

SOCIAL BEHAVIOR AND MIGRATION PATTERNS OF BLUE AND SNOW GEESE WINTERING IN LOUISIANA AND EASTERN TEXAS

by

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ABSTRACT

From 1969 to 1972, Blue and Lesser Snow Geese (*Chen caerulescens caerulescens*) were neck-banded to permit identification of individuals and family groups, and 592 geese were dyed or painted to facilitate the study of flock behavior. The geese were dyed or painted to facilitate the study of flock behavior. The geese were captured and marked on the Sabine National Wildlife Refuge, Cameron Parish, Louisiana.

Thirty-one neckbanded family groups were observed during the 3-year study. Eighteen families were seen together two or more times, while two families were seen together six or more times. The standard family pattern consisted of parents and cohort offspring. Offspring hatched in a family group. Neckbanded parents and yearlings or parents and 2-year-olds were seen together as families.

Flocks of 70 to 200 geese were dyed and released together. The dyed geese were observed to spread out in singles and groups of two to five for a distance of 130 airline miles along the coast. In 347 observations of dyed geese, only three observations revealed geese in groups of larger than size five.

Two-hundred sixty-four recoveries of Sabine NWR banded geese were noted to degree block on maps of North America. The snow phase showed a tendency to migrate to more western areas. The principle breeding grounds for Sabine area geese appear to be in northeastern Canada at Baffin Island, McConnell River and Cape Henrietta Maria.

The major influx of blue goose migration to the Sabine NWR, Cameron Parish, Louisiana, was delayed in 1971-72. Evidence for this include a late influx of predominately white phased flocks in from the Central Flyway and observations of neckbanded geese during the winter months in the Midwest.

INTRODUCTION

Louisiana and eastern Texas are the traditional wintering grounds for large numbers of Blue and Lesser Snow Geese which breed in northern Canada. These birds are two color phases of the same species. Both color phases will be referred to as the Blue Goose unless specific differences between the color phases are being discussed. Many of the birds winter at Sabine National Wildlife Refuge in southwestern Louisiana.

Although probably the most abundant goose species in the world, our understanding of the biology of the bird is limited. Most information has come from studies on the breeding ground, especially by Cooch (1958, 1961), and little work has been done with wintering birds on the Gulf Coast.

It has long been recognized that plumages of immatures are distinguishable from adult plumages of Blue and Snow Geese; the body feathers of immature birds are conspicuously darker than those of adults of the corresponding form throughout most of the first year of life (Bent 1923). Further, field observations

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over the years have suggested that the birds winter in family units consisting of young and their parents. Productivity measurements are made each fall from counts of such groups. Together with midwinter inventories of total numbers, these counts provide the major source of information on the annual population status of the birds (Lynch and Singleton 1964).

The presence of distinct family groups in Canada Geese (*Branta canadensis*) has been well documented; such social behavior is important in maintenance of different breeding populations (Martin 1964, Sherwood 1967). The role of social organization in Blue Geese has received little study. Therefore, this research was undertaken with the following objectives: (1) determine if the Blue Geese maintain family units during the winter, and evaluate the extent to which older offspring associate with their parents, (2) determine if there is interchange of individuals and families among flocks, (3) determine the general breeding grounds and migration routes of geese that winter at Sabine National Wildlife Refuge and (4) measure local movements of wintering birds.

During the course of this study the question of delayed migration was inadvertently thrust into the picture. Strong evidences of delayed migration began to appear. For this reason delayed migration and associated problems are discussed.

LOCATION

The geese were banded at Sabine National Wildlife Refuge in Cameron Parish in southwestern Louisiana (Figure 1). The refuge is only a few miles from the Gulf of Mexico and borders on both Calcasieu and Sabine Lakes which are little more than embayments of the Gulf. Habitat at the refuge is primarily brackish, intermediate and freshwater coastal marsh.

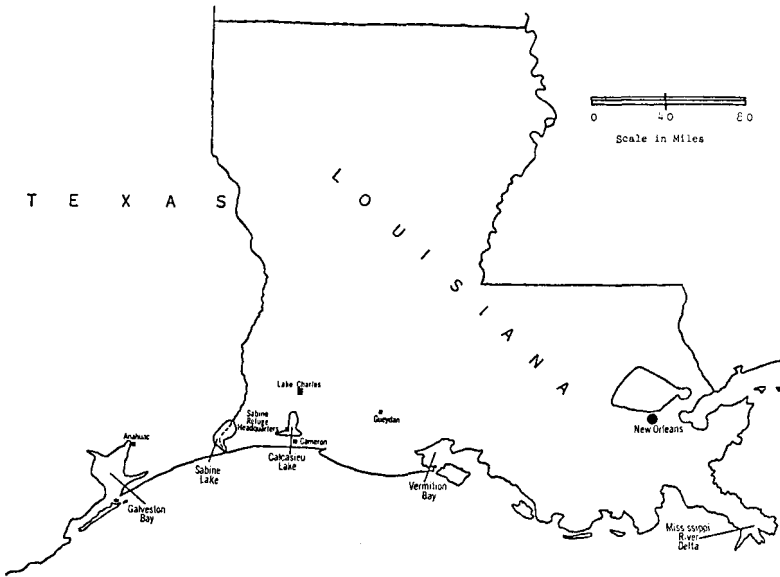


Figure 1. The Louisiana and East Texas Gulf Coast Region

METHODS

The geese were trapped at a grit site by firing cannon nets over them as they came in for sand. During the winters of 1969-70 and 1970-71 1,225 geese were banded with individually coded Plexiglas neckbands. The neckbands enabled identification of specific geese and family groups. During the winter of 1971-72, 592 geese were dyed with picric acid, gasoline dyes and fluorescent paint. The colors used were yellow, pink, green and fire orange, and the dyeing technique facilitated the study of flock behavior. In this paper, geese referred to as yearlings were 1.5 years old, and 2-years-olds were 2.5 years of age in December.

A blind built on a 28-foot high metal tower near the trap site provided an excellent vantage point to observe previously marked birds when they returned to the grit site. Observations made from the tower have accounted for the vast majority of site records reported here. Some sight records were obtained by observing flocks from aircraft.

RESULTS AND DISCUSSION

Breeding Grounds

Sabine NWR area geese are predominately blue phased and, according to the data of Cooch (1961) breed primarily in the Eastern Arctic and along the western and southern coast of Hudson Bay. A cline exists on the Gulf Coast with the blue phase decreasing to the west as the snow phase increases (Lynch 1972). Proportions of the color phases range from 95 percent blue at the mouth of the Mississippi River to about 65 percent blue at Sabine NWR headquarters and 50 percent blue near the Louisiana - Texas border, with the white phase becoming more and more predominant westward into Texas. Cooch (1961) found a similar cline in the Canadian breeding areas and concluded that it is difficult to explain without consideration of migration by breeding population.

Cooch (1961) described eight main breeding colonies in Eastern North America on areas ranging in size from 1 to over 200 square miles. These colonies include three on Baffin Island, three Southampton Island and the coast of Hudson Bay, one at Eskimo Point (McConnell River), and one at Cape Henrietta Maria. In Figures 2 and 3, 41 recoveries are shown of Sabine banded geese along the southern and western coast of Hudson Bay. These recoveries may represent both migrating (to areas still further north) and breeding geese. Two recoveries of geese banded at Sabine NWR and retrapped on Baffin Island were reported. According to H. Lumsden (*in litt.* 1972) of the Ontario Department of Lands and Forest, 9 geese banded at Sabine were retrapped at the Cape Henrietta Maria colony. There have also been numerous sightings of dyed geese on the southern coast of Hudson Bay, including James Bay (Smithey 1973). In the February 1972 Minutes of the Mississippi Flyway Council Technical Section, a preliminary report by H. Hanson and R. Jones indicated that 93 percent of the Blue Geese banded on Sabine NWR came from Baffin Island, Eskimo Point, and Cape Henrietta Maria based on feather mineral analysis (the sampling was done in one year, sample size 57).

Migration

In 1932, prior to Soper's 1929 discovery of the first known Blue Goose breeding colony in the Arctic, Bent stated that the Blue Goose (referring only to blue phase, Snows then thought a separate species) is known only from migration and winter residency and that it had been thought of as rare but was really abundant in remote regions of Louisiana. Bent (1923) added, "Its apparent rarity is due to the fact that on its migrations to and from this favorite resort (Louisiana) it (sic) seldom straggles far from its direct route to and from its unknown breed-

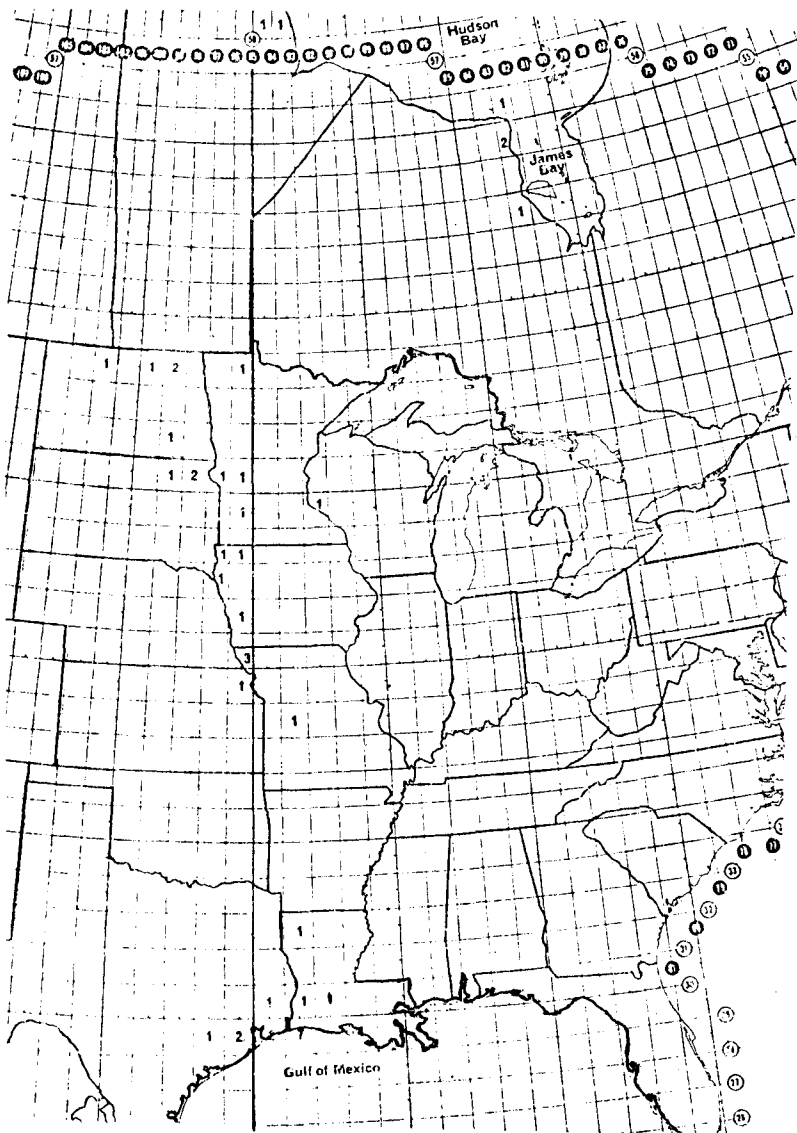


Figure 3. Indirect Recoveries of Snow Phase Geese Banded on Sabine National Wildlife Refuge, Louisiana

ing range." Cooch (1961) supported Bent's (1923) ideas, and further added that Snow Geese, because of slight differences in nesting phenology, are less likely to make the nonstop flight from Canada to the Gulf Coast, that is characteristic of the blue phase. McIlhenny (1932) said that "The principal southern flight arrives during October and early November. . . . in an unbroken wave which usually lasts from a day and night, to three days and nights."

The Snow Goose tends to be distributed more to the west in its migration corridors. Midwestern recoveries of both color phases were concentrated in the northern Mississippi Valley area (Figures 2 and 3). North of the Gulf States and south of Canada only two Snow Goose recoveries were reported east of the 95th meridian, which passes through the western portions of Minnesota, Iowa, and Missouri, and the eastern portions of Kansas and Oklahoma, while 20 recoveries of Snow Geese were reported west of this line. Numerous Blue Goose recoveries are scattered as far east as Ohio and Michigan in the Midwest (about the 83rd meridian). On the Gulf Coast, only two Snow Geese were recovered east of the 93rd meridian in Louisiana, while 15 indirect recoveries of snows were found west of this meridian. Twenty Blue Goose recoveries are east of the 93rd meridian in the Gulf Region.

An 11-year weekly population history of Blue and Snow Geese was gathered from the data on file in the narrative reports of Sabine NWR (Figure 4). These data are broken down by week (1-4) of each month, October through March, and an average of the Sabine goose population for a ten year period, the winter of 1961-62 through 1970-71, is shown in Figure 4. The winters of 1970-71 and 1971-72 were graphed separately for comparison.

Basically, the ten year average of goose populations at Sabine (1961-1971) would seem to fit McIlhenny's (1932) characterization of arrival dates, the major influx being in the last week of October and first week of November. By early November 1971, the great flocks of Blue Geese normally at Sabine NWR at this time were conspicuously absent. Trapping and marking operations were scheduled for the first week in November 1971 to correspond with the normal timing of migration, but were delayed until the third week of November when Blue Geese began arriving in any numbers (Figure 4). A second influx of geese, made up largely of Snows, began in January and peaked in February 1972.

Delayed migration could result in increased mortality rates of Blue and Snow Geese (because of inclement weather, disease, and increased shooting pressure) and merits additional study if the trend continues.

Social Behavior

Flock Structure. Some 70 to 200 geese were captured, dyed or painted one particular color, and released at a time. Within 2-weeks of the initial date of dyeing, color-marked geese from Sabine NWR were reported from Galveston Bay, Texas, to just west of the Gueydan area of Louisiana, a distance of 130 air miles. The geese spread out as singles or in groups of two to five (largely pairs and family groups) for a great distance in many directions. Sightings of dyed geese were reported over the Midwest and Canada during spring migration (Smithey 1973).

Color-marked geese were seen within a day of each other in small groups (often part of the large flocks) at such widely scattered places as Anahuac National Wildlife Refuge, Cameron Parish, Louisiana. In February 1972, 4 yellow geese were seen at Bunkie, Rapides Parish, Louisiana, which is about 100 miles inland in the center of Louisiana. The fact that numerous geese were dyed and released together, yet only small groups were resighted seems to indicate a lack of strict flock integrity. This represents a departure from traditional thinking such as that expressed by Cooch (1961) with reference to the blue/snow gradient.

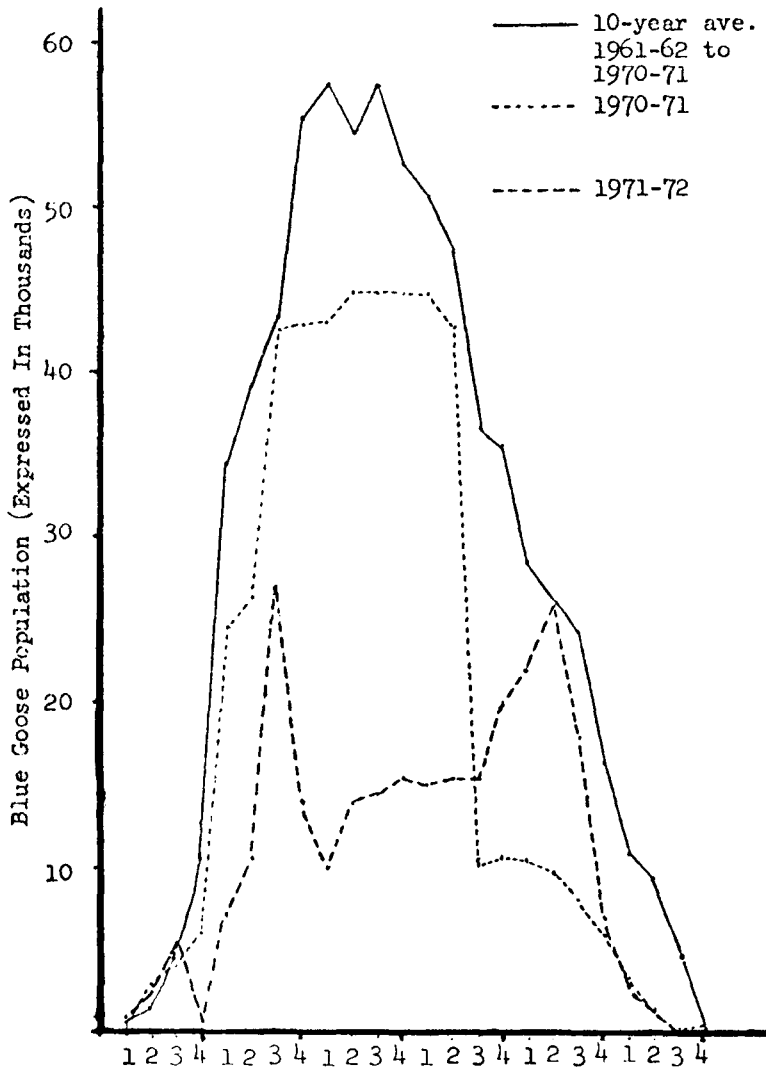


Figure 4. Population levels and timing of Blue and Snow Goose migration to Sabine National Wildlife Refuge. (Data from Sabine NWR narrative reports).

expressed by Cooch (1961) with reference to the blue/snow gradient.

An aerial survey provided an excellent illustration of the small number of color-marked geese seen together in large flocks. Mr. Hugh Bateman of the Louisiana Wildlife and Fisheries Commission flew an aerial survey of western Cameron Parish and observed 8 flocks of geese which ranged from 1,500 to 22,000 birds in size and contained from 1 to 15 yellow dyed geese in each.

The number of color-marked geese did not fluctuate much at three locations, but the number changed drastically at one location. The size of

one flock increased from 17,000 to 22,000, but the color-marked geese remained constant. In no flocks were more than four dyed geese closely associated together. Differences in behavior were not noticed in dyed geese. Observations of neckbanded geese revealed the same basic pattern in terms of size and distribution of groups. (Table 1).

A unique opportunity to test flock integrity was presented on 17-20 December 1971. During this time, a large flock of Blue Geese was roosting on the shore of Calcasieu Lake about one-half mile east of the tower, which was near the Sabine NWR Headquarters. The tower was manned just before dawn on 17, 19 and 20 December and the roosting flock was clearly visible in the distance at dawn. Only geese roosting in this flock were seen using the grit site during this period. Observations of neckbanded geese provide identification of individual birds. The blue/snow ratios and numbers of dyed geese observed allowed measurement of the change in flock composition around the individual goose, thus providing a test of flock integrity.

One female yearling was seen both on 17 and 20 December. This was the only goose known to be resighted during this 3-day period. Fourteen neckbanded geese and no dyed geese were seen on 17 December. Six neckbanded geese and no dyed geese were seen on 19 December. Four neckbanded geese, five yellow geese, and one red goose were seen on 20 December. The sample sizes of blue to snow on 17, 19 and 20 December were 1078 blues, 533 snows (67%-33%); 389 blues and 147 snows (73%-27%) snows, and 314 blues and 243 snows (56%-44%), respectively. Chi-Square tests revealed significant differences all three days: 17 and 20 December ($X^2 = 4.25, 95.0 < P < 94.5, \text{Id.f.}$); 17 and 19 December ($X^2 = 5.69, 9.75 < P < 99.0, \text{Id.f.}$); 19 and 20 December ($X^2 = 13.94, 99.95 < P < 100.0, \text{Id.f.}$), place Table 1.

Table 1. Winter and spring observations by cooperating individuals and agencies of Blue and Snow Geese captured and dyed or neckbanded on Sabine NWR in Louisiana.

Date	Location	Description
1 December 1970	Squaw Creek NWR, Mo.	Orange neckband on adult Snow Goose
1 November 1971	Silver Lake, Rochester, Minn.	Orange collar on adult Blue, blue collar on adult Blue, in flock of 350
12-18 November 1971	Gum Cove, La. 1 mile north of Moore Ranch	1 yellow Snow Goose in a flock of 1000
19 November 1971	Silver Lake, Rochester, Minn.	blue collar on adult Blue, flock size about 350
26 November 1971	Farm Unit Lacassine NWR, La.	4 yellow geese together, 3 yellow geese together, 5 single yellow geese, flock size 15,000 - 20,000
27 November 1971	Anahuac, NWR, Tex.	Yellow adult Snow and yellow immature Snow together in flock of 5,000
25-30 November 1971	Gum Cove, La.	5 yellow geese together, 3 single yellow geese in a flock of several thousand

Date	Location	Description
1 December 1971	Anahuac NWR, Tex.	Yellow adult Snow with yellow immature Snow, single yellow immature Snow in flock of 10,000
2 December 1971	near Katy, Tex.	1 yellow Snow
7 December 1971	Anahuac NWR, Tex.	3 yellow Snows, 2 Snows with red collars
7 December 1971	Barrow's Ranch, 7-1/2 miles north of Anahuac NWR, Tex.	1 yellow snow, 1 yellow Blue in a flock 2,500
8 December 1971	Gum Cove, La.	4 yellow geese in a flock of 17,000 aerial survey
8 December 1971	Johnston's Bayou, La.	1 yellow Blue, 2 yellow Snows 1 red Blue in a flock of 5000 (aerial survey)
8 December 1971	Lower Mud Lake, La.	1 yellow Snow in a flock of 2500 (aerial survey)
8 December 1971	Mud Lake, La. near Sabine Refuge south line	1 red and 7 yellow geese in a flock of 1,500 (no more than 4 colored geese together) (aerial survey)
9 December 1971	Unit 1, Backridge Sabine NWR, La.	2 yellow Snows together, 1 single yellow Snow in a flock of 1800
10 December 1971	Gum Cove, La.	4 yellow heese in a flock of 22,000 (aerial survey)
10 December 1971	Johnson's Bayou, La.	1 yellow Blue, 2 yellow Snows in a flock of 5000 (aerial survey)
10 December 1971	Lower Mud Lake, La.	4 red and 15 yellow geese in a flock of 2,500 (no more than 4 colored geese together) (aerial survey)
15 December 1971	15 miles SE Winnie Jefferson, County, Tex.	1 yellow Snow Goose
19 December 1971	Elk City Reservoir, Kansas	red collar on adult Blue Goose
January 1972	Backridge, Sabine NWR, La.	2 yellow Snows together, several sightings same place in marsh
2 January 1972	Anahuac NWR, La.	1 red collar on a Snow Goose
12 January 1972	Elk City GMA, Kansas	1 green collar on a Blue Goose
18 January 1972	Sabine NWR, La.	2 yellow Blue, 3 yellow Snow, 1 red Snow in a large flock 6716. 1 yellow Blue in another flock of 225 (aerial survey)

Date	Location	Description
19 January 1972	2 miles east of Gueydan, La.	red collar on adult Blue goose and red collar on adult Snow goose in a flock of 2-3000
27 January 1972	Brown Co. State Lake, Kansas	9 Blue and Snow Geese with plastic collars
10 February 1972	Bunkie, La.	4 yellow geese
12 February 1972	Magnolia Beach Calhoun Co., Tex.	1 red collar on a Snow goose in a flock of 50 Snows
March 1972	Backridge, Sabine NWR, La.	12 fire orange geese together
7 March 1972	Peveto Beach Cameron Parish, La.	1 fire orange Snow in a flock of 355
21 March 1972	Backridge near south line Sabine NWR, La.	2 fire orange Snows in a flock of 50
24 April 1972	Pool, Lacassine NWR, La.	3 yellow Snows in a flock of 22
30 April 1972	Farm Unit, Lacassine NWR, La.	3 yellow geese in a flock of 30-40

1d.f.); 17 and 19 December (X^2 u 5.69, 97.5 P 99.0, 1d.f.); 19 and 20 December (X^2 u 13.94, 99.95 P 1.00.0, 1d.f.).

The simplest and most logical inference from these data are that a breeding ground integrity exists as reported by Cooch (1961), but certain goose populations on the Gulf Coast have a "home range" over which they spread widely and overlap with other goose populations, i.e. they lack a flock integrity. The blue/snow gradient can be explained in terms of random diffusion of the two color phases from two different central points. The role of the flock in the population structure of Blue Geese on the Gulf Coast is primarily a numbers or herd phenomenon rather than a phenomenon of strict social structure. Blue Goose social structure is based on the pair and family. Only three observations of 348 dyed geese revealed groups larger than five (seven, seven, and 12). Single birds exist where mortality is a factor, or in cases such as an unpaired two-year-old (subadult). These pairs, family groups, and single birds mix freely in flocks with other Blue Geese.

Family Behavior

During the winter of 1969-70, 11 family groups were caught and neckbanded as families by using selective cannon shots. Forty-three geese were in these 11-families. Six families were later resighted together at least partially intact. A classic example of family integrity is illustrated by a blue goose family of five (two adults and three juveniles) banded as a family in 1969-70 and seen twice together in 1970-71, as a family of four (missing one yearling), and as a family of three in 1971-72 (missing two 2-year-olds). No young-of-the-year were present with this family in either 1970-71 or 1971-72.

A mass banding technique was used to neckband all other geese. Cannons were fired over large numbers of geese, and all geese caught in one shot were banded. Marked birds that were later observed grouped together were regarded as families. This is a seemingly valid assumption, since in a vast majority of the cases the marked birds were all banded on the same day, and of the 31 families sighted over the 3-year

period 28 (22 mass banded families; 6 banded as families) contained both birds banded as adults and birds banded as offspring. Eighteen families were seen twice or more, two families were seen six or more times, and nine families were observed a year or more following the initial observations (Tables 2 and 3).

The winter of 1970-71 produced 194 observations of 164 individual geese (Table 4). Twenty-eight of these were seen more than once (17 percent resighted). Sixty-eight were observed to be in 24 families.

Delayed migration may have had an effect on observations in 1971-72; however, 140 individual neckbanded geese had been seen in 289 observations that winter. Seventy of these were seen more than once (50 percent resighted). Twenty-four of those were in the nine families mentioned. The others were singles, pairs, or associated in groups with unmarked birds. The larger number of repeated observations in 1971-72 reflects more time spent in the field. No geese were neckbanded after 1970-71 so additional neckbanded birds were not a factor in 1971-72.

With few exceptions, the family groups seem to fit into a standard pattern of parent and cohort offspring in close association, even in several cases when the offspring were yearlings or 2-year-olds. Young-of-the-year have never been observed with marked parents and their yearlings or 2-year-olds, except in one questionable case, Family 1. Prevelt (1969) reported that such associations occasionally occur. Seven families contained members that were either not banded the same day or were seen with more than one family. This may indicate mixing, but only represents five geese out of 105 in 31 families. Six families contained unusual associations of members which were not easily classifiable into parent or offspring categories.

Table 2. Number of observations of family groups of blue geese.*

	Gulf Coast	Midwest	Total
Number of families identified	29	2	31
Number of families seen whole or partially intact twice or more	16	2	18
Number of families seen whole or partially intact four times or more	7	1	8
Number of families seen whole or partially intact six times or more	2	0	2
Number of families seen separated while members known to be alive	1	1	2
Number of families observed whole or partially intact four seasons of the year or more after initial observation	9	0	9

*Family groups must contain offspring or more than two adults, otherwise they would only be considered as a pair. Geese captured as a family with selective cannon shots, and banded as such are considered initially observed at the time of banding. Geese captured by mass banding techniques are not considered initially observed until seen re-grouped later. A different observation, such as seen twice or more or four times refers to sightings on different days.

Table 3. Blue goose family composition summation.*

	Families containing parents and offspring	Families missing both parents or parents not positively identified	Total
Number of families, members banded on any day	26	5	31
Number of families, all members banded the same day	24	4	28
Number of families, members banded on different days	2	1	3
Number of families with unusual associations of unclassifiable members	3	3	6
Number of families with one parent only	7	0	7

*Family composition is based on neckbanded geese only. Family groups must contain offspring or more than two adults to be recorded as such, otherwise they would usually only be considered as a pair.

Table 4. Numbers of blue geese neckbanded and observed neckbanded on the Gulf Coast in the winters of 1969-70, 1970-71, 1971-72.*

	1969-70	1970-71	1971-72	Total
Number neckbanded	376	849	--	1,225
Number observations	--	194	289	483
Number individual geese observed	--	164	140	253*

*Because certain individual geese and families were seen more than once, totals are less than the totals of the yearly figures.

Family 3, Family 29, and Family 30 were seen to separate and re-group. Most of the observations were at Sabine NWR, but one family was observed at Anahuac NWR, Texas and two others were seen at Squaw Creek NWR, Missouri. Pevett (1969) stated that family groups of parents and offspring travel together from the McConnel River breeding colony across the Midwest to the Gulf Coast and back. He further stated that in the exceedingly large flocks occurring in the fall on the relatively small wildlife refuges in the Midwest, members of families frequently lose contact. After losing contact they separated from its parents is probably more vulnerable to the gun. Pevett (1969) observed that separation was rarely the case in Louisiana and Texas where flocks tend to be smaller and less concentrated.

The data gathered from geese marked during this study confirms the theory that blue geese wintering on the Gulf Coast do maintain distinct family units during the winter, and under certain circumstances these family units may last

several years. Nine of the 31 families observed during this study were resighted together one to two years after initial banding. The normal blue goose family unit consisted of parents and cohort offspring. No concrete data were gathered that would suggest that there is much association, if any between parents, young-of-the-year, and older offspring.

No young-of-the-year were ever seen with neckbanded parents and yearlings or two-year-olds following banding. There is no evidence that neckbanding inhibited reproduction as found by Lensink (1968) in brant (*Branta bernicula hrota*).¹ An adjusted neckband retention rate was found to be 78 percent. Lynch (1971) reported productivity of Gulf Coast geese generally between 20-30 percent. Only three families which were banded the prior winter, and therefore could have reproduced, were sighted in 1970-71. Nine families, all banded in prior winters were seen in 1971-72 when productivity was 7.2 percent. This is not a statistically large sample, but combined with other data the evidence is strong. There were no families of neckbanded geese which contained more than two adult plumage birds and juveniles the year banded. Observations of dyed geese (observations of 348 geese on the Gulf Coast) never revealed groups with more than two adults and also juvenile birds. From this combination of data it is safe to conclude that if association occurs between parents, young-of-the-year, and older offspring it is rare.

Blue Geese on the Gulf Coast have strong family ties. If parents are successful in producing young, the yearlings will not likely remain with the family. The parents apparently chase them off after the new brood hatches. If parents experience one or more nesting failures, their yearlings or two-year-olds may remain with them as this research has documented. The geese attain sexual maturity at 2-3 year of age (Cooch 1958), and it is likely that they would leave their parents at this time regardless of the parents reproductive success. Two observations were made of neckbanded 2-year-old females not paired in December 1971 but paired in January 1972. Therefore, other than mortality, the factors most likely to influence the composition of a blue goose family are parental reproductive success and attainment of sexual maturity of offspring.

¹Scientific name from A.O.U. Check-list (1957)

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SUCCESS OF RESIDENT CANADA GEESE ON NATIONAL WILDLIFE REFUGES IN THE SOUTHEAST

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ABSTRACT

Resident flocks have become a hope for retaining wild Canada geese in the South. A history is presented of eight such flocks which were attempted on national wildlife refuges. Habitat requirements, management techniques, and significant problems are discussed. Successful flocks now established on five of the eight refuges are providing considerable public enjoyment.

The serious decline in numbers of Canada geese wintering in southern states has caused an increased interest in resident flocks. The notable success of some refuges in establishing flocks of giant Canada geese (*Branta canadensis maxima*) has made these geese very popular for breeding stock (Schoonover 1971). Eight national wildlife refuges in the Southeast have attempted to establish resident flocks of Canada geese with varying degrees of success.

Many southern refuges that winter Canada geese have had some type of goose pen for confining crippled birds or accommodating a decoy flock. Some refuges have had captive geese for years without making intentional efforts to establish a wild local flock. In the late 1950's and early 1960's, thousands of Canada geese were captured, transported south, rendered temporarily flightless, and released on southern refuges. Some of these birds were pinioned. It was hoped that these efforts would successfully establish new migration traditions to bring geese farther south, or to establish wintering flocks on new refuges. Again, the intent was not to establish resident flocks.

These mass transplants of geese all ended in almost total failure. By 1966, a new approach for keeping the Canada goose in the South was evolving. If migratory geese could not be induced to continue migrating south, perhaps it would be possible to establish resident flocks that would nest in the South and remain there year around. This is a history of eight efforts to establish such flocks on national wildlife refuges.

Cross Creeks National Wildlife Refuge is a 10,000-acre area on Barkley Reservoir near Dover, Tennessee. Most of the refuge is subject to temporary flooding by the flood control reservoir. Shallow impoundments on the refuge cover 1,800 acres, and 2,100 acres are forested. Cooperative farmers cultivate