DISTRIBUTION OF NESTING COLONIES AND HABITAT REQUIREMENTS OF ROSS' GOOSE

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The nesting grounds of the Ross' goose Chen rossii (A.O.U. Check-list, 1957) were the last of the North American geese to be discovered. During the early 1950's population estimates from the wintering grounds in California indicated a total number of 2,000 (Lloyd, 1952). In 1958 the population had increased to 10,000 (Munro, 1958). Banbin (1965) estimated the population to be 44,000. In view of the apparent increase in numbers, it was evident that there were more nesting colonies than reported by Cavin (1947) and Hanson, Queneau and Scott (1956) in the Perry River Region, Northwest Territories.

In 1965, 1966 and 1967, I investigated the breeding distribution of Ross' geese in the central Arctic in order to delineate its breeding range and determine the factors which define suitable nesting habitat for the species.

Between 18 July and 1 August 1949, Hanson et al (1956) aerial surveyed the mainland between Bathurst Inlet and the Simpson River, N.W.T. (See Fig. 1), in search of Ross' goose nesting colonies. The survey was conducted after the geese had dispersed from the nesting lakes. No Ross' geese were definitely identified.

In 1960, T.W. Barry, Canadian Wildlife Service, conducted an aerial survey of the western and central Arctic to locate Ross' goose nesting areas. The survey extended 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 dispersed from the nesting

areas, completed their post-nuptial molt and were able to fly. No nesting colonies were located although 9,000 Ross' geese were observed on the mainland along Queen Maud Gulf.

On 30 June 1938 Angus Gavin found the first recorded nesting colony of 100 Ross' geese at a small lake (now called Discovery Lake, 67°33'N, 101°49'W), 14 miles southeast of the Perry River estuary (Gavin, 1947). 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. The fourth colony of about 260 pairs was found by Hanson et al (1956) 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 known major nesting concentrations of Ross' geese in the central Arctic before this investigation. Hanson et al (1956) found that Discovery Lake was abandoned in 1949. They do not mention Gavin's other two colonies. Hanson et al (1956) found two Ross' goose nests on a flood plain adjoining the Perry River and one on a small island (Goose Island) in the Perry River in June 1949. All three nests were destroyed by rising waters during the spring break-up. A total of 52 Ross' geese have been reported nesting elsewhere; in the Hudson Bay area in 1953 (Cooch, 1954), the Boas River Delta on Southampton Island in 1956 (Barry and Eisenhart, 1958), 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, Hahn and Macpherson, 1956 and Barry, 1964).

METHODS

Before field studies, potential Ross' goose nesting areas were selected by reference to the Ogden Bay Map, National Topographic

Series #66/184 and 1947 aerial photographs. Based on the characteristics of sites of known colonies, lakes with islands were marked for surveillance. I have defined a colony as the population nesting at a lake.

A Cessna 185 aircraft equipped with floats was used. Flight routes were recorded on the Ogden Bay Map. The normal survey speed and altitude of about 100 miles per hour and 500 feet were reduced to 70 miles per hour and 50-75 feet when approaching a colony. Three flights were usually made over an occupied island, the first to estimate the number of geese, the second to estimate proportions of Ross' and lesser snow geese and the third to note habitat conditions. The aircraft landed at colonies where water conditions permitted.

Ross' geese in mixed Ross' and lesser snow goose (Chen hyperborea) nesting concentrations are comparatively easy to recognise from the aircraft by an experienced observer. The small body size and wing spread, stubby bill, rapid wing beat and short neck identify the Ross' goose. Mixed flocks of molting Ross' and lesser snow geese approached by aircraft flapped across the water surface. The small size of the Ross' geese was apparent and little difficulty was experienced in estimating the numbers of each species. The above parameters are not infallible and I estimate a 20% error in all population data.

Aerial surveys were conducted from 9-12 July 1965 and 14-15 July 1966. On 3-4 July 1967, 19 colonies discovered in 1965 and 1966 were inspected from the air to determine whether they were still being used by nesting geese.

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'N 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 River and the Kaleet River (Fig. 1). In 1966, 656 miles were flown between the Ellice River and Bathurst Inlet and 100 miles between the Kaleet River and Franklin Lake (Fig. 1 and 2).

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 (Fig. 1). The central lowland is a flat plain which 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 post-glacial 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 at an altitude of 1,000-2,000 feet above sea level. Near Bathurst Inlet deep river valleys and rough hilly country prevails. 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, predominantly Hierochloe alpina, Salix spp., Betula glandulosa, Papaver radicatum, Cassiope tetragona, Ledum decumbens, Vaccinium vitis-idaea and Dryas integrifolia.

RESULTS

Number and location of colonies— Thirty-five Ross'-lesser snow goose nesting colonies were located in 1965, 1966 and 1967. Twenty were discovered in 1965, 13 in 1966 and two in 1967. All 20 lakes used in 1965 were occupied in 1966 and two of 19 colony sites located in 1965 and 1966 were not being used in 1967 (Tables 1 and 2). Arlene 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'-67°34'N latitude and 97°02'-104°15'W longitude. 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 latitude and longitude are given for each site because most of the lakes are unnamed.

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 small to assume a safe landing. The

deep lakes in the survey area become free of ice later in the summer (See Peterson, 1965); Armark and MacAlpine Lakes were completely covered with ice in mid-July. The islands in frozen lakes and those with large quantities of floating ice were not used by geese for nesting.

Island characteristics—— Islands in lakes within the central lowland were of three types; 1) low and level with an estimated elevation of less than 5 feet above the water surface and with a smooth moss-grass cover; 2) high and rocky with extensive portions rising more than 30 feet from the surface and little or no vegetation and 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) (See 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 hyparctica, Cassiope tetragona and Pedicularis sudetica. Potagites frigidus and Senecio congestus are abundant at old nest sites, a result of fertilization by accumulated goose droppings. Kear (1962) reported 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, estimates were made of the numbers of Ross' and lesser snow geese at each colony (Tables 1 and 3). In 1966 no estimates were made because breeding ecology studies of Ross' geese prevented our conducting the survey until after hatching and dispersal from the nesting islands. Therefore, islands were designated as nesting sites only if there were freshly used nests on them 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 because in areas where colonies were close together (cf. Kaleet River, Fig. 2), it was impossible to judge from which lake a flock originated.

In July 1965, 30,037 Ross' geese and 8,429 lesser snow geese were seen on or near nesting islands and were considered breeding birds. An additional 2,049 Ross' and 1,473 lesser snow geese were not associated with nesting colonies and were classed as non-breeding birds in the post-nuptial molt. The size of 42 flocks of molting geese varied from 6 to 500 individuals with an average of 111.

DISCUSSION

Food availability and colony distribution— 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 require an abundant food supply. This allows recovery of weight lost during nesting (Ryder, 1967) and replacement of nutrients for the post-nuptial molt. The young must grow rapidly and fledge in approximately 40-45 days after hatching to avoid being flightless when autumn temperatures drop below freezing.

During the post-Wisconsin marine inundation, fine-grained silts were deposited on the central lowland (Bird, 1967). Organic material

incorporated into the deposits has produced a rich tundra soil which is reflected, in part, by the dense cover of wet tundra vegetation.

The relatively restricted drainage in the central lowland, as indicated by the many small, shallow lakes, waterlogged and shallow active layer (less than 1 foot in the Perry River area according to Hanson et al (1956)) has been important in the development of the wet tundra association. Typically Arctic soils are unfavourable for plant growth. They are cold, shallow, acid and lack nutrients (Bird, 1967). The organic and mineral deposits on the old sea bottom of the central lowland provide ample nutrients for plant life to flourish. That Arctic plants become luxurious in areas where mineral nutrients are readily available is striking around bird cliffs, dens of the Arctic fox (Alopex lagopus) and Arctic ground squirrel (Citellus parryi), animal skeletons and in goose colonies. The fertilization effect of goose droppings is evident in the marshes where the geese feed (Porsild, 1955). After the spring melting period in the central lowland, the many often continuous wet tundra marshes and meadows furnish an abundance of food for geese. In contrast, the extensive boulder fields and well-drained upland areas bordering the lowland are devoid of the extensive wet tundra meadows. The vegetation is sparse, dominated by an impoverished lichen-moss association. Food in such areas may be limiting.

lake requirements--- The present colony distribution may be a reflection of the availability of islands in shallow lakes. The mean depth of Arlone Lake and Karrak Lake is about 3 feet (Ryder, 1967) and 4 feet (Ryder, J.P. unpub.), respectively. The importance of shallow lakes to nesting success was illustrated at Arlone Lake in the spring of 1964.

The slow spring melt caused an ice bridge to remain between the mainland and one of the nesting islands until after the start of nesting (Ryder, 1967). In the first week of June, Arctic foxes destroyed a total of 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 predation by foxes. Barry (1964) found that Arctic foxes at the Anderson River Delta, N.W.T. avoided water. He reported that one fox walked nearly half a mile around a lake to get to a brant (Branta bernicla) nest which could have been reached by wading 20 feet. Duebbert (1966) reported that Gadwall (Anas strepera) hens desert nesting island when raccoons (Procyon lotor) are able to walk to islands on dry land during periods of low water levels. On 16 June 1967, before the late spring break-up, I observed five arctic foxes on an island which was connected to the mainland by ice at Karrak Lake, N.W.T. From a blind, I watched one of the foxes take one egg at a time from each nest, carry it to another location on the island and bury it about 3 inches below the surface. This was repeated for each egg in the clutch. More than 100 lesser snow goose nests were destroyed by this fox 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 it is possible that ice bridges allowed foxes access to the islands during the egg-laying period. In Spitsbergen, Barnacle geese (Branta leucopsis) avoid Arctic fox predation by nesting on off-shore islands (Norderhaug, Ogilvie and Taylor 1964). Occasionally Arctic foxes cross sea ice and cause severe damage to the nesting geese (Lovenskiold, 1964). Elliott

(1965) notes that a characteristic feature in the habitat selection of many ducks is a preference for nesting islands. He quotes authors who found that because of a lack of predation by mammals, ducks which nested on islands had significantly higher nesting success than the same species nesting on mainland areas. Townsend (1966) found that ducks nesting on islands in the Saskatchewan River Delta had 27 per cent higher nesting success than conspecifics 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 third week in June. This coincides with the average time at which most Ross' geese start nesting.

It is apparent from these investigations that if Ross' geese nested on islands in lakes over 6 feet deep, where melting is slower than in shallow lakes (Peterson, 1965), predation by Arctic foxes could be increased to the point where the annual reproductive success would be too low to maintain the population. Such predation would be an important factor limiting population growth particularly since it is unlikely that Ross' geese renest (Ryder, 1967).

Island requirements---- The elevation of an island above the lake surface is an important factor in its suitability for nesting. Low level islands (Type 1) tend to flood during the spring break-up in early June. I observed five islands become submerged at Karrak Lake on 8 June 1966 and 18 June 1967 when the water level rose 3.5 feet above the ice level. At least half of the clutches on other islands had been initiated. The

flood islands have a smooth moss-grass cover with only a few jutting rocks areas and summits less than 3 feet above the lake. Within five days of flooding each year the water level had receded and the five islands were exposed. Possibly the geese do not use these islands for nesting because previous loss of nests has resulted in current breeding populations being imprinted on other islands.

The high and rocky islands (Type 2) are unsuitable for nesting. They are usually steep-sided and lack level areas. In 1949 Hanson et al (1956) and in 1963 and 1964, Ryder (1967) observed no geese nesting on two islands of this type located at the south end of Arlone lake. The Type 2 island also lacks materials for nest construction and maintenance and food. Ross' and less snow geese do not bring nest material from other areas but use dead twigs and leaves of Betula glandulosa and Salix spp., moss and grass found close to the nest site. The sparse grass and sedge cover does not provide a sufficient food supply for geese during the incubation period. Before incubation, breeding geese feed mainly on the wet tundra marshes. During incubation, the pairs seldom leave the nesting island and are much more dependent on island vegetation for food.

I suggest that the Type 3 island is required for nesting because it furnishes all of the following requirements; 1) protection from flooding during the spring break-up, 2) necessary cover in the form of dwarf Betula glandulosa and Salix spp. and small jutting rocks and 3) a supplementary food supply for the geese during the incubation period when feeding areas on the mainland are infrequently visited.

Post-glacial submergence and colony distribution—— The distribution of Ross' goose nesting colonies coincides remarkably with the limit of the post-glacial marine transgression in the central Arctic (Fig. 2). MacInnes (1966) found a similar correspondence between the occupied nesting range of Canada geese (Branta canadensis) and the limit of the post-glacial sea in the Hudson Bay lowland. Although the reason for the apparent preference for such areas is unknown, MacInnes (1966) states that possibly the old sea bottom contains the most suitable topography or that available mineral nutrients may be involved (See Ryder, 1964).

There may be other factors which operate in the choice or suitability of colony sites. Possibly tradition is important in the continued use of a nesting lake. The general inaccessibility of the present day nesting colonies to Eskimos who have probably caused the abandonment of some Ross' goose colony sites near the coast (Hanson et al, 1956), possible past competition with the larger and more aggressive lesser snow goose (MacInnes and Cooch, 1963) and the inland location which relieves the geese from excessive depredation by gulls (Larus argentatus and L. hyperboreus) and jaegers (Stercorarius parasiticus, S. pomarinus and S. longicaudus) which abound along the coast (Barry, 1964) may all have contributed to the current distribution of Ross' goose nesting colonies in the central Arctic.

It is apparent from my observations that all the seemingly suitable nesting lakes in the central lowland are not being used at present. With the availability of unused islands in lakes and a continued increase in the population, future surveys will undoubtedly discover more colonies.

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SUMMARY

Thirty-five Ross' geese nesting colonies were discovered by aerial survey in the central lowland portion of the central Canadian Arctic in July of 1965, 1966 and 1967. Nesting colonies were on islands in shallow lakes estimated 2 to 6 feet deep and included lesser snow geese. A breeding population of 30,837 Ross' geese and 8,429 lesser snow geese was estimated on nesting islands in 1965.

Food availability in the form of sedges and grasses is likely of major importance in the observed colony distribution. The colonies are within a poorly drained area once inundated by the post-glacial marine transgression. It is possible that organic and mineral deposits on the old sea bottom have resulted in rich plant growth providing ample food for the geese. Uplands bordering the central lowland have extensive boulder fields and dry elevated areas which lack suitable vegetation. Food in these areas may be limiting.

Early melting water in shallow lakes prevents Arctic foxes (Alopex lagopus) from gaining access to islands across ice bridges. Suitable

nesting islands have elevations of 10-20 feet above the lake surface and do not flood during the spring break-up; they provide nest material and cover and a food supply during the incubation period when the pairs seldom leave the nesting island. High rocky islands, rising more than 30 feet from the lake with sparse vegetation do not provide suitable nest sites and sufficient food. Low and level islands, less than 5 feet above the water, flood during spring break-up and are unsuitable for nesting.

Other factors which may have contributed to the observed distribution of Ross' goose nesting colonies are; tradition, past competition with lesser snow geese and excessive avian and human (Eskimo) predation.

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TABLE 1

Location of Ross'-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	**	+
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	+	+

TABLE 1.---Continued

Nesting lake location	Date of discovery	Estimated population		Status in	
		Ross' geese	Lesser snow geese	1966	1967
66°43'N, 101°16'W	12 July	100	25	+	+
	Total**	28,525	7,929		

* + = colony site occupied, 0 = colony site unoccupied, - = not checked.

** This does not include 1,500 Ross' and 500 Lesser snow geese nesting at Arlone Lake and 12 Ross' geese nesting at Discovery Lake.

TABLE 2

Location of Ross'-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	+*
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	+

*Symbols represent status as indicated in Table 1.

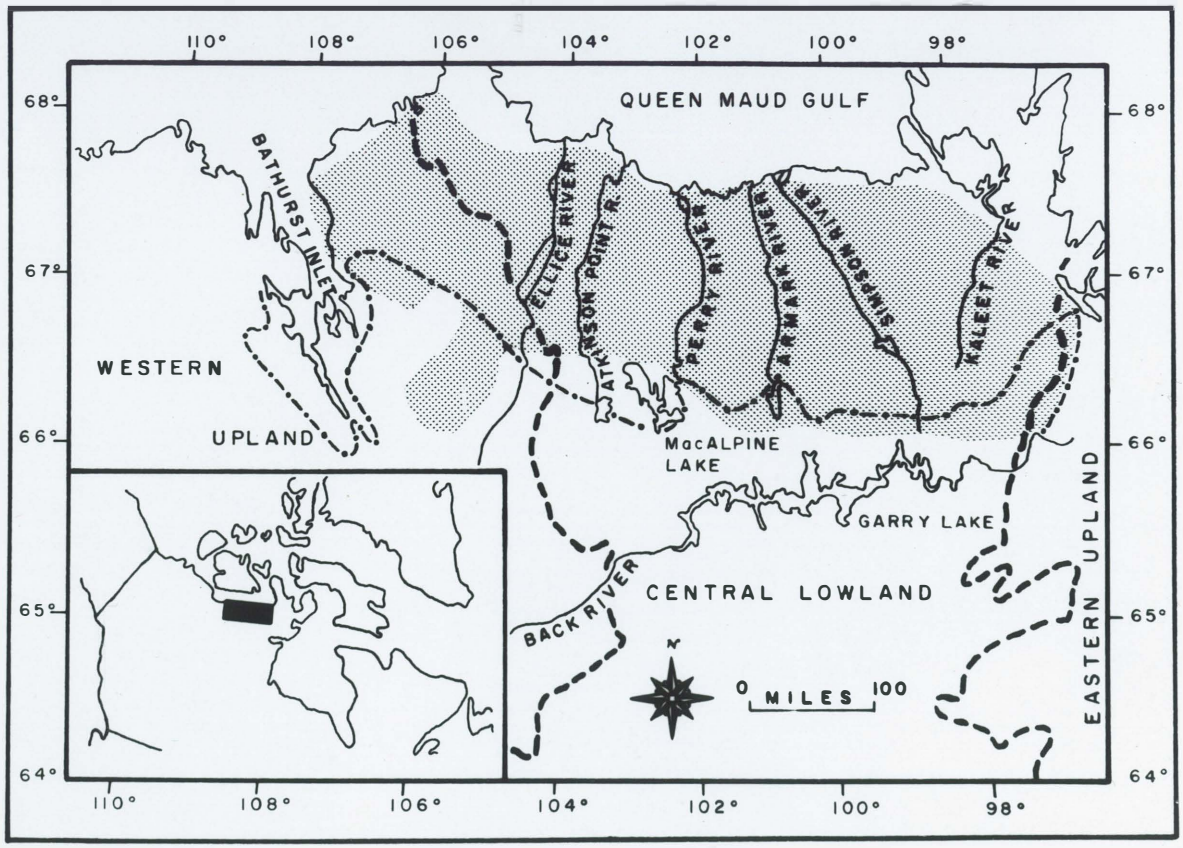
TABLE 3

Location of Ross'-lesser snow goose nesting colonies discovered in central Arctic in 1967

Nesting lake location	Date of Discovery	Estimated population	
		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

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).

Figure 2. Distribution of Ross' goose nesting colonies in central Arctic Canada. Circles, square 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. 1967 survey route not shown (See text). The heavy dot-dash line is southern limit of post-glacial marine transgression (After Bird, 1967).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ATKINSON POINT R.
PERRY RIVER
ARMARK RIVER
SIMPSON RIVER
KALEET RIVER
WESTERN
UPLAND
MacALPINE
LAKE
GARRY LAKE
CENTRAL LOWLAND
BACK RIVER
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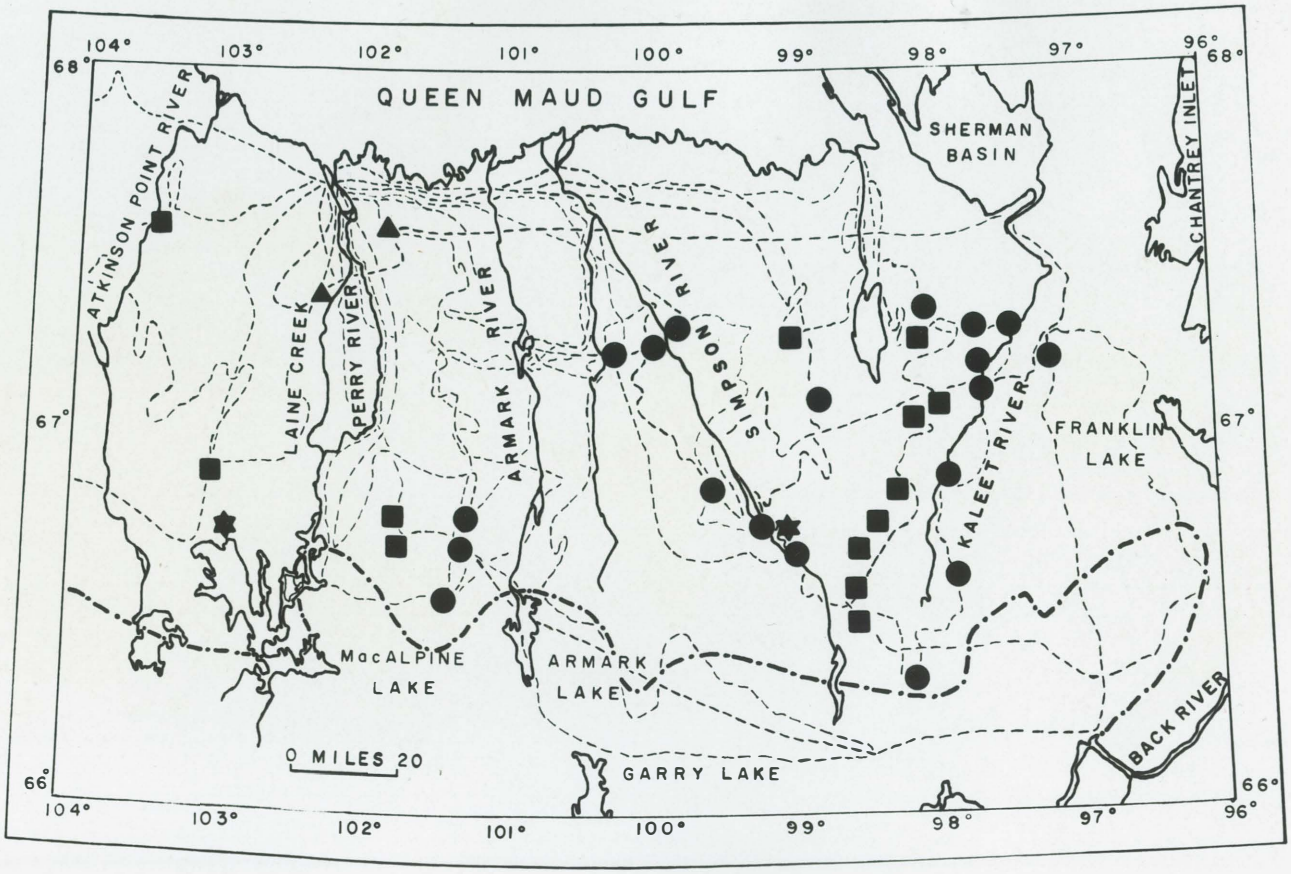
QUEEN MAUD GULF
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BASIN
CHANTREY INLET
ATKINSON POINT RIVER
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