THE BREEDING BIOLOGY OF THE GREATER SNOW GOOSE, Chen hyperborea atlantica ON BYLOT ISLAND, N.W.T.

by

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Introduction

The population of the Greater Snow Goose, Chen hyperborea atlantica increased in number approximately from 4,000 in 1900 to 80,000 in 1957, according to censuses taken in the Cap Tourmente area on the St. Lawrence River 40 miles east of Quebec City. (As discussed later, some Lesser Snow Geese, C. h. hyperborea, may mix with the flock.) The increase, while most satisfactory, made it essential for good management to understand better the natural history of the subspecies.

The geese winter along the Atlantic Coast of the United States from New Jersey to North Carolina, where the range is extensive and the food abundant. The flocks stop at Cap Tourmente during spring and autumn migration; there they occupy a very limited area where the food supply (Scirpus americanus) might conceivably become a factor limiting the size of the population.

It was desirable to find out what the limiting factors are on the arctic nesting-grounds, as little was known on the subject. It was my privilege to be sent north in 1957 by the Canadian Wildlife Service for that purpose. Bylot Island was chosen as the site of investigation when it became apparent upon preliminary enquiry that a considerable number of geese nested there.

I left Mont-Joli, P.Q., May 18, arrived at Frobisher Bay on the 19th and, after some delay, landed at Pond Inlet on the 27th. I crossed by dog sled to Bylot Island on June 4 and camped for the summer at the mouth of the Actineqdjuak River (see map). I returned to Pond Inlet on August 26 and boarded the C.G.S. C.D. Howe there on August 29 for the home voyage.

Study Methods

I found two goose colonies not far from my camp site, one with 28 nests, the other with 33. I visited the colonies regularly at intervals of two or three days, numbered the nests, and measured and marked the eggs. Data were recorded for each nest on nest location, egg laying, clutch size, incubation, and hatching. Other colonies were located later, and observations were made of some nests in them as well. After hatching was over, I followed the broods as they spread out overland, and watched their progress and movements until the young reached the flying stage. I explored thoroughly the southwest corner of the island, noting topographical features, vegetation, other goose colonies, etc. Observations were made on the food, feeding habits, behaviour, and moult of the geese. Seven hundred and seventy-nine (779) geese were trapped and banded.

Topography and Climate

Bylot Island, (Lat. 73° N.; Long. 80° W.), lies northeast of Baffin Island, from which it is separated on the west by Navy Board Inlet and on the south by Eclipse Sound and Pond Inlet. It is bounded on the north by Lancaster Sound and on the east by Baffin Bay. It is roughly rectangular in shape, is approximately 80 miles long from

east to west and 70 miles from north to south, and has an area of about 4,500 square miles. Most of the island is mountainous and covered by a snow field; the mountains and glaciers extend to the sea except at the northeast and southwest corners of the island, where there are rather extensive lowlands. I spent the summer of 1957 at the southwest corner of the island, which may be further described as follows.

East of the Actineq River in Eclipse Sound, a mountain range runs inland from the coast northwesterly, to fall again into the sea just south of Canada Point in Navy Board Inlet. The triangular area between the hills and the west coast, which has a superficies of 500 square miles, is a vast outwash plain cut by rivers and creeks flowing from the glaciers. The plain is elevated above sea level, forming a plateau which can best be described as very gently rolling. The plateau is wet and marshy; much of it is grassy although some high areas are bare and gravelly, probably the result of drainage and exposure to wind. The plain is dotted with small lakes and ponds, all very shallow and generally devoid of aquatic vegetation. There is a drop of up to 200 feet from the plateau to the shore, where the terrain is much rougher; the declivity is deeply cut by the large rivers and to a lesser extent by streams and rivulets, and has been eroded by rain and wind. The slopes of the ravines are usually covered by heath (Cassiope tetragona) and willows (Salix sp.) mixed with a variety of other flowering plants. Snow accumulates in the gullies but melts rapidly in the spring as the temperature rises. In Eclipse Sound

the wind is almost always from the east. The westward slopes of the valleys and ravines, sheltered from the wind, exposed to the afternoon sun, and well protected by the snow cover in winter, support a dense vegetation; but the eastward slopes, of exposed glacial material, are generally barren. In Navy Board Inlet, where the wind is mainly from the northwest, its effect on the land is not so apparent and most of the valleys are uniformly covered with vegetation.

Below the main slope from the plateau there are two or three raised beaches of re-washed glacial debris leading to the present seashore which is sandy and gravelly.

Winter was drawing to its end when we arrived at Pond Inlet on May 27. The days were long and the snow was beginning to melt. The sun did not set from early June to late July. There was surprisingly little snow, the average annual snowfall being approximately 10 inches. Ice, however, reportedly forms about six feet thick in the bays and straits. The ice in Eclipse Sound did not break up until the last part of July, and it was August 6 before I could use a small boat.

The temperature was occasionally below freezing in early June, but throughout the summer it averaged on the coast 45° F. during the day and 36° F. in the evening. Temperatures were sensibly higher inland, away from the chilling influence of the sea ice or water; they sometimes rose to 60° F. and once to 65° F.

The sky was generally clear, but twice we had a week of continuous high winds and rain. On the whole, the season was dry, although the inhabitants of Pond Inlet referred to it as unusually wet.

Breeding Biology of the Snow Geese

Arrival and Nesting

We saw a small group of four geese on May 30, flying eastward along the high cliffs of southeast Bylot Island, headed for Button Point or perhaps the floe edge. The weather was still windy at that time and snow had hardly begun to melt. On June 2, an Eskimo arrived at Pond Inlet who had seen snow geese at the southwest corner of Bylot. On June 5, I observed about 200 geese behind my camp below the main plateau on the island; from then on, geese could be seen every day. No great flocks were ever seen arriving but the number of geese in the area built up rapidly. Breeding birds were already paired and soon retired from the beaches to the nesting sites. Only non-breeders remained in flocks that could be seen here and there throughout the summer.

I found the first nests on June 13. The geese breed in ravines at the edge of the plateau and sometimes on rather flat land between hills, generally in colonies ranging from 25 to 300 nests, though a few isolated nests were seen. No nests were found anywhere but on the slope leading to the plateau, between one-quarter mile and two miles from the seacoast.

Not all the ravines were occupied by nesting geese, and the Eskimos reported that the birds do not necessarily use the same ones year after year. They seem to choose their nesting areas each year from a vast number of favourable locations scattered between the Actineq River and Canada Point, a distance of about 60 miles. In 1957, the easternmost breeding colony was situated two miles east of the site of my camp. Eskimos say that the Actineq River valley is sometimes colonized by geese, but not often. I studied closely a stretch of coastline 15 miles long and found colonies spaced along it at an average interval of one mile.

Along the south shore of Bylot, the geese generally nest on the westward slopes of ravines which, as has been mentioned, are the protected ones and have a good cover of vegetation. The entire slope, from top to bottom, may be utilized. I found nests on the tops of hills or on screes where there was no protection from wind; however, around these sites there was always some vegetation, from which the nest was built. The nest site must be dry. Snow may remain all summer along some of the ridges. The melting snow wets the slopes beneath, and those wet spots are not used for nesting. Geese feed there, however, since the moist earth is easy to dig in. For the colonies located on relatively flat land between hills good drainage is also a requisite. A few isolated nests and sometimes groups of two to five nests are found occasionally a considerable distance from any colony.

No eggs were laid in the colonies under observation after June 20. The laying period therefore extends approximately from June 8 to June 20, and reaches its peak between June 12 and June 17.

Eggs are laid at the rate of one per day, except that there is often a break after the third egg is laid when one day is generally skipped.

One hundred and twenty-three (123) eggs were measured. The average length was 81.2 mm., (range 73.8 mm. to 91.4 mm.), and average diameter 53.4 mm. (range 50.0 mm. to 57.4 mm.).

One hundred and eighteen (118) nests contained a total of 545 eggs. The average clutch size was thus 4.6 eggs (s.d.: 1.5), and the clutches varied from two to nine eggs.

There is a tendency for early nests to have larger clutches than late ones, as seen in the following table.

Date first egg laid	No. & Size of clutches	Average clutch size
June 10	4(7,6,7,6)	6.5
June 11	2(6,5)	5.5
June 12	6(5,5,5,5,4,5)	4.9
June 13	6(5,3,4,3,4,4)	3.9
June 14	4(4,5,5,2)	4.0

It may be that late nesters are young birds breeding for the first or second time.

The fate of 253 eggs in 52 nests was determined and is presented in the following table:

Fate	Numbers	%
Hatched	147	58.1
Deserted	76	30.9
Destroyed	30	11.9
Not hatched	106	41.9
Total	253	100.0

Of the 52 nests, 13 were deserted, four were completely destroyed by predators and eight had part of their complement of eggs destroyed. Of the latter, six lost one egg each and two lost three eggs each. Eggs which remained in the eight nests hatched.

Eggs noted as destroyed were probably taken by weasels, ravens, jaegers, or other predators, although some may have been accidentally broken by incubating geese.

No infertile eggs were noted.

Desertion may have been caused in part by my visits to the colonies.

In an attempt to obtain information on egg replacement, I removed from one to three eggs from ten other nests. The missing eggs were never replaced nor were any identifiable re-nesting attempts observed.

Incubation and Hatching

Although the adult birds remain on or near the nest during the egg-laying period, incubation presumably begins only after the clutch is complete, since all the eggs in a nest hatch at about the

same time. The length of the incubation period is here considered as the period extending from the time the last egg of the clutch is laid to the time that same egg hatches. The length of the incubation period could be ascertained from 18 nests as follows:

No. Days	No. Nests
23	8
24	6
25	4

Thus incubation lasts from 23 to 25 days.

It appears that only the female incubates, although this was not verified by marking the birds. Only the females incubate among Lesser Snow Geese (Chen hyperborea hyperborea) and Pink-footed Geese (Anser brachyrhynchus), and probably the same is true of greater snow geese. I never observed the birds to alternate at the nest. The male stands watch near the nest, always at the same post. As the season advances the droppings accumulate at his post and this has also been noted for pink-footed geese by Scott and Fisher (A Thousand Geese, 1954). The gander's watch-post may be a few feet away from the nest or close to it.

The geese are territorial, the territory consisting in a very small defended area around the nest. Both birds were observed defending the territory against other geese which penetrated it.

The geese are quite shy of human beings. They generally flew or walked away when we got to within about 200 feet of the nest. Only near the end of the incubation period or during the hatching period did some birds become bolder, keeping close to

their nest and hissing at us in a fine display of defensive behaviour. They were usually quick to return to their nests after we had departed.

The geese do not move around much during incubation: they feed in the valleys near the nesting sites. They fly hardly at all at that time except when disturbed, and one can seldom see any geese but non-breeders except in breeding colonies.

Hatching in 56 nests took place between July 8 and 13 as follows: July 8, two; July 9, 16; July 10, 8; July 11, 16; July 12,12 July 13, two.

I saw only two unhatched clutches after July 13.

Hatching success was perfect; in the nests seen, all the eggs hatched except those destroyed by predators or deserted.

The Young

As soon as all young are dry, the broods are taken to the main plateau where they gradually spread out, some going far enough inland to reach the foot of the mountains. Approximately a week after the hatching period, the broods are scattered all over the plateau and the ravines are completely deserted. The food of the young geese consists mainly of paludal herbaceous plants on which they browse. They feed very actively almost twenty-four hours a day.

Family ties are very strong and exclusive. I placed among one brood three goslings captured when their parents deserted them during a chase. The foster parents soon moved away to another pond with their own brood, leaving the newcomers behind unattended. Incidentally, the three young birds remained on their pond throughout

the season and matured successfully to the flying stage.

In August, when the young geese have attained a good size, the broods start moving back slowly toward the coast. Flocks are formed as broods meet, small at first, but enlarging rapidly as they get closer to the shore. By August 20, huge flocks of geese are seen on the coast all along the southwest corner of Bylot.

The Moult

Breeding birds begin to moult soon after the young are hatched, about July 25. On August 16 adult birds were seen flying again for the first time, but some were still flightless on August 25.

In the spring the non-breeding geese spend their time feeding and resting near the coast or at the edge of the plateau while those breeding are busy nesting. They remain in flocks throughout the summer: flocks of anywhere from 20 to 200 were seen. In July when the snow melts, they begin to go farther inland and frequent the large ponds. On July 14, the first moulting sub-adults were seen, 16 on one pond and 10 on another. There were a few broods on the same ponds. On July 16, a flock of 60 flightless non-breeders was found. Later we trapped 131 from one large pond. On August 6, we saw the first flying sub-adults, a flock of 250. The smaller flocks probably group together after the moult is over.

The Food of the Geese

Early in the spring, at the beginning of June, the geese seem to feed mostly on the roots of Oxytropis maydelliana. This plant grows in clusters which often stand out through the thin snow cover and are readily spotted. The geese dig the roots out and most

clusters showed signs of having been worked over. For the rest of the summer the food of the adult geese is the bulbous root of Polygonum viviparum which is very abundant. It grows on all kinds of terrain, dry or wet, gravelly, sandy or humic. It is specially common on wet slopes, growing through the moss cover. The root is easily dug out of such ground and the geese feed intensively on it, especially in areas close to the nesting sites. On well-utilized slopes, the moss may be seen pulled out and laid aside for roots of Polygonum to be dug up and eaten. The activity of geese feeding on this plant may generally be observed all over the feeding area.

It is evident that the geese also feed on other vegetation such as blades of grass and leafy plants, especially during the time they spend on land with their broods.

The food of the young geese is mostly paludal vegetation, which they browse. During some of the drives we organized to trap flightless birds, I noticed that the young birds fed constantly while walking, on blades of grass.

The food supply is certainly not a problem on Bylot, plants such as Polygonum being abundant. It seems that such plants are common all over the areas where greater snows breed.

Trapping and Banding

As previously stated we banded 779 geese on Bylot. The first captured were 12 flightless non-breeders located on a small pond on July 14. Three broods with non-moulting adults accompanying them also occupied the pond. The trap we used throughout the summer was made of poultry wire of one-inch mesh, four feet high. The

trap was ten feet or less in diameter. It opened into a long funnel built of nylon fish netting of two-inch mesh, five feet high. The trap was located at a convenient place on the shore where the pond was narrow and shallow. The wings of the funnel were extended along both shores. We then stretched a strong rope over the pond, and, starting from the side opposite the trap, drove the geese toward the funnel. We soon found out that a water-tight tin can containing a few pebbles was of great help: it served to float the rope and rattled merrily when the rope was jerked. It could also be moved sideways when the rope was pulled by either operator. In that fashion we moved toward the trap pushing the geese ahead of the rope. We often had difficulty with the rear bird, which would try to jump the rope and swim back to the other end of the pond. If it succeeded in getting over or under the rope, the others would invariably follow, and we had to start all over again. When the birds were close to the trap we generally had to enter the water to force them into it. In one instance where 131 sub-adults were trapped on a rather large lake, we had to work the birds for three hours to capture them.

The reaction of the geese as we approached them from a distance was not always the same. If we could surprise them they would swim to the middle of the pond when they saw us. If, however, they could see us coming from a distance they would often scramble up the shore and take off, running overland at a speed we could not match. This often rendered our work difficult as the flatness of the plateau made it hard to sneak up on the birds.

On July 29, we banded the first broods after trapping them in the manner described above. The young were then big enough to wear bands. In our banding we covered the area to a distance of about twelve miles from camp to the west, six miles to the east, and six miles inland. We continued banding until August 7 when the small motorboat we were to use until the end of the expedition arrived at the camp. We then made a trip to Cape Hay during which we noted that the geese were concentrating on the coast.

On August 16, we went by boat to the southwestern tip of the island on a banding expedition. The first flocks we met, congregations of broods, were on the shore. When they saw the boat the birds would start running ahead of it on the shore. Our technique then was to catch up with them and let two men jump ashore with the trapping equipment and run after the geese to prevent them from fleeing inland. Eventually the flock would take to the water where the motorboat would round them up and bring them back to the site where the trap was being put up. The trap was built on the shore, one side of the funnel entering the water and the other extending along the shore about 15 feet from the water. The two men ashore hid themselves while the motorboat operator herded the geese ashore. He then jumped out after the geese while the other men showed themselves and all together worked the birds into the trap. Half of the flock often managed to escape by swimming away, but catches were nevertheless good.

When we arrived at the point on the corner of the island, we spotted large flocks of geese on a coastal marsh. We set up a trap

on shore and went after the closest group, about one-quarter mile away. We surrounded that flock and drove it slowly to the trap. There were close to 300 birds in the flock, but many escaped by running away. We finally caught 43. However, we had learned a technique during that drive and believed we could do better if we tried again.

The main flocks were quite a distance away from us, but we decided to try and round up a few. One man followed the shore, one headed inland to surprise the geese from behind, while the third after a short wait walked straight for the geese. The pincer movement was successful and we finally had about 2,000 geese herded together. We then undertook to walk them to the trap, a mile and a half away.

One man walked in front of the flock and the two others brought up the rear. The Eskimos think that the geese follow the leader but I rather believe that they are pushed forward by the men behind and the leader merely prevents them from running away. It is interesting to note that the flock assumed a triangular shape to match the arrangement of the three men, one side of the triangle facing each man. The flock was thus moving on a broad front which tapered off to the sides and rear. As long as we kept the flock moving we had no trouble keeping the birds in order; but if we stopped they faced in all directions and tried to escape. During the march the birds we had to watch were these at the tips of the triangle; a few rapid steps would bring them back into the flock. Some birds had completed their moult and they took to flight; but

after a few circles around the flock they would generally alight back among the group, showing a strong gregarious instinct.

We finally let half the flock go; this was easily done by the lead man's abruptly stopping to let part of the flock walk past him. We then re-formed the remainder for driving. After a one-hour walk, including detours around bodies of water, we reached the trap site. We ran in enough geese to fill the trap, backed the remainder away, and two men held them while the other built a second trap from one wing of the funnel. We filled that trap too and then let the rest go. They settled down a hundred feet from the trap, many going to sleep, and finally walked slowly away. We banded the 340 geese we had captured. The banding expedition had lasted 38 hours and 514 geese had been banded.

Those were the last geese we trapped. After that date most of the geese could fly and could not be captured. However, some broods not so far advanced were seen.

Culmen Length

I measured the culmen of 79 of the adult geese banded; the average length was 64.1 mm, the minimum 57.0 mm, the maximum 71.0 mm, and the standard deviation 3.3 mm. I had previously measured the culmen of 79 geese shot by hunters during the fall of 1956 at Cap Tourmente. The average length in that case was 62.0 mm., the minimum 54.7 mm., the maximum 70.7 mm., and the standard deviation 3.0 mm.

The difference between the means, 2.1 mm., is significant ($\pm$.0). However, since 47 of the bands I placed on the geese

at Bylot have up to now been recovered in the Cap Tourmente area and only one elsewhere in Canada it is safe to assume that the Bylot geese are from the Cap Tourmente flock. Possibly enough lesser snow geese join the flock at Cap Tourmente to cause the difference in culmen length; the hypothesis is supported by the recovery at Cap Tourmente in October, 1957, of a snow goose banded in August, 1957, on Southampton Island. Moreover, only three blue geese (Chen caerulescens) were seen at Bylot out of approximately 20,000 snow geese, while at Cap Tourmente, the ratio of blues to snows is roughly one out of 1,000. Since the presence of blues generally indicates the presence of lesser snows, one may conclude that there are more lesser snow geese mixed with the flock at Cap Tourmente than on Bylot. However, only immatures of the year were measured at Cap Tourmente, while only adults were measured at Bylot; it could be that the culmen of young birds is not yet fully grown when they arrive at Cap Tourmente in autumn. That is probably the more plausible explanation for the observed difference in culmen size.

Predators

The snow geese are not bothered to any great extent by predators on their Bylot breeding grounds. Foxes, weasels, dogs, ravens, owls and jaegers may occasionally prey on the adults, eggs, or young.

Foxes were not abundant enough in 1957 to cause much trouble; no evidence of fox depredation was noted. Eskimos and

whites agreed that the effect of foxes is very limited. Weasels may destroy some eggs, but one goose should be able to deal with a weasel easily unless, of course, it came at a time when both geese were away from the nest. Dogs can undoubtedly cause much destruction in a goose colony; Eskimo dogs roam the country constantly whenever they are let loose, and often cover great distances. I have seen dog tracks in a goose colony while there was still snow on the ground, and evidence of dog depredation on eggs. Fortunately, Eskimos do not often camp on the part of Bylot Island where the geese breed. Jaegers are specially abundant in the area but ravens are scarce. The geese showed signs of wariness when they sighted either of those birds, but it does not appear that they are important predators. Snowy owls apparently do not prey on goslings very much. Only once did I find a dead gosling on the rim of an owl's nest, while there were always a few dead lemmings there. The geese would not nest so close to owls if they were usually bothered much by them. They may even do so because owls rid the habitat of weasels.

The natives do not take many geese or eggs. They are busy hunting seals and other marine mammals throughout the nesting season. Food is plentiful then so they do not bother going after geese or goose eggs. Children from a camp may go egging if there is a goose colony close by. According to R.C.M. Police and the Hudson's Bay Company people, the Eskimos do not utilize geese to any great extent in the Pond Inlet district. On the other hand, my guide was quite familiar with techniques for catching geese; and the birds we forced

into the water and rounded up with the boat could easily have been clubbed or shot. It is a fair presumption that travelling Eskimos occasionally procure a few geese in that manner. Since the meat cannot be preserved at that time of the year I doubt whether they take more than what they can use in a short period. I do not think Eskimos would make special trips after geese unless food became scarce.

Conclusions

The number of observations is often too small to allow drawing definite conclusions, but I believe we now have a good enough idea of the whole picture for management purposes. I do not think that any factors in the breeding area of the geese might be considered as limiting the size of the population. The breeding grounds are so vast that additional nesting areas would certainly be available if the population increased significantly, specially when considering that geese do not require exclusive nesting sites. The food supply is not a problem either; the plants which the geese feed on are widely distributed and common throughout the Eastern Arctic.

There have been, however, some poor reproductive seasons for greater snow geese and it is safe to assume that there will occasionally be others. It must be borne in mind that the breeding period of the geese extends throughout the whole favourable season in the high Arctic - they start to nest when spring has hardly begun and leave with their young in September when winter is well on its way. Nights were already long when I left Bylot at the end

of August and were lengthening rapidly, and ice was beginning to form at the edge of small ponds. It is quite apparent that a late spring, it may be also an early autumn, could have a very adverse effect on the reproduction of the geese. A heavy snowfall in the spring, at the time geese normally start nest building, might cover the ground long enough to delay them so long that the young would not be able to leave on time in the autumn. There is normally just enough time for the geese to breed successfully during the summer, and any shortening of that time would be important.

Summary

The author spent the summer of 1957 on Bylot Island, N.W.T., studying the breeding biology of the greater snow geese. He arrived in the area on May 27 and remained until August 29. The geese nest mainly at the southwest corner of Bylot, where the land is relatively flat and marshy, and is protected from the north by the high mountains.

The first geese arrived on June 2. A total of approximately 15,000 nest in colonies on the slopes of ravines or on sheltered plateaus. Two colonies were closely studied and information gathered on egg laying, clutch size, incubation and hatching. The food, feeding habits, behaviour, and moult of the geese were also studied. The young begin to fly about August 20, approximately six weeks after hatching.

Seven hundred and seventy-nine (779) geese were banded, mostly young birds. Forty-seven bands have since been recovered

at Cap Tourmente, Quebec.

Food is plentiful for the geese on their breeding grounds, and it appears that there are no factors limiting the increase of the greater snow goose population in those areas.

DATE	ISSUED TO