torr^{-1}. Note that pores on the outer surface of the eggshell are represented by colorless circles of varying sizes. As can be concluded from Figure 1, counting of pores is a very simple matter. One of the dyed pores was selected for examination with SEM (Fig. 2). As can be seen from the micrograph, the procedure worked well even though the pore channel was mostly occluded.

The staining technique also provides information about pore size. Forty-seven dyed pores were selected for measurements of actual pore mouth area and the area of the corresponding colorless circle on the stained eggshell. SEM images (scanning angle = 45°) were used to measure pore mouth area and a micrometer-equipped light microscope was used to measure the area of the colorless circles. Pore mouths were assumed to be either circular or elliptical. The relationship between these two areas is given in Figure 3 where $R^2 = 0.629$. When the two outlying data points are deleted from the data set, R^2 increases to 0.758. Probably contributing to unexplained variation are difficulty in accurately measuring actual pore area (note irregular shape of pore mouth in Fig. 2) and influence of shell thickness on movement of dye solution through pore channels. Although all of the pores included in Figure 3 were from one eggshell, it is possible to use the procedure to make comparisons among eggshells from different eggs. However, such comparisons are useful only when the procedure is applied in exactly the same way (timing, concentration of solutions, etc.) to each egg.

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NESTING OF THE ROSS' GOOSE AND BLUE-PHASE SNOW GOOSE IN THE SAGAVANIRKTOK RIVER DELTA, ALASKA[1]

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Since 1980 we have been studying the small population (100 to 200 pairs) of Snow Geese (*Chen caerulescens*) nesting on Howe Island in the Sagavanirktok River delta, Alaska (Fig. 1). Our study has included (1) an annual (1980 to 1987) round-up and banding of geese during the brood-rearing/molt period, (2) behavioral observations of molting geese during 1981, and (3) behavioral observations of incubating geese during 1984. During these investigations we documented nesting by Ross' Geese (*Chen rossii*) and blue-phase Snow Geese (hereafter blue geese).

ROSS' GEESE

Nearly all Ross' Geese nest in the central arctic of Canada (Ryder 1972, McLandress 1983). The breeding range is predominately adjacent to the Queen Maud Gulf with some breeding records from Southhampton Island and the Hudson Bay coast (see summary in Bellrose 1976). Ross' Geese typically nest in mixed colonies with Snow Geese (Ryder 1972, Kerbes et al. 1983). In recent years the breeding population has increased (Kerbes et al. 1983) and their range has expanded, mostly eastward to Snow Goose colonies along the west coast of Hudson Bay (Frederick and Johnson 1983). Ross' Geese have been found nesting on Banks

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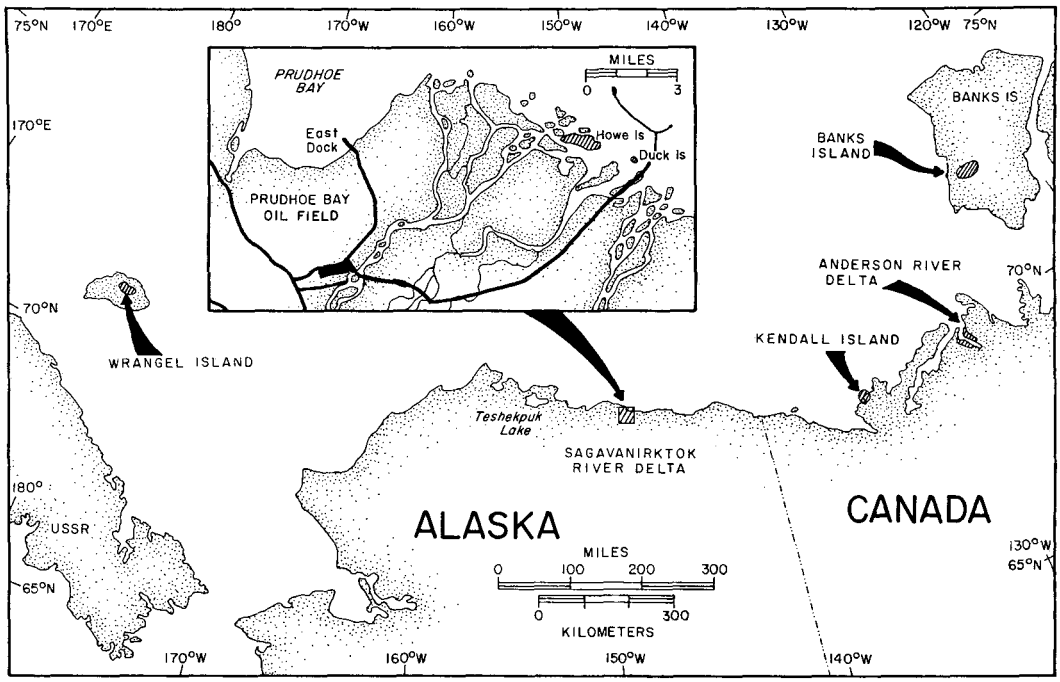

FIGURE 1. Location of the Sagavanirktok River delta Snow Goose colony relative to neighboring colonies. The insert shows Howe and Duck islands within the delta. The road and causeway through the delta were constructed in 1986; thus they were absent during most of the study period discussed in this article.

Island subsequent to 1960 (T. W. Barry, Canadian Wildlife Service, pers. comm.). However, this species has not been recorded nesting at the Anderson River delta or the Kendall Island Snow Goose colonies. Ross' Geese (two in 1981 and one in 1982) recently were reported in the Wrangel Island Snow Goose colony, but so far there is no evidence of nesting (Stishov et al. 1985).

The first record of a Ross' Goose in Alaska was of an individual shot (from a flock of 30 possible Ross' Geese) in 1907 at the mouth of the Stikine River in southeastern Alaska (Willett 1921). Other records of Ross' Geese, all from northern Alaska, include an adult female banded by the U. S. Fish and Wildlife Service (USFWS) in July 1976 near Teshekpuk Lake, four seen about 15 km NE of Teshekpuk Lake on 18 August 1977 (Kessel and Gibson 1978), and one observed at the Canning River delta, in June 1980 (Martin and Moitoret 1981).

We banded an adult male Ross' Goose, captured with a flock of Snow Geese, in the Sagavanirktok River delta on 19 July 1983. On 28 June of the following summer, during a survey of Duck Island, Stephen R. Johnson flushed an incubating Ross' Goose from a nest containing three eggs. Duck Island is a small (4 ha) sand and gravel island located approximately 1.6 km E of Howe Island. Other nests on Duck Island included 23 Brant (*Branta bernicla*), one Canada Goose (*B. canadensis*), 25 Common Eiders (*Somateria mollissima*), 47 Glaucous Gulls (*Larus hyperboreus*), but no Snow Geese. The Ross' Goose nest and the nests of the Brant, eiders, and Canada Goose all were on or near a small sparsely-vegetated patch of tundra at the east end of the island. The Ross' Goose flew overhead for several minutes and was joined by another Ross' Goose, presumably its mate. This represents the first known breeding attempt by Ross' Geese in the United States.

BLUE GEESE

Blue geese constitute a large but variable proportion of Snow Goose colonies in central and eastern North America. The abundance of this color morph decreases rapidly from eastern to western North America. Blue geese are rare on Banks Island but have been seen there annually since 1960 (T. Barry, pers. comm.). Low numbers (four to eight pairs) have been found nesting at both the Anderson River delta (first nest recorded in 1963) and the Kendall Island (first sighting in 1958, positive nesting in 1984) colonies (T. Barry, pers. comm.). There is a single record of a blue goose on Wrangel Island, USSR (Palmer 1976:134). Prior to our studies, Alaska records of blue geese were limited to the intermittent occurrence of one or two birds during spring migration in Fairbanks from 1963 through 1980 (Kessel and Springer 1966; Kessel and Gibson, unpubl. records).

In 1980 a male blue goose was observed in the Sagavanirktok River delta colony paired with a white-phase Snow Goose. This mixed pair had five flightless goslings—three white-phase and two blue-phase. This appears to be the first record of a breeding attempt by a blue goose west of Kendall Island. Concurrent with

our study, J. W. Helmericks (pers. comm.) observed a blue goose summering near Smith Bay, 175 km W of the Sagavanirktok River delta, in 1981 and 1982, and also observed a migrant on the Colville River delta in the spring of 1985. The Smith Bay bird mentioned above also was paired with a white mate (J. W. Helmericks, pers. comm.) and probably nested in both 1981 and 1982.

In late July 1981 the Sagavanirktok River delta geese were captured and banded, including the adult male blue goose and the two blue-phase goslings. It was impossible to identify with certainty the male and white-phase goslings of the blue goose. The adult blue goose and the two blue goslings were all males. One of the goslings was shot in December 1981 in the Sacramento Valley, California. None of these blue-phase birds has been recaptured in the Sagavanirktok delta. In 1984 two blue geese, one male and one female, were captured and banded. No blue goslings were found and we have no evidence that these two birds were a mated pair, other than their occurrence in the same brood-rearing flock.

These observations further suggest the possible westward expansion of blue geese in North America (Dzubin 1979). However, as discussed by McLandress and McLandress (1979), the frequency of blue-phase individuals among Snow Geese in the Pacific Flyway (0.02%) also can be at least partially explained by periodic mutation of a single gene. Winter records of Snow Geese from the Sagavanirktok River delta are predominately from California and New Mexico. Surprisingly, the recovery of the Sagavanirktok delta blue goose was in California, where the blue morph is quite rare, rather than in New Mexico, where there are more blue geese.

To date neither Ross' nor blue geese can be considered established as regular breeding birds in Alaska. No Ross' Geese young were found in the delta in 1984, and no further sightings of this species have been reported in Alaska. None of the blue geese raised in the Sagavanirktok River delta has been captured in subsequent banding programs in the delta, but a blue goose was sighted there during early summer 1986 (R. M. Burgess, pers. comm.). This bird was collared with the type of marker we have been using and was evidently a returning bird, but its identity was uncertain.

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