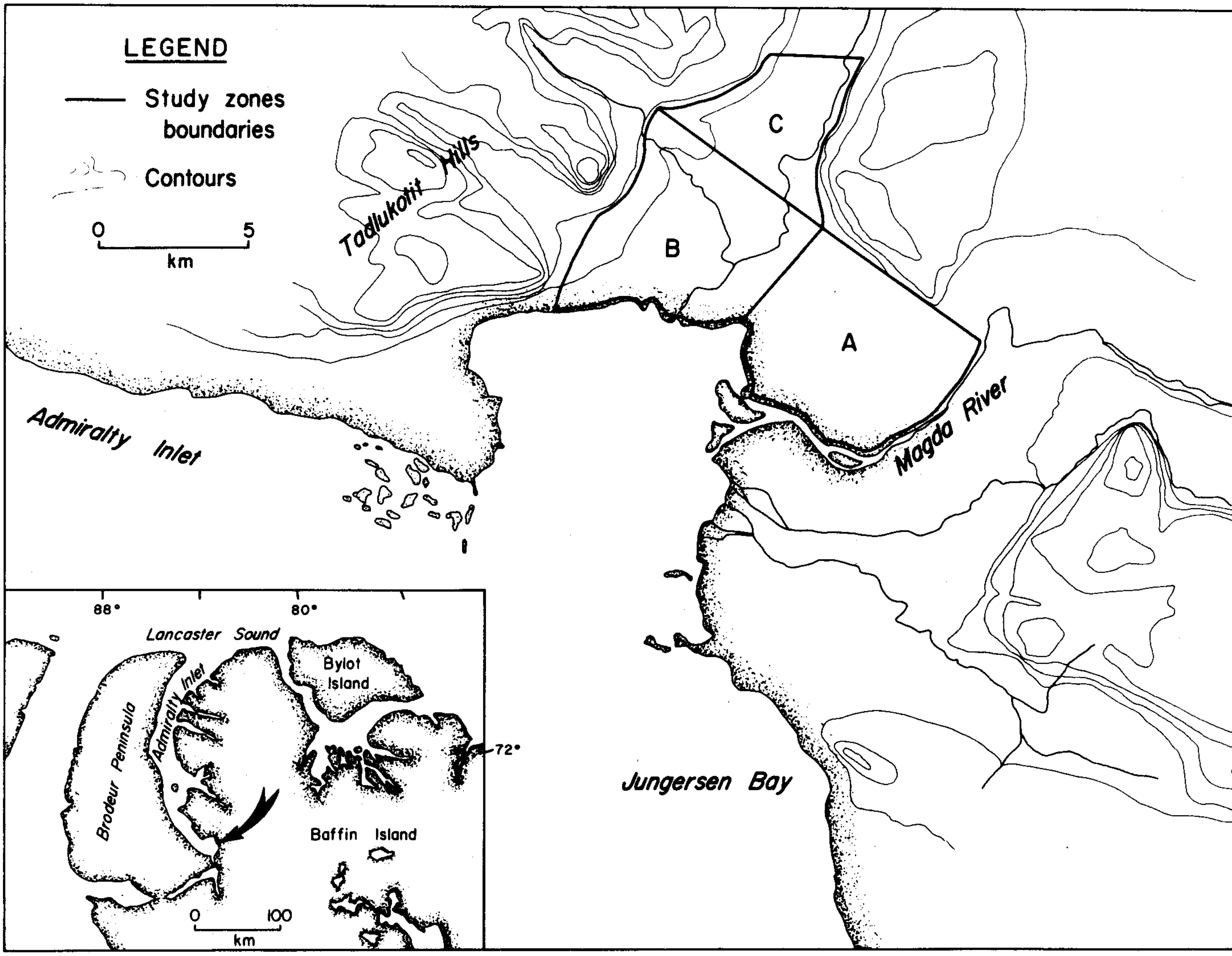

FIG. 1. Map of Jungersen Bay showing the three study zones.

elevated site by the same observer (Y.B.) using a spotting scope (25×). We collected and identified a sample of each plant species that had been grazed by geese. Nomenclature for vascular plants follows Porsild (1957). Notes on habitats such as the relative density of ponds, the species of vascular plants present, and soil moisture conditions were recorded along with subjective assessments of habitat use by geese. To estimate the area covered by each habitat, we used a planimeter and referred to a 1958 black and white aerial photo (scale 1:59 400).

Fifty grams of vegetation (fresh weight of the ungrazed tips of monocot species used by geese) was collected at each of seven sites within the study area. Material was dried at 85 °C for three hours using a portable oven in the field, and freeze-dried in the laboratory for 48 h. Fiber content was determined by the Neutral Detergent Fiber (NDF) method as described by Goering and Van Soest (1970). Protein was determined as the percent nitrogen × 6.25, using the Kjeldalh method with a Kell-Foss automatic apparatus. All analyses were done in duplicate, or in triplicate whenever the difference exceeded 2%.

RESULTS AND DISCUSSION

The number of geese observed in the study area increased from ~1000 to ~1700 adults between the beginning of our observations and 4 August, then decreased to ~300 at the end of the study (Fig. 2). The mobility of the birds at this season is demonstrated by these fluctuations and also by our behavioural observations (Giroux *et al.*, unpubl. data): we frequently saw large groups of geese (usually families) walking across the tundra in one direction without any apparent reason. No predominant movement or orientation could be discerned within the study area.

Two groups of geese could be distinguished on the brood-rearing area: families, including adults and young; and adult-plumaged birds unaccompanied by goslings. This latter category presumably included one- and two-year-old birds (subadults), adults (3+) that did not attempt breeding, and failed breeders. When families were feeding at Jungersen Bay, they were scattered over the wet meadows. We observed both solitary families and groups composed of up to 17 families.

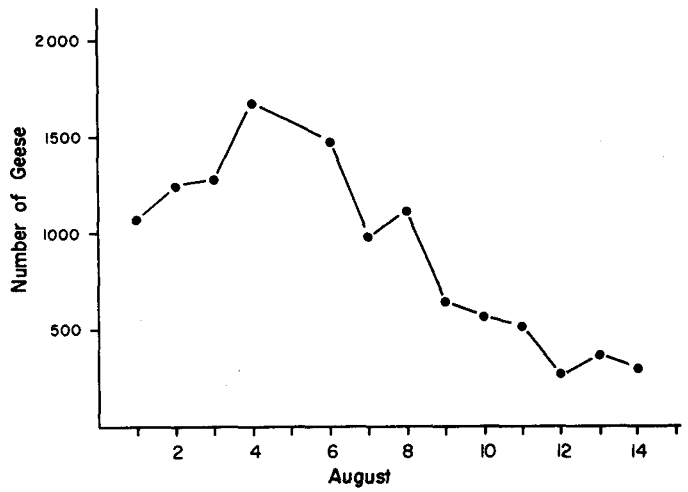

FIG. 2. Numbers of Greater Snow Geese observed at Jungersen Bay, August 1981.

These multi-family groups averaged 7.8±1.2 (SE, N=22) families per group. The average number of young per family (solitary or in a group) was 2.8±0.1 and did not change during the study period ($t=0.05$, $df=161$, $P>0.05$).

At the approach of either light aircraft or potential predators such as arctic fox (*Alopex lagopus*), families congregated into one group and swam towards the centre of the nearest pond. Lemieux (1959) observed similar behaviour on Bylot Island, and Reed (pers. comm. 1981) reported that most observations of Greater Snow Geese during aerial surveys consisted of such groups. We could not determine whether such disturbances resulted in the breakup of family units leading to mixing of young. These observations show that ponds constitute a potentially important feature of Greater Snow Goose habitat during the brood-rearing period.

Groups of non-breeding geese varied between 2 and 145 individuals, averaging 21.5±5.4 (N=31). On feeding areas, non-breeders occasionally approached families, but the two groups always remained distinguishable. The flying capacity of non-breeders, which moult earlier than breeders, increases their mobility and favours segregation. We observed the first non-breeders in flight on 1 August. Thereafter, they were regularly noted until 10 August when flight frequency started to decrease. The last geese seen in flight were recorded on 13 August, when they probably left the area. Little is known about adult-plumaged geese observed without young. Those seen in August at Jungersen Bay could have completed a moult migration from other nesting areas. Such migration has been documented by Abraham (1980) for the Lesser Snow Goose (*A. c. caerulescens*). Non-breeding geese may also have spent the summer at Jungersen Bay after their spring arrival with the breeding segment of the population.

Habitat Types

We distinguished three types of habitat used by Greater Snow Geese during the brood-rearing period. The first habitat (Type I) consisted of tidal marshes dominated by *Carex subspathacea* and *Puccinellia phryganodes* (Fig. 3A). These marshes resembled in appearance those at La Perouse Bay described by Cargill (1981). Type I was the most intensively used habitat, as shown by the accumulation of droppings and feathers, and by our daily surveys. Plants were 1-2 cm high and formed a uniform reddish carpet. Nearly every green shoot had been grazed and the majority of plants lacked flowering parts. The soil was waterlogged but there was no standing water, and many ponds dotted the terrain.

The second type of habitat (Type II) was characterized by very wet areas adjacent to ponds (Fig. 3B). These sites supported a cover of bryophytes and could have up to 5 cm of standing water. Some of these areas were characterized by

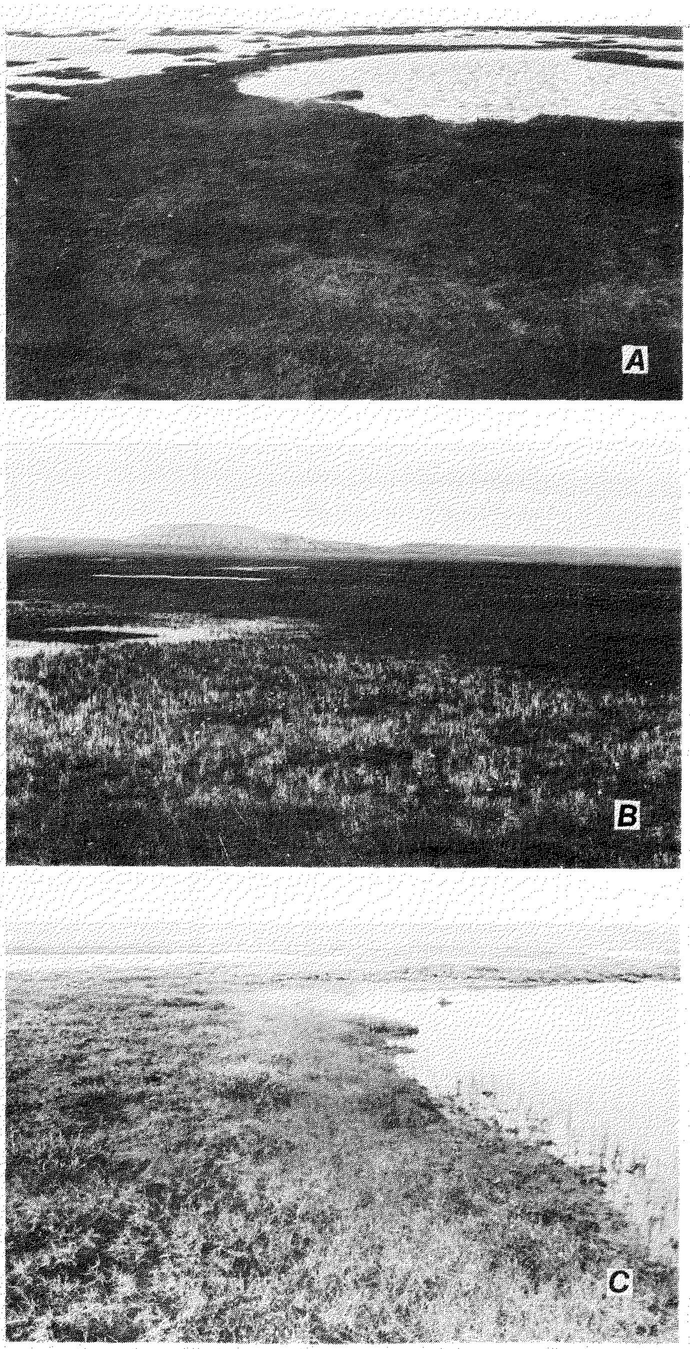

FIG. 3. Habitats used by Greater Snow Geese during the brood-rearing period at Jungersen Bay: A - Type I; B - Type II; C - Type III.

grasses such as *Agropyron violaceum* var. *hyperarcticum*, *Dupontia fisheri*, *Calamagrostis neglecta*, and *Arctagrostis latifolia*, whereas others were dominated by sedges, *Carex stans* in particular.

Type III habitat was found in dryer areas farther from the coast, where there was a lower density of ponds. Of the three types of habitat, this was the least used by geese. Grazing was limited to a 1-2 m band around ponds (Fig. 3C). *Carex stans* was the dominant species around the ponds but we also recorded *C. atrofuscus*, *Dupontia fisheri*, *Arctagrostis latifolia*, and *Calamagrostis neglecta*. This band of vegetation appeared greener than the vegetation away from the ponds, which was dryer and dominated by lichens and *Salix* spp. Grazing was limited to certain areas around the ponds but we were unable to discern any obvious reasons for the uneven distribution of used sections.

TABLE 1. Plant species grazed by Greater Snow Geese at Jungersen Bay during the brood-rearing period, 1981

Species	Relative Importance[a]
Arctagrostis latifolia	**
Dupontia fisheri	**
Calamagrostis neglecta	*
Puccinellia phryganodes	****
Agropyron violaceum var. *hyperarcticum*	*
Carex stans	***
C. rupestris	*
C. subspathacea	****
C. membranacea	*
C. atrofusca	*

[a]The relative importance of each species used by Greater Snow Geese for feeding increases with the number of asterisks.

Feeding Habits

Greater Snow Geese grazed 10 species of monocots (Table 1). The three most important were *Puccinellia phryganodes*, *Carex subspathacea*, and *C. stans*. This does not necessarily reflect the food preferred by geese but simply the degree of grazing, which is influenced by the relative abundance of each species. Geese grazed primarily on the leaves but we also observed that the flowering heads of some grasses had been systematically consumed in one grass meadow. Grubbing (feeding on the below-ground parts of plants) was recorded in a wet meadow covered by bryophytes and grasses. Tufts of mosses had been pulled out and were lying on the ground but we were unable to determine what the geese had eaten at these sites. Old signs of grubbing, probably from spring feeding, were noted along a river. On Bylot Island, Lemieux (1959) reported that geese ate *Oxytropis maydelliana* roots in early spring and fed on the bulbous roots of *Polygonum viviparum* and the blades of grasses and leafy plants later in summer. The use of grass and sedge shoots by Greater Snow Geese was confirmed on Bylot Island by Drury (1961). At La Perouse Bay, Cargill (1981) observed that Lesser Snow Geese grazed primarily on *Puccinellia phryganodes* and *Carex subspathacea*. From these observations, it appears that during the brood-rearing period when geese are spending a large proportion of their time feeding (Harwood, 1977; Giroux *et al.*, unpubl. data), they consume mainly the aerial parts of grasses and sedges. At that time, vegetation reaches a maximum in both quantity and quality (Harwood, 1977).

The Neutral Detergent Fiber content (NDF) of the vegetation collected at Jungersen was $49.6 \pm 1.5\%$ (N=7), which is high when compared with other food types consumed by geese (Gauthier, 1981). It is also substantially higher than the crude fiber content of 30.7% reported by Haag (1974) for a wet meadow at Tuktoyaktuk. This difference may have resulted from different analytical procedures since crude fiber estimates usually provide lower values than NDF (Van Soest and Robertson, 1977). On the other hand, our vegetation was collected on feeding sites after geese had already grazed. If geese select their food as Owen (1980) reports, we may have collected what the birds had avoided, and this material may be of lower quality as reflected by the high NDF content. To verify this possibility, we analyzed the protein content of the vegetation to see if it was lower than expected. We found a mean of $17.3 \pm 1.1\%$ (N=7), which is intermediate between the values reported by Muc (1977) for *Carex stans* on Devon Island (19.1%) and those reported by Harwood (1977) for monocots at McConnell River (14-16%). These preliminary results have potentially important implications for the feeding ecology of these birds. Greater fiber content is associated with lower digestibility (Drent *et al.*, 1978/79) which may consequently necessitate a greater food intake by geese in order to meet their energy requirements. On the other hand, greater food consumption can increase nitrogen intake even if the protein content is low. Additional work is required to clarify this aspect.

Density of Geese

Geese were distributed unevenly among the three study zones (Table 2). Zone A, which covered 40% of the area, was clearly preferred over the other two: 72.6% of the total number of geese counted during our daily surveys were observed in that zone. This differential use can be attributed to the higher proportion of the most preferred habitats, i.e. Types I and II, covering Zone A (Table 2).

TABLE 2. Utilization of three study zones by Greater Snow Geese at Jungersen Bay, August 1981 (total area = 71.1 km²)

Zone	% of total area	% of geese observed (N=11 531)	Relative preference[a]	% of area covered by habitat Types I & II[b]
A	39.9	72.6	+2.9	24.6
B	42.9	17.6	−4.2	8.2
C	17.2	9.8	−2.7	0.0
Total	100.0	100.0		13.4

[a]10(% use - % availability)/(% use + % availability)
[b]See descriptions in text

The maximum number of geese observed during our daily observations was 1680 adults on 4 August. If we assume that all these birds represent families with an average of 2.8 young, there must have been 2352 uncounted young, for a total of 4050 birds. Using a 9.5-km² area of suitable habitat (Type I and II), we calculated a density of 425 geese·km^{-2}. This is low compared to Snow Geese nesting at La Perouse Bay, where approximately 20 000-25 000 geese used a 5.4-km² marsh during the brood-rearing period (Cargill, 1981). The resulting density of 3700-4600 geese·km^{-2} is therefore approximately 10 times that at Jungersen Bay.

At La Perouse Bay, Cargill (1981) found that Lesser Snow Geese removed 75-115 g·m^{-2} (dry weight) of the above-ground vegetation, i.e. 70-80% of the net aerial primary production (NAPP). This intense grazing stimulated the growth of *Puccinellia* and *Carex* and increased the NAPP by 30-80%. Cargill (1981:159) concluded that it is unlikely that this level of use by geese could severely damage the vegetation. She suggests that dwindling of the food supply would lead to a reduction in grazing intensity before permanent damage could be caused to the plants. Such information is not available for Jungersen Bay and the primary production of the marshes at this latitude (71.6° N) is probably lower than at La Perouse Bay (58.5° N). Cargill (1981) reports a NAPP of 50-100 g·m^{-2} for the ungrazed meadows of *Puccinellia* and *Carex*, whereas Muc (1977) found a NAPP of 44 g·m^{-2} for monocots in a wet meadow at Truelove Lowland on Devon Island (75.6° N). The maximum above-ground biomass at Truelove Lowland varied less than 10% during the three years of the study. In summary, even if the primary production at Jungersen is half that at La Perouse Bay, the density of geese at Jungersen is at least 10 times lower, making it unlikely that geese could have a detrimental effect on their food supply there. Moreover, the mobility of Greater Snow Geese during the brood-rearing period may reduce the possibility of over-grazing at any given site.

Estimated Habitat Requirements

Concern has been expressed recently about the increasing flock size of this subspecies and the available food supply in its Canadian Arctic summering range (Anon., 1981). To obtain a first approximation of the minimum area of brood-rearing habitat required to support the entire Greater Snow Goose flock, we first calculated the energy requirements of the birds. From this estimate, we calculated an estimate of daily food intake. Finally, we compared this requirement to the forage production available across the arctic range occupied by this subspecies.

Drent *et al.* (1978/79) suggest that geese in the wild require 2.6 × BMR daily, where BMR is the Basal Metabolic Rate (in kcal/day) equal to 73.5 × weight (in kg)$^{0.734}$ (Aschoff and Pohl, 1970). Using a weight of 3.095 kg for a Greater Snow Goose (weight upon leaving the St. Lawrence River estuary staging grounds; Gauthier, 1981), we can establish the net daily energy requirements of a single bird at 438 kcal·day^{-1}. Assuming an apparent digestibility (AD) of 30% for the summer forage available to the birds, this net energy requirement will be met through the ingestion of 1460 kcal·day^{-1} (gross energy intake). The AD value of 30% was established by Gauthier (1981) for Greater Snow Geese feeding on a diet of 90% grasses and 10% clover in spring. The gross energy requirement can be converted into an estimate of 305 g (dry weight) of food per day using the figure 4.78 kcal·g^{-1} obtained by Muc (1977) for various monocots on Devon Island. Finally, the summer population has been estimated at 300 000 (Anon., 1981), including about 120 000 goslings which, despite their smaller size, can be treated as adults because of their greater growth requirements. The daily consumption by the entire flock would thus amount to 91 500 kg and since the population resides on its arctic range for about 100 days, its seasonal gross food consumption (dry weight) can be estimated at 9150 metric tons. As discussed previously, a conservative NAPP estimate of 35 g·m^{-2} is probably reasonable for the arctic rearing habitats, so the 9150 metric tons of forage could be produced in an area of about 300 km². The Arctic Ecology Map Series of the Canadian Wildlife Service (1972) shows a total area of 47 500 km² defined as "waterfowl habitat" within the Greater Snow Goose breeding range as outlined in Anon. (1981). Even if we assume that only 13% of this area is optimal (as in our Jungersen Bay study area), we find that over 6000 km² of suitable habitat is available for Snow Geese, or 20 times the minimum area required for the current flock, estimated on the basis of bioenergetic considerations.

Though these calculations are crude, and dependent upon many unverified assumptions, they nevertheless suggest that suitable summering habitat in the Canadian Arctic Archipelago is not likely to be in short supply at current population levels.

CONCLUSIONS

After Bylot Island, Jungersen Bay is the second most important breeding area for Greater Snow Geese (A. Reed, pers. comm. 1981). Based on our preliminary observations and on Cargill's (1981) work at La Perouse Bay, we conclude that it is unlikely that the present goose population will have a detrimental effect on the vegetation used as a food source. We recommend that sites important to Greater Snow Geese be located and surveyed using the habitat types described in this paper. The presence of numerous ponds within wet meadows appears to be an essential characteristic of goose habitat during the brood-rearing period. The vascular plants consumed by geese are more abundant in such areas, and in addition, ponds provide an essential means of escape from predators or other disturbances during the birds' flightless period. Once located, these areas should receive special protection.

Further habitat studies should determine the plants selected by Greater Snow Geese as food sources. This would require quantifying the relative availability of each species within the marshes as well as determining their proportion in the diet. It would be interesting to conduct such an evaluation at several sites across the Greater Snow Goose breeding range. The next step would be to determine the biomass consumed by geese and to evaluate the effect of such grazing on the plants. The experimental design used by Cargill (1981) with a series of exclosures and control plots is a promising approach. Finally, this information could be placed in perspective with bioenergetic studies including time and energy budgets.

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