NESTING COLONIES OF ROSS' GOOSE

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THE last nesting grounds of North American geese to be discovered were those of the Ross' Goose, *Chen rossii*. During the early 1950s population estimates from the wintering grounds in California indicated a total of 2,000 birds (Lloyd, 1952; Hanson et al., 1956). In 1958 the population had increased to 10,000 (Munro, 1958). Recently Dzubin (1965) estimated the population to be 44,000. In view of the apparent increase in numbers, evidently more nesting colonies now exist than Gavin (1947) and Hanson et al. (1956) reported in the Perry River Region, Northwest Territories. I investigated the distribution of Ross' Geese in the central Arctic in 1965, 1966, and 1967, to delineate its breeding range and determine the factors that define suitable nesting habitat for the species.

Between 18 July and 1 August 1949, Hanson et al. (1956) made aerial surveys of the mainland between the Ellice and Simpson Rivers, N.W.T. (see Figure 1), in search of Ross' Goose nesting colonies. The geese had already dispersed from the nesting lakes and no colonies were located.

In 1960, T. W. Barry, Canadian Wildlife Service, surveyed the western and central Arctic by air from the Anderson River (69° 45′ N, 129° 00′ W) to Sherman Basin (68° 00′ N, 98° 21′ W) (Barry, 1960). At the time of the survey (16–22 August) most of the geese had left the nesting areas, completed their postnuptial molt, and were able to fly. No nesting colonies were found, although 9,000 Ross' Geese were seen on the mainland along Queen Maud Gulf.

On 30 June 1938 Angus Gavin (1947) recorded the first nesting colony of 100 Ross' Geese at a small lake (now called Discovery Lake, at 67° 33′ N, 101° 49′ W) 14 miles southeast of the Perry River estuary. During subsequent searches in 1939, 1940, and 1941, Gavin found two other nesting colonies near Discovery Lake and estimated a breeding population of 600 pairs on the three lakes. Hanson et al. (1956) found a fourth colony of about 260 pairs on 28 June 1949, 25 miles south of the mouth of the Perry River on what is now known as Arlone Lake (67° 22′ N, 102° 10′ W). These four lakes were the only major nesting concentrations of Ross' Geese known before the present investigation. Hanson et al. (1956) found that Discovery Lake was abandoned in 1949, but do not mention Gavin's other two colonies. They found two Ross' Goose nests on a floodplain adjoining the Perry River and one on Goose Island, an islet in the Perry River, in June 1949; rising waters during the spring breakup destroyed all three nests. A total of 52 Ross' Geese have been reported

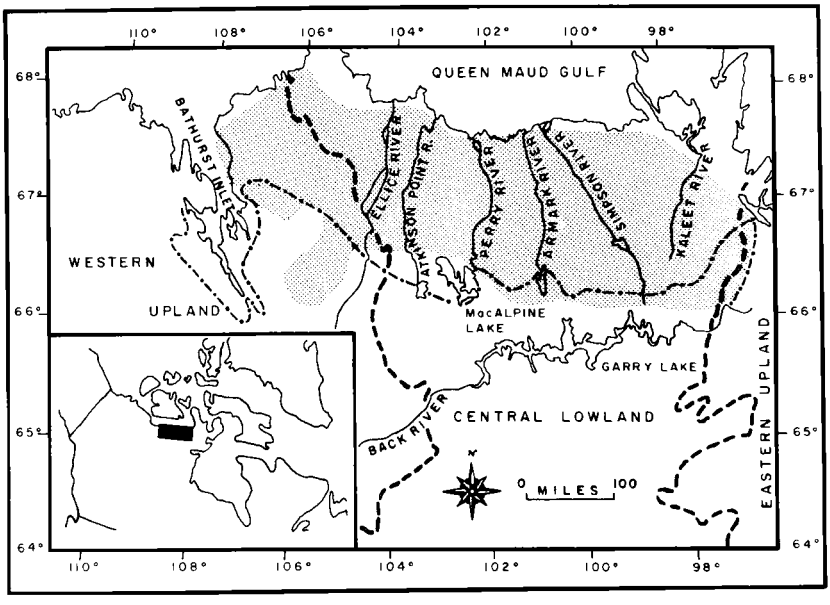

Figure 1. Map of aerial survey area (stippled) in the western upland, central lowland, and eastern upland portions of the central Arctic. The heavy broken lines separate the three physiographic regions. The dot-dash line is southern limit of post-glacial marine transgression (after Bird, 1967).

nesting elsewhere; in the Hudson Bay area in 1953 (Cooch, 1954), in the Boas River Delta on Southampton Island in 1956 (Barry and Eisenhart, 1958), on the McConnell and Boas Rivers in 1960 and the Boas River in 1961 (MacInnes and Cooch, 1963), and on Banks Island in the western Arctic (Manning et al., 1956; Barry, 1964).

I follow the A.O.U. Check-list (1957) in assigning the Ross' and Lesser Snow Geese to the genus *Chen*. Opinions differ regarding the status of *Chen*, which many students now lump with the genus *Anser*, following Delacour (1954).

Methods

Before initiating field studies, potential Ross' Goose nesting areas were selected by reference to the Ogden Bay map, National Topographic Series #66/104, and 1947 aerial photographs. Based on the characteristics of known colony sites (I define a colony as the population nesting at a lake), I marked lakes with islands and plotted flight routes on the Ogden Bay map. The normal survey speed and altitude of our float-equipped Cessna 185 aircraft were about 100 mph and 500 feet. These we reduced to 70 mph and 50–75 feet when approaching a colony. We usually made three flights over an occupied island, the first to estimate the number of geese, the second to estimate proportions of Ross' and Lesser Snow Geese (*Chen hyperborea*),

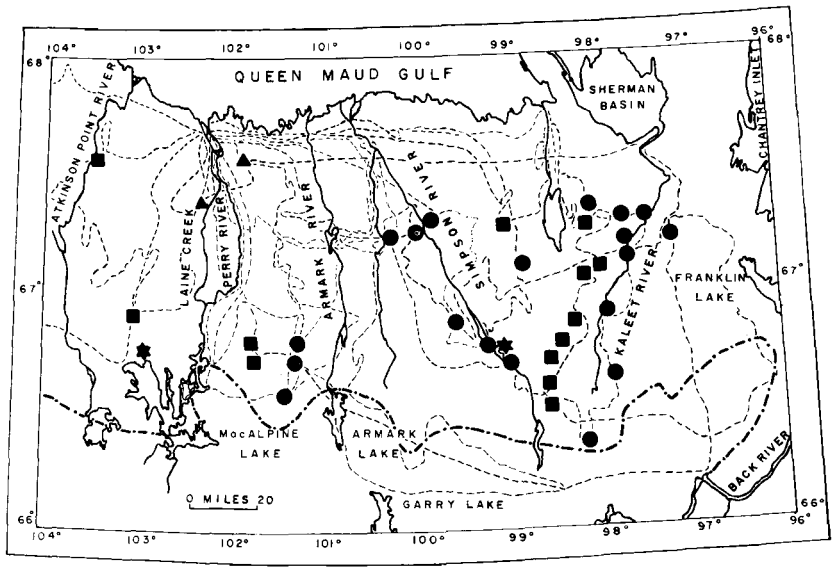

Figure 2. Distribution of Ross' Goose nesting colonies in central Arctic Canada. Circles, squares, and stars represent colonies discovered in 1965, 1966 and 1967 respectively. Triangles show location of Arlone Lake near Laine Creek, and Discovery Lake east of Perry River. Broken lines are daily flight routes of 1965 and 1966 survey. The 1967 survey route is not shown (see text). The heavy dot-dash line is the southern limit of postglacial marine transgression (after Bird, 1967).

and the third to note habitat conditions. The aircraft landed at colonies where water conditions permitted.

Ross' Geese in mixed Ross' and Lesser Snow nesting concentrations are comparatively easy to recognize from an aircraft. The small body size and wingspread, stubby bill, rapid wing beat, and short neck identify the Ross' Goose. When flocks of molting Ross' and Lesser Snow Geese approached by the aircraft flap across the water surface, the small size of the Ross' Geese is usually apparent, and we had little difficulty in estimating the numbers of each species. But the recognition marks are not infallible, and I estimate an error of perhaps 20 per cent in all population data.

Aerial surveys were conducted from 9–12 July 1965 and 14–15 July 1966. On 3–4 July 1967 we inspected from the air 19 colonies discovered in 1965 and 1966 to determine whether geese were still nesting on them.

SURVEY AREA

The survey boundaries in 1965 were 66° 10′ to 67° 59′ N and 96° 55′ to 104° 15′ W. In 1966 the boundaries were expanded to 66° 09′ to 68° 10′ N and 96° 05′ to 108° 14′ W. The survey covered a total of 3,876 miles. Of this total, 1,750 miles in 1965 and 1,370 miles in 1966 were flown in the central lowland between the Ellice and Kaleet Rivers (Figure 1). In 1966 we flew 656 miles between the Ellice River and Bathurst Inlet and 100 miles between the Kaleet River and Franklin Lake (Figures 1 and 2).

TABLE 1

LOCATION OF ROSS' AND LESSER SNOW GOOSE NESTING COLONIES DISCOVERED IN CENTRAL ARCTIC IN 1965

Nesting lake location	*Date of discovery*	*Estimated population*		*Status in*	
		Ross' Geese	*Lesser Snow Geese*	*1966*	*1967*
67° 15′ N, 100° 15′ W	9 July	12,000	5,160	+[1]	+
66° 35′ N, 101° 22′ W	9 July	30	150	+	+
67° 18′ N, 99° 45′ W	10 July	60	40	+	+
67° 15′ N, 99° 52′ W	10 July	200	30	+	+
67° 08′ N, 98° 47′ W	10 July	50	4	+	0
66° 54′ N, 99° 30′ W	10 July	2,600	1,200	+	+
66° 46′ N, 99° 11′ W	10 July	6,000	200	+	+
67° 22′ N, 98° 03′ W	11 July	5,000	600	+	+
67° 19′ N, 97° 25′ W	11 July	40		+	0
67° 18′ N, 97° 02′ W	11 July	60	25	+	+
67° 13′ N, 97° 10′ W	11 July	300	60	+	−
67° 11′ N, 97° 38′ W	11 July	60		+	+
67° 09′ N, 97° 40′ W	11 July	1,200	300	+	+
66° 53′ N, 97° 54′ W	11 July	40		+	+
66° 43′ N, 98° 55′ W	11 July	20	10	+	+
66° 39′ N, 97° 52′ W	11 July	200		+	+
66° 21′ N, 98° 10′ W	11 July	375	75	+	−
66° 55′ N, 104° 15′ W	12 July	50		+	−
66° 48′ N, 101° 16′ W	12 July	140	50	+	+
66° 43′ N, 101° 16′ W	12 July	100	25	+	+
	TOTAL[2]	28,525	7,929		

[1] + = colony site occupied, 0 = colony site unoccupied, − = not checked.

[2] This does not include 1,500 Ross' and 500 Lesser Snow Geese nesting at Arlone Lake and 12 Ross' Geese nesting at Discovery Lake.

The survey area includes the region of the Arctic commonly referred to as the "Barren Lands." Physiographically it incorporates parts of the western and eastern uplands and the northern sector of the central lowland in the Canadian or Hudson Bay Shield (Figure 1). The central lowland is a flat plain that slopes down to the north about 2.5 feet per mile (Bird, 1967). The range of relief is less than 20 feet except for an occasional Precambrian rock outcrop. Highest relief of 800 feet above sea level is at Nelson Hill (66° 46′ N, 102° 35′ W).

Structurally the lowland is of Precambrian rock which was overlain with sand and silts during the last glaciation and postglacial marine transgression (Bird, 1963). In the southern part of the lowland near MacAlpine lake, rock outcrops and extensive drumlin and boulder fields dominate the landscape. Similar conditions exist in the western upland which is basically a plateau 1,000–2,000 feet above sea level. Near Bathurst Inlet deep river valleys and rough hilly country prevail. The eastern upland is a lower plateau with level areas restricted by abrupt hill ridges and frequent rock surfaces and boulder fields (Bird, 1963).

Wet meadow and marsh tundra dominate the central lowland. It is characterized by frost-heaved tussocks of *Eriophorum vaginatum*, *Carex* spp., *Betula glandulosa*, *Ledum decumbens*, and *Rubus chamaemorus*. On elevated, well-drained sites a lichen-moss-vascular plant association exists with a variety of mesophytic and xerophytic species, predominately *Hierochloe alpina*, *Salix* spp., *Betula glandulosa*, *Papaver*

TABLE 2
LOCATION OF ROSS' AND LESSER SNOW GOOSE NESTING COLONIES DISCOVERED IN CENTRAL ARCTIC IN 1966

Nesting lake location	*Date of discovery*	*Status in 1967*
67° 34′ N, 103° 26′ W	14 July	+[1]
66° 54′ N, 103° 00′ W	14 July	–
66° 48′ N, 101° 43′ W	14 July	–
66° 43′ N, 101° 40′ W	14 July	–
67° 17′ N, 98° 58′ W	15 July	–
67° 16′ N, 98° 05′ W	15 July	–
67° 06′ N, 97° 57′ W	15 July	–
67° 04′ N, 98° 05′ W	15 July	–
66° 52′ N, 98° 15′ W	15 July	–
66° 43′ N, 98° 30′ W	15 July	–
66° 42′ N, 98° 30′ W	15 July	–
66° 37′ N, 98° 34′ W	15 July	–
66° 31′ N, 98° 30′ W	15 July	+

[1] Symbols represent status as indicated in Table 1.

radicatum, *Cassiope tetragona*, *Ledum decumbens*, *Vaccinium vitis-idaea*, and *Dryas integrifolia*.

RESULTS

Number and location of colonies.—We located a total of 35 Ross' and Lesser Snow Goose nesting colonies, 20 in 1965, 13 in 1966, and 2 in 1967 (Tables 1, 2, 3). All 20 lakes used in 1965 were occupied in 1966, and 2 of 19 colony sites found in 1965 and 1966 were not being used in 1967 (Tables 1 and 2). Arlone Lake was occupied by Ross', and Lesser Snow Geese all three seasons. Six pairs of Ross' Geese nested at Discovery Lake in 1965.

The colonies were situated between 66° 21′ to 67° 34′ N and 97° 02′ to 104° 15′ W. The location of 36 nesting colonies is shown on Figure 2. An additional colony at 66° 55′ N, 104° 15′ W lies outside the map area. The location and date of discovery of each colony is given in Tables 1–3. Only coordinates are given for each site because most of the lakes are unnamed.

TABLE 3
LOCATION OF ROSS' AND LESSER SNOW GOOSE NESTING COLONIES DISCOVERED IN CENTRAL ARCTIC IN 1967

		Estimated population	
Nesting lake location	*Date of Discovery*	*Ross' Geese*	*Lesser Snow Geese*
66° 46′ N, 99° 03′ W	4 July	150	250
66° 45′ N, 102° 53′ W	4 July	80	120

Lake characteristics.—All Ross' and Lesser Snow Geese were nesting on islands in shallow lakes estimated to be 2 to 6 feet deep. The aircraft could be landed on only four of them (66° 35′ N, 101° 22′ W; 67° 04′ N, 98° 05′ W; 67° 15′ N, 100° 15′ W; and 67° 22′ N, 98° 03′ W). The other 33 lakes were too turbid and/or too small to assure a safe landing. The deep lakes in the survey area become free of ice later in the summer (Peterson, 1965); Armark and MacAlpine Lakes were completely covered with ice in mid-July. No geese nested on the islands in frozen lakes and those with large quantities of floating ice.

Classification of island types.—Islands in lakes within the central lowland are of three general types. Type 1: Low and level with an estimated elevation of less than 5 feet above the water surface and with a smooth moss-grass cover. Type 2: High and rocky with extensive portions rising more than 30 feet from the surface and little or no vegetation. Type 3: Varied topography with well-drained rock-gravel areas 10–20 feet above the lake surface and a variety of plant and rock cover including moss-grass regions.

The vegetation of the islands at Arlone Lake is described elsewhere (Ryder, 1967). Island vegetation at Karrak Lake (67° 15′ N, 100° 15′ W) (Hornby, 1967) and three other colonies visited on the survey consists of areas of sedge (*Carex* sp.), mosses, especially along the low peripheral portions, scattered stands of *Betula glandulosa* and *Salix* spp., and patches of *Ranunculus sabinii, Potentilla hyperarctica, Cassiope tetragona,* and *Pedicularis sudetica. Petasites frigidus* and *Senecio congestus* are abundant at old nest sites, a result of fertilization by accumulated goose droppings. Kear (1962) reports a similar effect at goose roosts in England.

The vegetation on the nesting islands is similar to that on the dry portions of the mainland tundra. This may result from a similarity of substrate and elevation between the nesting islands and moraines, eskers, and rock outcrops. All are higher than the wet tundra, are well-drained, and have a dry soil in contrast to the deeper, wet organic soil of the wet tundra (Ryder, 1967).

Populations.—In 1965 and 1967 we estimated the numbers of Ross' and Lesser Snow Geese at each colony (Tables 1 and 3). We made no estimates in 1966 because breeding ecology studies prevented our making the survey until after hatching and dispersal from the nesting islands. We designated islands as nesting sites that summer only if they had freshly used nests and broods of geese in the vicinity. The number of adults and young near such islands was not considered a reliable indicator of the breeding population. In areas where colonies were close together as

at Kaleet River (Figure 2), it was impossible to judge from which lake a flock originated.

In July 1965 we saw on or near nesting islands 30,037 Ross' Geese and 8,429 Lesser Snow Geese that we considered breeding birds. An additional 2,049 Ross' and 1,473 Lesser Snow Geese not associated with nesting colonies we classed as nonbreeding birds in the postnuptial molt. The size of 42 flocks of molting geese varied from 6 to 500 individuals with an average of 111.

DISCUSSION

Food availability.—I suggest that the availability of food in the form of sedges and grasses is of major significance in the observed colony distribution. After the hatching period breeding adults need food in abundance to recover weight lost during nesting (Ryder, 1967) and to replace nutrients for the postnuptial molt. The young must grow rapidly to be able to fly when autumn temperatures drop below freezing approximately 40–45 days after they hatch. After the spring melting period in the central lowland, the many wet tundra marshes and meadows furnish an abundance of goose food. In contrast the extensive boulder fields and well-drained upland areas bordering the lowlands have a sparse vegetation dominated by an impoverished lichen-moss association. Food in such areas may be a limiting factor.

Lake requirements.—The present colony distribution may reflect the availability of islands in shallow lakes. The mean depth of Arlone Lake is about 3 feet and of Karrak Lake 4 feet. The importance of shallow lakes to nesting success was illustrated at Arlone Lake in the spring of 1964 when the slow spring melt allowed an ice bridge to remain between the mainland and one of the nesting islands until after nesting started (Ryder, 1967). In the first week of June arctic foxes (*Alopex lagopus*) destroyed 144 Ross' Goose nests and 122 Lesser Snow Goose nests. The geese then moved to other islands on the lake where water on all sides prevented further fox predation. Barry (1964) found that arctic foxes at the Anderson River Delta, N.W.T. avoided water; he describes how one fox walked nearly half a mile around a lake to reach a Brant (*Branta bernicla*) nest instead of wading 20 feet. Duebbert (1966) reports that Gadwall (*Anas strepera*) hens desert nesting islands when raccoons (*Procyon lotor*) are able to walk to them during periods of low water. On 16 June 1967 before the late spring breakup, I saw five arctic foxes on an island connected to the mainland by ice at Karrak Lake. From a blind I watched one of the foxes take the eggs from each nest one at a time, carry it to another location on the island, and bury it about 3 inches below

the surface. This fox destroyed more than 100 Lesser Snow Goose nests in a 5-hour period.

Similar ice conditions may have caused the abandonment of two lakes occupied in 1965 but deserted in 1967 (Table 1). Large pieces of floating ice were present in these lakes on 3 July 1967, and possibly ice bridges gave foxes access to the islands during the egg-laying period. In Spitsbergen, Barnacle Geese (*Branta leucopsis*) avoid arctic fox predation by nesting on offshore islands (Norderhaug et al., 1964), but occasionally arctic foxes cross sea ice and cause severe damage to the nesting geese (Lovenskiold, 1964). Hilden (1965) notes that a characteristic feature in the habitat selection of many ducks is the presence of the islands for nesting. He quotes authors who found ducks that avoid mammal predators by nesting on islands had significantly higher nesting success than the same species nesting on the mainland. Townsend (1966) found that ducks nesting on islands in the Saskatchewan River Delta had 27 per cent higher nesting success than those nesting on the mainland. Although no such comparative information is available for Ross' Geese, nesting success (the number of nests in a sample from which at least one egg hatches) at Arlone Lake in 1963 and 1964 was 97 per cent and 83 per cent respectively (Ryder, 1967). Except for the two instances cited for Arlone and Karrak Lakes, the islands were separated from the mainland by open water by the 3rd week in June. This coincides with the average time when most Ross' Geese start nesting.

If Ross' Geese nested on islands in lakes over 6 feet deep where melting is slower than in shallow lakes, arctic fox predation could increase to the point where the annual reproductive success would be too low to maintain the population, particularly as it is unlikely that Ross' Geese renest.

Island characteristics.—The elevation of an island above the lake surface is an important factor. Low level islands (Type 1) tend to flood during the spring breakup in early June. I saw five islands become submerged at Karrak Lake when the water level rose 3.5 feet above the ice level on 8 June 1966 and 18 June 1967. At least half the clutches on other islands had been started. The flooded islands have a smooth moss-grass cover and rise less than 3 feet above the lake. Possibly the geese have learned by experience not to nest on such islands.

The high rocky islands (Type 2) are unsuitable for goose nesting because they are usually steep-sided, have no level places, and lack food and nest materials. Both Ross' and Lesser Snow Geese must have dead twigs and leaves of *Betula glandulosa* and *Salix* spp., moss, and grass close at hand for nest construction. The sparse cover on these islands does not provide the geese enough food during the incubation period. Before in-

cubation the geese feed mainly on the wet tundra marshes. Incubating pairs seldom leave the nesting islands and are largely dependent on island vegetation for food.

The type 3 island is ideal for nesting because it furnishes all of the following requirements: (1) protection from flooding during the spring breakup, (2) necessary cover in the form of *Betula glandulosa* and *Salix* spp. and small jutting rocks, and (3) a supplementary food supply during the incubation period.

Postglacial submergence.—The distribution of Ross' Goose nesting colonies lies within the limit of the postglacial marine transgression in the central Arctic (Figure 2). Hanson and Smith (1950) and MacInnes (1966) found a similar correspondence between the occupied nesting range of Canada geese (*Branta canadensis*) and the limit of the postglacial sea in the Hudson Bay lowland. Although why such areas are preferred is unknown, MacInnes (1966) suggests that possibly the old sea bottom offers the most suitable topography or that available mineral nutrients may be involved (Ryder, 1964).

Other factors may influence the choice or suitability of colony sites. The inland location is generally inaccessible to Eskimos who have probably caused Ross' Goose to abandon some colony sites near the coast (Hanson et al., 1956). Past competition with the larger and more aggressive Lesser Snow Goose (MacInnes and Cooch, 1963) and the absence of depredation by gulls (*Larus argentatus* and *L. hyperboreus*) and jaegers (*Stercorarius parasiticus*, *S. pomarinus*, and *S. longicaudus*), which abound along the coast, also may have influenced the current distribution of Ross' Goose nesting colonies in the central Arctic.

The area surveyed has many lakes with islands that appear suitable for nesting Ross' Geese. Unless mortality on migration and on the wintering grounds limits them, further expansion of the Ross' Goose population can be expected.

ACKNOWLEDGMENTS

I would like to thank J. B. Gollop and Alex Dzubin, Canadian Wildlife Service, Prairie Migratory Bird Research Center, Saskatoon, and W. J. Maher, University of Saskatchewan, Saskatoon, for help with this article. Appreciation is extended to Spencer Sealy, Severin Sverre, and Sam Emingak for their assistance in the field. Financial support and equipment were supplied by the Canadian Wildlife Service. This paper is based on data collected for a graduate degree at the University of Saskatchewan, Saskatoon, Saskatchewan.

SUMMARY

Aerial surveys of the central lowland of the central Canadian Arctic in July of 1965, 1966, and 1967 revealed 35 Ross' Goose nesting colonies on islands in shallow lakes estimated 2 to 6 feet deep. The population

estimated on nesting islands in 1965 was 30,037 Ross' Geese and 8,429 Lesser Snow Geese.

Food availability in the form of sedges and grasses is of major importance in the observed colony distribution. The colonies are within a poorly drained area once inundated by the postglacial marine transgression and characterized by extensive wet tundra marshes and meadows. Food for the geese is plentiful.

In shallow lakes early melt water prevents arctic foxes (*Alopex lagopus*) from reaching the islands across ice bridges. Suitable nesting islands rise about 10–20 feet above the lake surface and do not flood during the spring breakup. They provide nest material, cover, and food during the incubation period. Other factors that may have contributed to observed distribution of Ross' Goose nesting colonies are past competition with Lesser Snow Geese and heavy avian and human (Eskimo) predation.

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