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FAMILY BEHAVIOR AND AGE-DEPENDENT BREEDING BIOLOGY OF THE BLUE GOOSE, ANSER CAERULESCENS

by

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ABSTRACT

From 1966 to 1969 over 10,000 blue geese, Anser caerulescens were marked with individually coded aluminum neck collars at the McConnell River breeding colony, N.W.T. (60° 51'N 94°25'W). They were observed during fall and winter in the United States and on the breeding ground in order to study integrity and longevity of the family group, behavior of subadults and breeding behavior of young geese.

Mixing of goslings between families up to flight stage was uncommon, involving about 5% of broods and 2% of goslings. Most interchange likely occurred in the first week before individual recognition between parents and offspring had developed.

Over 95% of marked geese eventually regrouped after mass banding drives. Where relationships before banding were known, regrouping involved re-establishment of family ties; these bonds persisted through the fall and winter period. About 20% of juveniles and 15% of adults had become separated from their families when they were sighted in the United States.

Integrity of families seen on migration in the north-central United States and on the Gulf Coast wintering areas differed markedly. Entire families were intact just 55% of the

time in the former but on nearly 95% of observations in the latter area; individual geese were temporarily separated from other family members on over 20% of all observations in the Northern States but less than 5% on the Gulf Coast. Only 21% of families were intact each sighting in the Northern States in contrast to 84% on the Gulf Coast: 90% vs. 54% of family members were recorded at least once in a nonfamily status in the two areas. If separated from their families, lone birds rarely associated with other geese. Differences between the two areas were attributable to much greater densities and a higher rate of disturbance, causing more frequent temporary splitting of families in the Northern States

Most geese (>75%) seen in families in winter and spring were still together shortly after arrival back at the breeding ground. Families usually disintegrated as the adults established nests, but some yearlings remained at or continued to visit the nest during incubation. Broods stayed together after separation from adults.

Geese in their second winter (yearlings) were occasionally still with their parents (10%) or with siblings (5%) but most were alone (80%), as were over half of two and three-year-olds. Courtship involving the latter was noted during spring

migration.

Approximately 25% and 50% of two and three-year-old females and nearly all four-year-olds nested. Four times more females than males were seen back at the breeding ground suggesting that many young males paired in spring with females from, and accompanied them to, other colonies. Clutches of two-year-olds were smaller than those of adults and three-year-olds.

The effectiveness of fall and winter field counts of social groups to estimate average family size and the proportion of adults successfully rearing young is considered. Counts of landing geese were most accurate (95% of individuals tallied in the correct social status) followed by those at take-off (88%) and in flight (78%). All error sources taken together (from the counts and due to temporary changes in the social status of individuals) showed that family size was under estimated by 15% in and around blue goose concentration areas in the north-central United States but that "landing" and "take-off" counts provided accuracy of 95% on the Gulf Coast. It was concluded that the latter figures were sufficiently accurate to estimate breeding success by winter appraisals but that fall counts in the Northern States should not be used.

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INTRODUCTION

1.1 PERSPECTIVE

Although the social life of wild geese has been the subject of considerable comment in popular writings and has led to much speculation in the scientific literature, there is little concrete knowledge of family relationships in large, natural populations, particularly during the non-breeding season. Nonetheless, techniques for estimating annual productivity in goose populations have been formulated based on assumed continuity of the family unit into winter (Boyd 1959, Lynch and Singleton 1964).

The blue goose (Anser caerulescens) is a very successful species. It has adapted well to changes caused by man's agricultural activities on its migration pathways and wintering areas and its numbers appear to have increased within the past decade. Its breeding areas are still remote and for the most part enjoy legal protection. Because of its abundance the blue goose will likely be one of the most important recreational waterfowl species of the future. It

is thus desirable that we learn as much as possible about the biology of blue geese in order to monitor and manage their numbers effectively. Modern game management seeks to model the population dynamics of each species, population, or local stock in order to predict optimum levels of exploitation, yielding a maximum harvest while maintaining an adequate breeding stock. Present knowledge of the blue goose falls far short of that necessary for such management.

This study had sought to enlarge our understanding of the social habits of wild geese and supplement knowledge in two aspects of blue goose biology particularly important in developing population models: monitoring year to year reproductive success, and determining the contribution of various age components to the reproductive effort.

1.2 AIMS

To gather information on:

1) Permanency of blue goose families. Can the presence of family groups in autumn and winter be used to gain estimates of reproductive success of the previous breeding season?

   The following must be known:

   - the existence and persistence of the family unit;

- extent of brood mixing and adoption of strays into existing families;
- extent of breakup of families due to hunting or other factors prior to field counts;
- behavior of family remnants;
- behavior of yearlings, older prebreeders and unsuccessful breeders during fall and winter.

2) Effects of age on reproductive biology of blue geese:

- age at which geese first breed, including differences due to sex;
- the proportion of the various age classes which breed;
- relative reproductive success of different age classes.

3) Other aspects of blue goose behavior which lend themselves to investigation and which would contribute to our knowledge of social life of geese:

- time of family breakup and subsequent behavior of young birds;
- duration of pair bond and behavior of survivor when one adult dies.

1.3 BACKGROUND

The existence of small groups of swans and geese (Anserinae) has long attracted the interest of waterfowl

observers. In most North American Anserinae, many of the smaller groupings often visible within large migrating or wintering flocks consist of two adult-plumaged birds with variable numbers of juveniles, usually between one and five. As early as 1916 Phillips (1916) collected "family" group data for Canada geese (Branta canadensis), supposing that the small parties were adult pairs with their offspring hatched in the preceding summer. Elder and Elder (1949) summarized the many general observations lending support to this interpretation. Other small groups are composed of birds in adult plumage, presumably unsuccessful or sexually immature pairs, yearling sibling groups, or perhaps casual associations. Occasional small parties of juveniles are also seen, possibly brood remnants or groups of unrelated orphans.

The presence of apparent family groups in fall and winter flocks of several species of swans and geese has been exploited to obtain valuable data on yearly reproductive success, thereby avoiding difficult and costly trips to remote and vast breeding areas for this purpose. An unparalleled series of yearly productivity records for blue geese wintering on the Gulf Coast, based on group counts,

dates back to 1932 (lynch and Singleton 1964, Lynch 1972).

Collection of simple ratios of adults to young geese can often give a general indication of productivity. However, a high proportion of juveniles in the population could as likely be caused by a scarcity of prebreeders in adult plumage as by above-normal production of young. Similarly, low ratios of juveniles could be due to the presence of large numbers of prebreeders as a result of successful breeding one or two years earlier, regardless of success in the preceding summer. Low numbers of juveniles could also result from lowered overall reproductive output, or to markedly reduced production of some sexually mature birds but normal success of others, perhaps between different breeding areas. These aspects have been discussed by Boyd (1957, 1959) and Lynch and Singleton (1964).

Many of the difficulties can be resolved by also making carefully conducted counts of "families" and other small groups. Data collected in this manner yield estimates not only of the ratio of adults to juveniles, but also of the average number of young per successful brood and the proportion of geese in adult plumage bringing young south. When used in conjunction with accurate counts of total numbers, estimates of the survival of different age components of the

population and of the proportion of mature females failing to produce broods are possible. Hence, there is the potential of learning not only extent of year to year changes in numbers, but how those changes came about (Boyd 1957, 1959 and Lynch and Singleton 1964).

Of course, if families do not remain intact, if dominant geese adopt young from subdominant pairs (as demonstrated in several southern breeding populations of Canada geese, reviewed in Raveling 1969a:314), if orphaned young are adopted into existing families or if unrelated birds form "pseudofamilies", most of this information would be spurious and seriously misleading.

Most direct evidence for family unity has come from geese in captive or semicaptive flocks (e.g., Heinroth 1911). More recent observations of wild Canada geese (Martin 1964, Sherwood 1967) showed that marked families observed before fall migration were often still together when they returned to breeding areas the following spring. Raveling (1969a) found that groups of adult and juvenile Canada geese captured in winter and outfitted with radio transmitters behaved as intact units. Observations of Martin and Sherwood, however, did not include the winter period and involved geese from relatively small, discrete populations, while in Rave-

ling's study, the number of marked families was small and chosen selectively - only those families still intact on arrival at the wintering location could be marked. Further, results from Canada geese might not be applicable to other species. Thus, it was desirable to study family behavior in a species, such as the blue goose, with large populations in which families, chosen at random, were marked on the breeding ground and observed throughout the nonbreeding season.

2. METHODS AND MATERIALS

2.1 TAXONOMY

In this paper, the species is called the blue goose, Anser caerulescens. When reference is made to one color phase in particular, it is called "snow goose" or "blue phase".

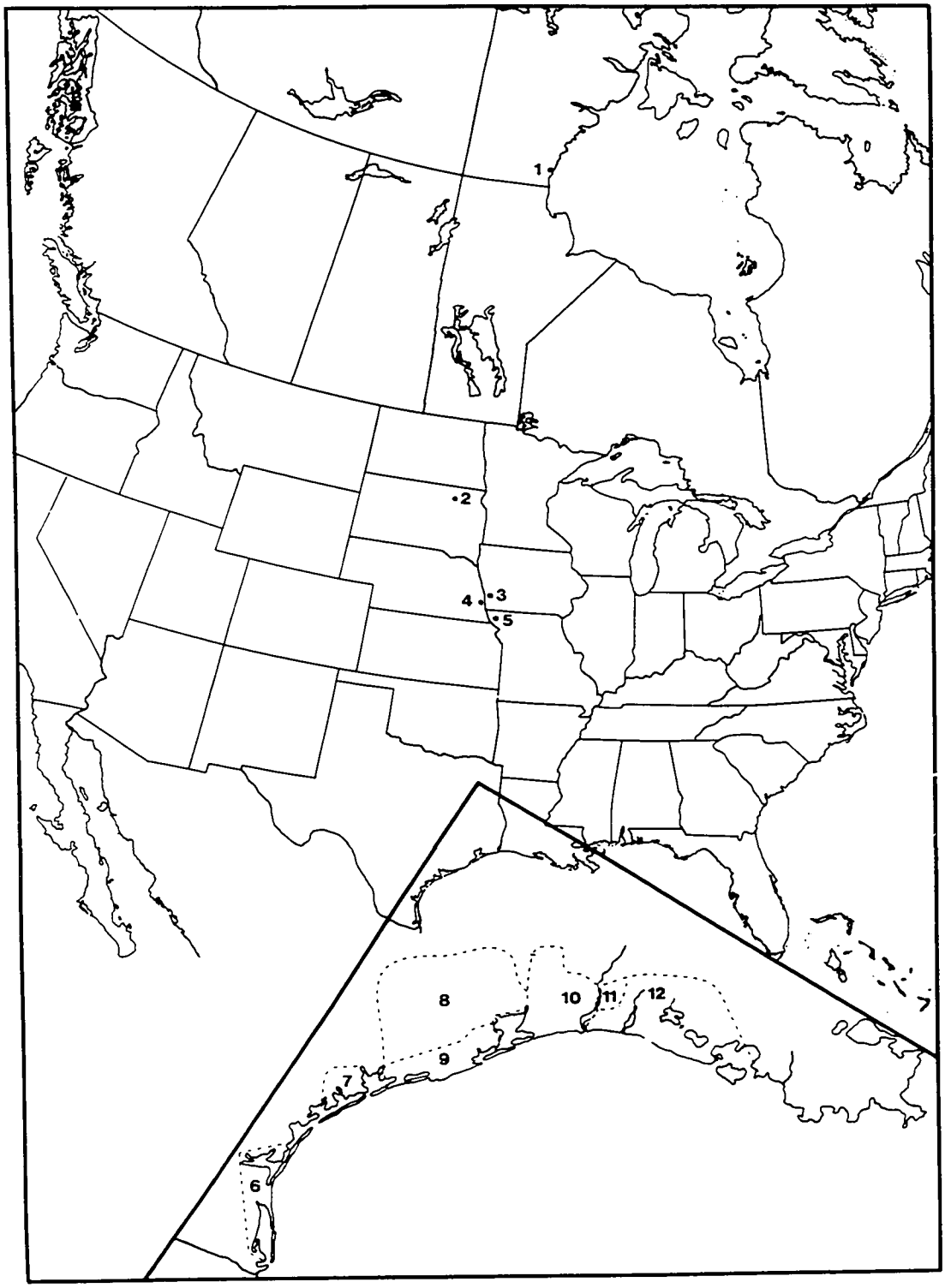
Other scientific bird names follow the A.O.U. check-list (1957) except when otherwise noted.

2.2 LOCATION AND DURATION OF STUDY

The study was conducted on a major blue goose breeding ground and at several locations within the migration and wintering range of the blue goose (Figure 1). Five summers (mid May to mid August from 1966 to 1970) were spent at the blue goose nesting colony at the mouth of the McConnell River, N.W.T. ($60^{\circ}50'N$, $94^{\circ}25'W$). The McConnell River delta is situated on the low coastal plain on the west coast of Hudson Bay, a region of post-Pleistocene emergence (Lee 1968:512-516). MacInnes (1962) has described the area. It is characterized chiefly by flat, wet tundra containing

FIGURE 1.

Locations visited during this study to observe neck-collared blue geese: 1. McConnell River, 2. Sand Lake National Wildlife Refuge, South Dakota, 3. DeSoto N.W.R., Iowa, 4. Plattsmouth Waterfowl Management Area, Nebraska, 5. Squaw Creek, N.W.R., Missouri (2 to 5 are "Northern States"), 6. South Coast of Texas, 7. Aransas-Calhoun Counties, Texas, 8. Katy, Lissie and Garwood Rice Prairies, Texas, 9. Brazoria-Madagorda Counties, Texas, 10. East Texas, 11. Gum Cove, Louisiana, 12. remainder of Louisiana, mainly in the vicinities of Sabine and Lacassine N.W.R. (6 to 12 are "Gulf Coast").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numerous shallow ponds. The breeding population of Anser caerulescens was estimated at approximately 45,000 pairs in 1971 by C. von Barloewen (pers. comm.), but might be twice this number (R. H. Kerbes, pers. comm.). This colony has contained about 26% blue phase birds during the course of the study.

Most of two winters (early October to early April, 1968-1969 and 1969-1970) and ten weeks of a third (10 October to 18 November, 1967, 15 February to 14 March, 1968) were spent searching for neck-banded geese in the United States. In addition, a brief reconnaissance survey was made to Texas and Louisiana from 18 December to 10 January, 1966-1967. The American observations in 1968-1969 and 1969-1970 were made starting in October on National Wildlife Refuges, state management areas and occasionally on private land holdings in states bordering on the central Missouri River from South Dakota to Missouri. Many of these areas were again visited during spring migration. Winter sightings were from the Gulf Coast wintering grounds of Louisiana and Texas. Most of the latter observations were of geese on private land with a minority from birds using National Wildlife Refuges. Specific areas for observation were chosen on the basis of recoveries of geese banded at the

McConnell River (Cooch 1958, C. D. MacInnes, pers. comm.). Although band recoveries indicated that many McConnell River blue geese passed through North Dakota, few observations were attempted there for logistical reasons and due to lack of a favorable area where large numbers of blue geese could be viewed at close range (C. S. Schroeder, pers. comm.).

The three federal refuges in the central United States (Sand Lake, DeSoto, Squaw Creek), where the bulk of fall and spring sightings of neck-banded geese were made, encompassed 21,000, 7,800, and 6,800 acres, respectively. Each refuge included one or more bodies of water, farmland, and wooded areas. Over 100,000 blue geese used each of the refuges for extended periods each fall of the study and occasionally more than 200,000 geese were recorded on an individual refuge (refuge files, Sand Lake, DeSoto, and Squaw Creek National Wildlife Refuges). Individual flocks sometimes numbered over 75,000 birds. Cereal crops (principally corn) and greens (fall wheat, rye grass) were grown on the refuges under varying sharecropping agreements with local farmers. Most of the refuges' share of grain was left in the fields for the use of the geese. Geese also fed on private land in the vicinity of the refuges, particularly at Squaw Creek, but they usually returned to the refuge to spend mid-day and

night. Because hunting was in progress during the entire fall observation period, virtually all autumn sightings were made on protected areas. In spring, however, geese took advantage of waste grain in fields within several miles of the refuges and many observations were made in these situations. At this time refuges were less intensively used, serving mainly as loafing areas.

During the years of the study, blue geese on the Gulf Coast of Texas and Louisiana used two distinct habitats: the coastal marshes and agricultural land. The latter was primarily used for growing rice. In alternate years of the two or three year rotation, the fields were often planted in rye grass and cattle allowed to graze in them. Geese fed on both waste rice and green growth in fallow fields. The use of agricultural areas by blue geese is recent; McIlhenny (1932:281-282) stated that blue and snow geese were never found more than eight miles back from the salt beaches of the Gulf Coast.

The majority of winter sightings were from geese in rice-growing areas. Difficulty in approaching geese closely enough to make observations, and poor visibility due to tall vegetation, severely hindered work in the marshes.

Rarely did geese occur on the Gulf Coast in the large

concentrations characteristic of the northern refuges. Only a few flocks numbered more than 20,000. The usual pattern was of many moderately sized flocks well spaced in any given area. After the hunting season (about mid-January), blue geese became very tame, often feeding on the periphery of fields alongside roads; many times in these circumstances observations were made at less than 50 metres.

2.3 TECHNIQUES

That geese must be identified individually in a study of this type is obvious. For this purpose an aluminum neck collar was developed that could be coded individually by different two-symbol combinations, and for age and year of banding by different color combinations of background and symbols, each supplied by adhesive plastic film tape (see MacInnes *et al*. 1969). Appendix A.1 shows the number of bands applied each year and the proportion that were sighted in the United States the following fall and winter. A family party of blue geese wearing neck collars is shown in Figure 2.

Blue geese reacted more vigorously to their collars than did Canada geese (*B. c. hutchinsii*) banded at the McConnell River, resulting in occasional bill sticking or

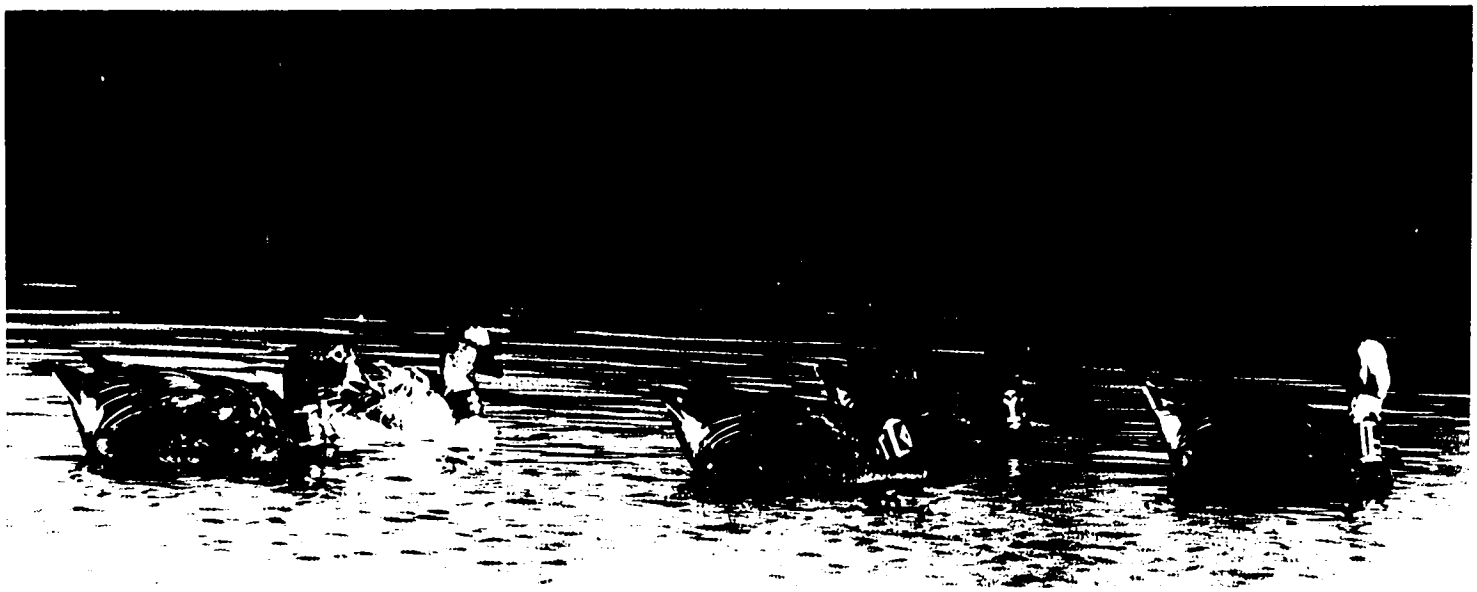


Figure 2. A neck-banded family of blue geese at Squaw Creek National Wildlife Refuge consisting of one blue phase adult, three blue phase juveniles and one snow phase juvenile. A second adult was not seen with this family and presumably had been shot or permanently separated. Photograph by Mary M. Tremaine.

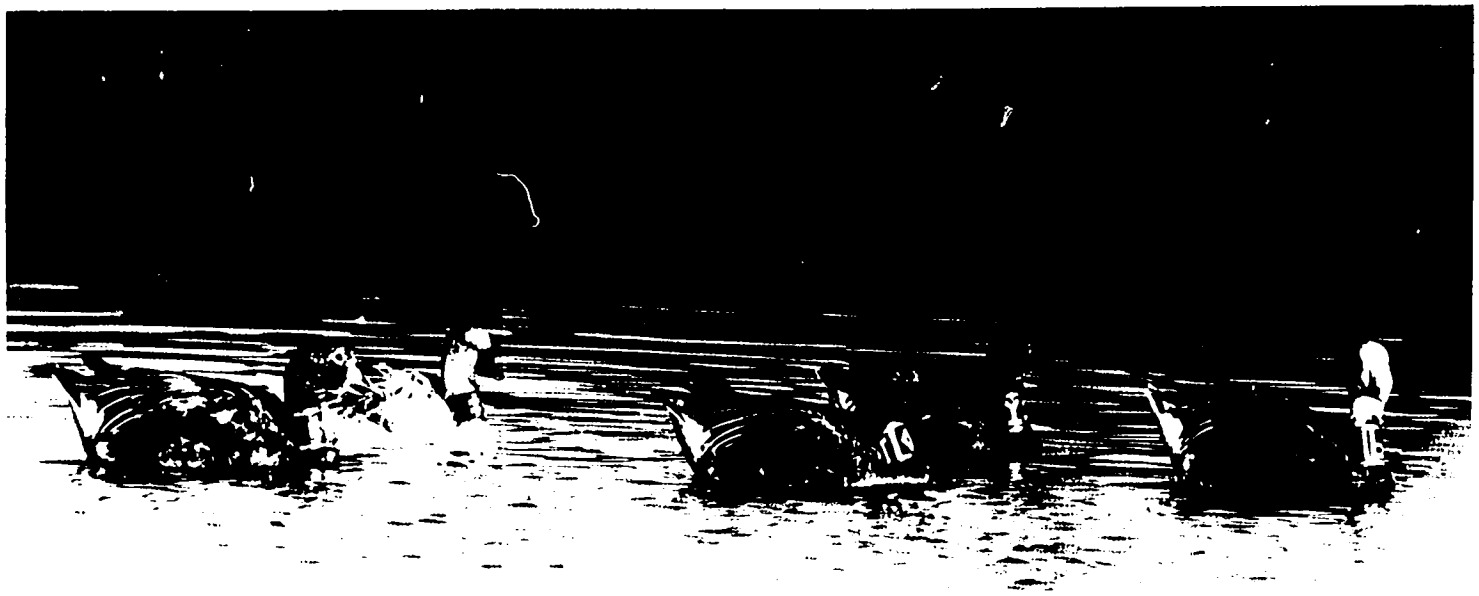


Figure 2. A neck-banded family of blue geese at Squaw Creek National Wildlife Refuge consisting of one blue phase adult, three blue phase juveniles and one snow phase juvenile. A second adult was not seen with this family and presumably had been shot or permanently separated. Photograph by Mary M. Tremaine.

injury to the geese and frequent disfiguration of code symbols on the bands (MacInnes et al. 1969). The application of a transparent protective layer retarded but did not eliminate mutilation. Consequently, it became increasingly difficult to follow the histories of geese more than a year after bands had been put on (Appendix A.2).

Flightless geese were captured for banding by mass drives (Scott, Boyd and Sladen 1953:68-73, Cooch 1956). Geese were kept in holding pens until all were banded. To minimize breakup of families, the entire catch was released simultaneously (Scott and Fisher 1953:20). In large drives, adults and juveniles were held in separate pens to prevent trampling of goslings. Goslings held without food and water for as long as eight hours frequently straggled when released so in 1968 and 1969 geese were herded into the river following banding. They always remained tightly bunched as they swam away from the banders, thus facilitating re-formation of families. Geese banded in 1966 and 1967 were obtained in drives designed to catch large numbers of geese for a concurrent study by C. D. MacInnes. It became apparent, however, that in the confusion when such large numbers of geese were released, some families did not regroup. Consequently, in 1968 and 1969, an effort was

made to catch fewer geese per drive. In 1967 the average catch was over 900 per drive but in 1968 was close to 500 (Appendix A.3).

In order to identify brood mates at banding, newly hatched goslings were marked with numbered poultry patagium tags in the patagium or foot webbing, or mink ear tags in the foot webbing (Grice and Rogers 1965:8-11). If adults had been neck-banded in previous years, the relationships between adults and juveniles were also known. An experimental series of Peterson fish tags were applied to the patagium in 1967. Appendix A.4 shows the number of tags put on each year and recaptured at banding.

A permanent elevated observation blind was constructed in a blue goose feeding area at the McConnell River in 1968. Marked adults and their broods were observed for approximately four weeks following the hatch in 1968, 1969, and 1970 in order to determine the amount of brood mixing that occurred in this interval. Also, due to the fortunate tendency of goose flocks to return to habitual feeding areas after they have been banded, it was possible in 1968 and 1969 to watch the process of family regrouping following drives that caught geese feeding near the blind.

2.4 OBSERVATION PROCEDURES

Goose flocks at migration stopover areas and on wintering grounds were very wary of men on foot but frequently

allowed close approach by motor vehicles and domestic livestock. For this reason, most observations were made from vehicles. Only when geese in an area could not be observed near roads were sightings attempted on foot. This method proved to be quite useless and goose flocks in some areas on the Gulf Coast could not be examined. Roads on National Wildlife Refuges in the northern states often permitted approach to within 100 meters of large goose flocks whereas on the Gulf Coast considerable searching was sometimes required to find flocks near enough to roads to allow adequate viewing. Neck band symbols could be read at distances over 300 meters in favorable light.

Goose flocks were scanned using Bausch and Lomb 16 to 60 variable power telescopes and neck band codes and social status of marked geese were recorded. The status of collared geese in families was usually easy to decide since the association of a party of marked individuals among predominately unmarked geese was obvious. If one or more adults of a family did not wear neck bands (previously leg-banded geese could not be neck-collared at banding), however, it was often very difficult or impossible in densely packed flocks to decide with certainty if just one adult still remained in the family, or, if marked juvenile(s)

were not with adults at all. In the latter cases, the status of juveniles frequently had to be recorded as "undetermined". Similarly, the true status of marked adults or prebreeders in adult plumage unaccompanied by other collared geese often could not be ascertained. When geese were walking or swimming, careful observation sometimes revealed whether a marked bird consistently followed, or was followed by, unmarked individual(s). Failure to perceive this, however, did not always mean that the neck-banded bird was alone since observation of marked parties showed that all group members did not always walk or swim close together. Marked geese behaving in a seemingly independant manner from geese nearby were recorded as "alone".

In order to best study day to day composition of family groups, emphasis was placed on sighting the maximum number of different neck-banded geese as many times as possible. Consequently, little information of an "ethological" nature was obtained such as form, motivation, releasing situation and function of behavior patterns, intra and inter-family actions and reactions, and the effects of social status and family size on dominance. Many of these aspects have been studied in other geese (e.g., Boyd 1953,

Fischer 1965, Johnsgard 1965, Balham 1954 and Raveling 1970). Differences between species are not marked. On waterfowl refuges in the Northern States up to 50,000 blue geese could often be searched and re-searched for neck bands; over 150 different collars have been identified in a single day. Because flocks were more dispersed on the Gulf Coast, fewer than 25,000 geese could usually be closely studied and rarely were more than 50 different neck bands read in a day.

Detailed counts (see MacInnes 1966:541) were made at all locations to determine the ratio of neck-collared to unmarked geese. In addition, "average group counts" of geese landing or taking off were conducted throughout the fall and winter in the manner of Lynch and Singleton (1964). Figures from the latter counts served as a control, making it possible to compare the social status of unmarked and marked geese.

Neck band observations on the breeding grounds were made from the time geese arrived, usually in the last week of May, until four to six weeks after the hatch (early August) when banding started. Throughout incubation nests of collared geese were located and marked with wooden stakes. Clutch sizes and locations of nests were recorded. Informa-

tion on nesting and hatching success was obtained for some of these pairs. Due to the large size of the nesting colony, equal effort was not given to searching all parts of the colony; those areas within normal walking distance of camp (8 to 10 km) received closer attention than more distant areas. Visits were made to virtually the whole colony in most summers, however. When possible, flocks of nonbreeding geese on the periphery of the colony and in areas of low nesting density were scanned for neck-banded geese.

2.5 DEFINITIONS

Geese in their first year, from hatching until their return to the breeding colony the following spring, are juveniles. At this time (eleven months of age) they become yearlings and one year later, when approximately 23 months old, become two-year-olds. Adults have attained sexual maturity.

Prebreeders are geese that have not reached sexual maturity or have not yet bred. Failed breeders nested unsuccessfully while nonbreeders are sexually mature individuals that apparently did not breed.

Families refer to groups containing adults and juven-

iles, and, occasionally, yearlings. Family remnants are part families with adults, juveniles, or both, missing. Brood remnants are sibling groups that have become separated from parents and, or, other siblings.

Nesting success refers to the proportion of nests in which at least one egg hatches successfully. Hatching success is the proportion of eggs that hatch.

Throughout, the term "status" is used to refer to the social position of geese: in families, paired, alone, with siblings (brood remnant), in a casual association of geese, or of undetermined social status.

2.6 STATISTICS

Statistical tests follow Sokal and Rohlf (1969). Most statistical analyses involved comparisons of ratios and were carried out by Chi-Square tests of independence (X^2_{df}, where the subscript df refers to degrees of freedom). Fisher's test for exact probabilities was used when possible in cases where samples were small. If samples were too small to permit testing, minimum expected values are indicated by "E values <N" (Cochran 1954:420-421, R. K. Misra, pers. comm.).

3. FAMILY GROUP BEHAVIOR

3.1 THE FIRST SIX WEEKS

Individually numbered tags were applied to the foot webbing or patagium of goslings still in the nest in order to identify broods among the large number of families caught in banding drives five to six weeks later. The rate of recapture was disappointingly low, ranging from less than 1% to 7% (Appendix A.4). Since average brood size between hatch and banding dropped by approximately 25% each year, one fourth of the sample of web tags was quickly lost. Also, the capture of goslings with holes in their webs indicated that about 12% of the web tags came off in five to six weeks following hatch. The main problem, however, was apparently due to "dilution" of marked birds during the post-hatch dispersal. The pattern of recovery of marked broods showed that thorough mixing of geese from different parts of the colony had occurred between hatch and banding. Consideration of numbers of geese thought to breed in the colony and caught in banding drives indicated that we could expect to recapture no more than about 3% of tagged broods.

Thirty-one broods containing two or more tagged goslings were recaptured, providing information on persistence of families during the first six weeks (Appendix A.5). Of a total of 84 marked juveniles, three were captured in different banding drives than those including other goslings from their families and in another drive the marked parent of a tagged gosling was not caught. Capture of tagged siblings in different drives or in drives without their parents indicated that brood mixing had occurred, or possibly, that their parents had escaped the drive.

Considering conditions under which tagging was carried out, it was almost inevitable that some artificial brood mixing resulted. An investigator walking through the closely spaced nests during the hatching period was bound to cause disturbance. First-hatched goslings emerged from the shell more than a day before those hatching last and consequently were stronger. When adults with newly hatched young or clutches only partially hatched were approached by a potential land predator they generally moved away from the nest. Goslings unable to leave the nest or to keep up with their parents might be abandoned. These orphans might subsequently wander near another brood and be adopted before bonds had formed between parents and offspring. Heinroth

(1911) described how incubator-raised goslings about a day old could be introduced successfully into a brood of similar age. Orphans encountered during web-tagging procedures were placed in nests with newly hatched young at McConnell River. Observations from a distance revealed that when adults returned to their nest they apparently did not notice the strange juvenile; females often quickly commenced brooding.

Disturbances of this type were of fairly regular occurrence, even under natural conditions. Wolves (Canis lupus), foxes (Alopex lagopus) and polar bears (Thalarctos maritimus) have all been observed at the McConnell River; wolves and foxes have been seen preying on geese. Also, caribou (Rangifer tarandus) were frequently sighted in the breeding colony. Geese left their nests leading those goslings able to follow when any of these animals came near; brood mixing could be a fairly frequent occurrence under these circumstances. While walking through the colony, investigators have frequently seen different broods merge and interchange of goslings take place as pairs walk away to avoid the approaching humans.

While controlled experiments were not conducted, experience with adding orphans to nests during web-tagging led to the conclusion that color of goslings had little effect

on adoption.

Females returning to their nests usually quickly brooded introduced goslings along with their own offspring, regardless of color. When goslings a day or more old were substituted for recently hatched goslings, the adults sometimes appeared "uneasy" at first and inspected the goslings closely, but they were not observed to desert them.

On infrequent occasions ganders have been observed to deliver mild pecks to introduced goslings. Although there was noticeable individual variation in the response of pairs to introduced or substituted goslings, most pairs appeared to accept them if they were introduced into the brood within approximately the first three days after hatching.

Several studies of Canada geese (B. c. moffitti and B. c. maxima) have shown that brood mixing often occurs (summarized in Raveling 1969a:314). Sherwood (1966:130) found that dominant pairs frequently "adopted" goslings of sub-dominant pairs under crowded conditions. In several areas average brood size increased up to about two weeks after hatching. No such trend occurred in brood sizes of blue geese at McConnell River (Figure 3) although occasional large broods have been seen that must have been due

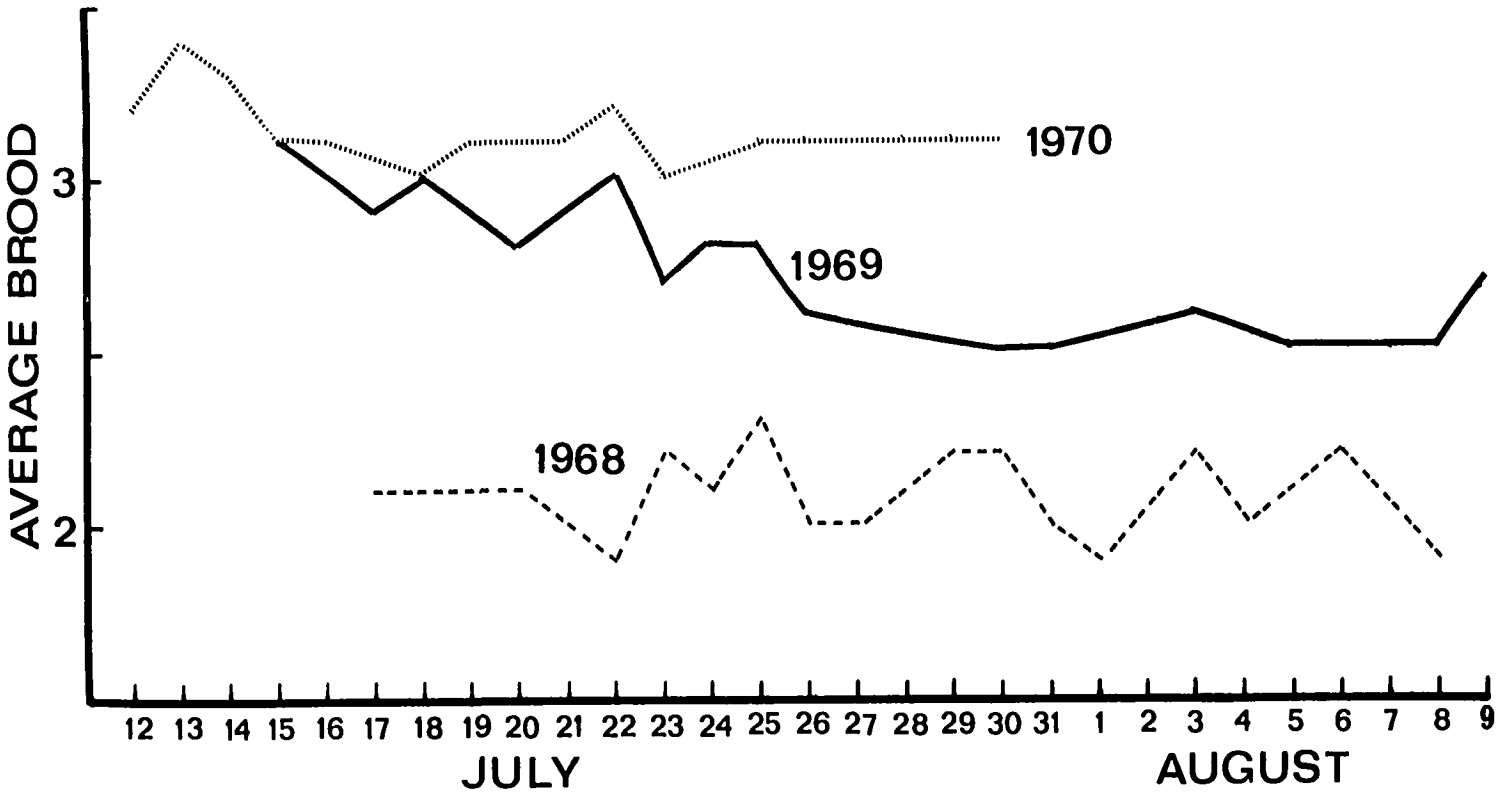


Figure 3. Sizes of blue goose broods between hatch and banding at McConnell River.

to brood adoption. On 22 July, 1969, B. C. Lieff (pers. comm.) saw a pair of snows with 11 goslings and on 25 July he noted a snow pair leading approximately 19 goslings (all snow phase) in the same area. Similarly, following banding in 1969, two adult blues were observed with 14 juveniles (12 blues and two snows) on 20 and 21 August. Two other "families" each containing nine goslings have been observed during the brood-rearing period at the McConnell River.

Most large broods are not apt to have resulted from large clutches. The average potential clutch size of blue geese is 4.4 (Cooch 1961:77) and clutches containing more than six eggs are unusual. Promiscuous egg-laying, however, is common some years at the McConnell River. In 1968, L. S. Prevett (unpubl. data) estimated that approximately 20% of all blue goose eggs laid in nests along a 4 km transect did not come from females belonging to the nests. Nests were found in 1968 containing up to 19 eggs; others had up to 41 additional eggs scattered around the cup. Although "dump" nests could be responsible for some large broods observed following the hatch, it is doubtful that blue goose females are capable of effectively incubating as many as 11 eggs (see Ryder 1967:30).

A third source of information on brood mixing was ob-

tained from families in which adults were neck-banded (Appendix A.6). Fluctuation in the number of goslings occurred in only seven of 68 (10%) broods that were sighted on three or more days, involving seven of 194 (4%) goslings. In five of seven cases, goslings were lost and gained the same day; each brood was recorded with one fewer goslings than on preceding days but with the "correct" number a few hours later. The goslings could have wandered away from their families and rejoined them later, temporarily joined another family, or they could have been present but not recorded. The last explanation was most likely as small goslings feeding in slight but steep depressions of dried-up stream beds and shallow pools were sometimes completely hidden while the rest of the family fed in plain view. Thus, a more likely estimate of incidence of temporary brood mixing during the post hatch flightless period would be two of 68 broods (3%), involving two of 194 goslings (1%). Lieff (unpubl. data) has noted a similar low incidence of temporary "trading" of goslings between Canada goose families at the McConnell River. During the brood rearing period blue goose families live in loose flocks scattered over suitable feeding habitat up to 50 km from the breeding colony. Aggression between families normally prevents broods

from comming into close contact. Soon, family behavior is further coordinated through cues based on individual recognition and the bonds cementing family structure quickly develop (Fischer 1965:253-258).

Adults could apparently recognize their offspring within about a week following hatching. Goslings of this age that had become separated from their parents during disturbances frequently approached strange families. They were invariably threatened and were often attacked by the adults even though they were of a very similar size to the adults' own goslings. It wasn't until about three weeks after hatching that young geese were observed to attack strange goslings, suggesting that recognition between siblings might develop about this time. Ganders appeared to threaten and attack stray goslings more commonly than did females, although there was considerable variation between pairs. Interestingly, adults attacked herring gulls harrassing goslings they had themslves attacked moments before.

In conclusion, information from three independent sources has shown that adoption of goslings and mixing of goslings between broods is uncommon among blue geese at the McConnell River, involving less than 5% and probably no more than 1% to 2% of goslings. Most mixing apparently

occurred within the first week of hatching before individual recognition among family members had developed. Much of the observed adoption was probably due mainly to activities of researchers although natural disturbances could have produced the same effects.

3.2 EFFECTS OF BANDING ON FAMILY STRUCTURE

In the process of mass banding drives and subsequent handling, members of every goose family were separated at least temporarily. The validity of fall and winter sightings depended on the success with which families re-formed after they were banded. Since most blue geese returned to their habitual feeding area after they were set free from the banding pen, the process of regrouping of families could be observed following drives that caught geese feeding near observation towers. As Cooch (1958:125) also noted, for the first several hours after release geese milled about in a confused manner. Goslings, having been held for six to eight hours without food or water often formed more or less separate groups since they stopped to feed sooner than adults. The latter normally ran farther from the pen before stopping in loose, disorganized groups. To compound the confusion, the geese were not yet accustomed to their new

neck bands and some individuals showed considerable preoccupation with biting and scratching at the collars. Gradually, however, as the small flocks merged, family members were able to recontact each other.

Data on regrouping are set out in Table 1. It was sometimes difficult to be sure of the size and composition of all families during observations on the day of the drive due to the tendency of geese that had not yet recontacted members of their family to feed and walk near other families. Therefore, only groups and individuals seen at least twice in the six days following banding are included in order to reflect more accurately their true status. Most geese regrouped. Ninety-five percent of the 80 groups containing adults and juveniles either remained intact or had added more members at second or subsequent sightings in the two years. Just over 10% of families lost members (6% had both additions and losses) but most of these (five of nine) resulted from incorrect classifications or loose association of birds the day of the drive before the resorting process was complete. There were fewer changes in groups first seen on the second or later days after drives. Only 5% of 120 adults and 8% of 178 juveniles seen more than once in the six days following banding did not recontact other family

members or left groups. Of eight adults apparently associated as pairs, two had separated by the second sighting. A more detailed breakdown is shown in Appendices A.7 and A.8.

The above figures provide no information on geese not seen after drives and are therefore misleading. The proportion of adults that did not regroup was also estimated by comparing the incidence of single-adult families before and after drives. In brood counts prior to banding in 1968 and 1969, families with only one adult did not amount to more than 4% of all families. However, following the drives six of 40 (15%) families in 1968 and ten of 38 (26%) families in 1969, of which some members were seen more than once, had just one adult. Thus, as many as 11% (1968) and 22% (1969) of adult pairs failed to reunite within six days of banding in the two years. The number of adults probably not seen after the drive is indicated in Table 1. In order to minimize the holding time for geese in banding drives adults were not sexed, so possible differences in the sex ratio of adults from the single-adult families could not be tested.

Average brood size was compared before and after banding to provide an independent estimate of the proportion of juveniles failing to regroup (Appendix A.9). In 1968, the average brood was 3% smaller (1.94 vs. 2.01) after banding

TABLE 1

RE-FORMATION OF MARKED ADULT AND JUVENILE BLUE GEESE INTO FAMILIES AFTER RELEASE FOLLOWING MASS BANDING DRIVES IN 1968 AND 1969 AT McCONNELL RIVER, N.W.T. ONLY BIRDS SEEN AT LEAST TWICE ARE INCLUDED.

CLASS	TOTAL SEEN (No.)	REGROUPED					DID NOT REGROUP, OR SEPARATED					EST. NOT SEEN (%)
		TOTAL (%)	WITH FAM. EACH OBS. (%)	JOINED FAMILY (%)	JOINED ADULT (%)	CHANGED FAMILY (%)	TOTAL (%)	LEFT FAM. (%)	LEFT AD. (%)	ALONE (%)	WITH JUV. (%)	
Adult	142	85	63	16	4	1	15	4	1	1	--	10
Juv.	178	92	72	16	--	3	8	3	--	4	1	0
Fam.	80*	95	--	--	--	--	11	--	--	--	--	--

* - Six percent of families showed both breakup and regrouping.

and in 1969, 9% smaller (2.28 vs. 2.52). Both figures were very close to the proportion of juveniles seen outside of families (Table 1). Brood size was not statistically different after banding in either year (1968: $F_{(1,130)} = 0.148$, $P > 0.25$; 1969: $F_{(1,161)} = 1.607$, $P > 0.10$). Hence more adults than juveniles were not seen. This probably reflected the tendency mentioned earlier for some adults to run farther after release from banding drives before stopping.

A trend toward both a higher proportion of single-adult families and non-family juveniles after 1969 banding drives (although in neither case were differences significant: $X_1^2 = 1.530$, $P > 0.10$ and $X_1^2 = 2.083$, $0.10 > P > 0.05$, respectively), suggested that regrouping was not as complete as in 1968. Although total geese captured in the drive for birds around the observation tower was lower in 1969 than 1968 (486 vs. 674), they behaved differently when released. In 1969 part of the geese crossed river channels into the delta islands while the remainder returned to the area near the tower, soon settling into a normal routine. It is probable that some of the birds that went into the delta did not come into contact with the latter group during the six days of observations.

Some geese from a larger drive (1957 birds caught)

covering an area upriver of the banding pen did not return to that area with the main flock but instead appeared around the tower. Many were goslings that were evidently left behind following release. These geese are not included in Table 1 since observations could not be made of the remainder of the flock that had returned to their normal feeding area. Thirteen of the 33 juveniles seen at least twice banded together into five groups and 14 others were seen on two days with a "permissive" pair of adults while only four were in families of normal size. Two of the juvenile parties were together two different days and might have been siblings. The other three groups showed considerable mixing of members. Two of eight goslings in the latter groups were from the flock caught near the observation tower and hence were definitely not related to the others. The number of goslings actually belonging to the adult pair of the large "pseudo-family" was not known. Twelve of the 14 were blue phase, the same as the adults. Since the young blues were likely hatched in a nest where at least one adult was a blue, they were probably more strongly attracted to adults of the same color phase as their parents (cf. Cooke et al. 1972). The gregariousness of A. caerulescens goslings deprived of parental guidance evidently caused some to band together

into loose groups or attempt to follow other families even though they were unrelated and did not share a common Triumph Ceremony, the bond which unites goose families (Lorenz 1967:176).

In all, over 90% of neck-collared geese (95% of juveniles and 90% of adults) re-formed into families within six days after they were banded in 1968. In 1969 the figure was 85% (89% of juveniles and 78% of adults). Regrouping continued, however, after the post-banding observation period (Section 3.3, Appendices A.11 and A.12). Eighty three families were seen later in the United States. About 12% of adults and 5% of juveniles in these families had joined them since the post-banding observations. Thus, virtually all adults and juveniles in 1968 and almost 90% and 95%, respectively in 1969 eventually regrouped into families.

3.3 EXISTENCE OF TRUE FAMILIES

The few observations of individuals whose relationships before banding were known indicated that the groups of adults and young forming following banding drives were true families (Appendix A.10). Of 11 juveniles captured at banding with others of their brood and seen later, nine were with known siblings, three of them also with known parents.

This suggests that neck bands did not interfere with the ability of related geese to recognize each other. The remaining two juveniles were alone, indicating that if contact between parents and siblings was broken, young birds did not form new associations. Six other web-tagged juveniles were sighted in the United States in fall and winter: three were alone, two were with adult pairs of the same color phase as when tagged at the nest and the remaining bird was part of a family. Since none of its three siblings were caught at banding, this juvenile must have been adopted, possibly due to mixing as a result of tagging operations.

Additional information on regrouping was obtained by comparing the number and color phase of goslings (not web-tagged) of marked adults before and after banding drives. This data also indicated that groups forming after banding were based on family ties. Data from four groups were available: a marked pair without goslings had re-formed within six days, one adult seen previously with a family was alone six days following banding, and two adult blues had one fewer gosling two days after the drive. A third family regrouped slowly. Two days after the drive the female was seen with four goslings of the correct color phase and by the sixth day the male had joined them but with an addi-

tional juvenile. It is not known whether the male or female had adopted the extra gosling. Apparently, then, successful adoption can occur in exceptional cases as late as five to six weeks after the hatch.

Disruptive effects of mass banding drives, while extreme, were not entirely unique. Several times blue goose flocks were observed running away from foxes, wolves, and caribou. On one occasion in 1967, B. C. Lieff (unpubl. data) saw large flocks of blue geese streaming towards his observation tower pursued by a wolf. Some flocks merged and bunched tightly, much like geese "brought under control" in banding drives. Subsequent to this disturbance geese milled about calling loudly in a manner very similar to a flock recently released from a banding pen. Several different groups numbering up to about 20 goslings wandered about unaccompanied by adults and many were still "alone" at least 12 hours later.

Permanence of groups forming following drives was determined by comparing their composition then with sightings in the United States from October to April (Tables 2 and 3 and Appendices A.11 and A.12). Few families were identical in makeup (25% in 1968 and 13% in 1969). Some had continued to regroup (19% and 18%) but the main difference was in

TABLE 2

COMPOSITION IN THE UNITED STATES IN FALL AND WINTER OF MARKED GROUPS OF BLUE GEESE SEEN FOLLOWING BANDING DRIVES IN 1968 AND 1969 AT McCONNELL RIVER, N.W.T.

TYPE OF GROUP	TOTAL SEEN (No.)	GROUP SAME (%)	REGROUPING OCCURRED (%)	BREAKUP OCCURRED		BREAKUP AND REGROUPING OCCURRED (%)
				BIRDS MISSING (%)	ONE BIRD OF GROUP SEEN (%)	
Family	83	18	8	37	25	11
Adult Pair	12	25	25	--	50	0
Juv. Group	8	0	0	13	87	0

TABLE 3

GROUP STATUS IN THE UNITED STATES DURING FALL AND WINTER OF MARKED BLUE GEESE SEEN FOLLOWING BANDING DRIVES IN 1968 AND 1969 AT McCONNELL RIVER, N.W.T.

AGE	TOTAL SEEN (No.)	IN SAME STATUS				REGROUPING		BREAKUP			CHANGED FAMILY (%)
		IN FAM. (%)	WITH MATE (%)	WITH JUV. (%)	ALONE (%)	JOINED FAMILY (%)	JOINED ADULT (%)	LEFT FAM. (%)	LEFT ADULT (%)	LEFT JUV. (%)	
Adult	126	56	5	--	2	9	3	18	6	--	1
Juvenile	130	60	--	2	2	5	--	25	--	6	0

groups in which breakup had occurred: 61% of families in 1968 and 81% in 1969. These included family remnants where some members were missing, or groups represented by a single individual that was alone when seen in fall and winter.

The majority of individual adults and juveniles were in the same groups in fall and winter. Others that were alone or not seen after banding had rejoined families before they were first sighted in the United States. The greater proportion of adults (12%) than juveniles (5%) now in families is consistent with greater numbers of adults that had not regrouped during the six days of post-banding observations (Section 3.2). In the two years just one bird (an adult) was seen with a different family in the United States but many (> 20%) were no longer with family members. This is not to be taken as evidence that groups forming following banding were not true families, or, alternatively, that the normal process of family disintegration had already begun. Rather, the severe hunting pressure and extremely crowded conditions on migration stopover refuges were the probable causes of the high proportion of broken families (Section 3.4).

Parties of juveniles forming after drives proved to be unstable. In only one of eight such groups were some of the young birds still together when sighted in the United

States. These juveniles had apparently formed unstable groups of unrelated birds when separated from families in banding drives. There were no statistical differences between years in the proportion of groups or individuals changing status, or between adults and juveniles.

The strong tendency for individuals to associate with the same birds they were with after banding or to be alone indicates that families re-formed after mass banding drives, and that once separated, members of such groups did not form new associations.

3.4 BEHAVIOR OF FAMILIES IN FALL AND WINTER

In 1968 and 1969 approximately 35% of geese banded in summer were sighted during the course of fall and winter observations in the United States while in 1967, when less than half as much time was spent in the field, 14% were seen (Appendix A.1). Many birds were seen on several occasions and at different locations, providing much information on day to day activity and behavior. It quickly became apparent that the family status of many individuals, particularly in the Northern States, fluctuated a great deal. For example, adults from a family might be sighted alone, with their mates only, or with all or parts of their families

on the same or different days. Consequently, in order to be reasonably certain of their true status, only those families and individuals seen on three or more occasions are included in the tabulations in this section. This resulted in exclusion of approximately 45% of all sightings (71% of individuals) from the following analyses.

The status of neck-collared adults and juveniles, determined on the basis of three or more observations, is shown in Table 4 (and Appendices A.13 and A.14). The social status of adults and juveniles at each location, and changes in status of individuals seen in successive time periods is diagrammed in Figures 4 and 5 for convenient reference throughout this paper. The proportions of adults recorded in each status in fall and winter were remarkably constant between years and were also similar between the Northern States and Gulf Coast. Differences occurred for juveniles; in the Northern States fewer were in families in 1967 and 1969 than in 1968 ($X_1^2 = 18.768$, $P < 0.001$ and $X_1^2 = 9.872$, $P < 0.01$, respectively). On the Gulf Coast a higher proportion of juveniles was alone in 1969 than in 1968. (Too few juveniles were seen three or more times on the Gulf Coast in 1967 to permit statistical comparison.)

More juveniles were not in families in years of high

TABLE 4

GROUP STATUS OF NECK-COLLARED ADULT AND JUVENILE BLUE GEESE SIGHTED THREE OR MORE TIMES IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING, 1967-'68 TO 1969-'70.

AGE	YEAR	AREA	TOTAL SEEN (No.)	GROUP STATUS: IN FAM. (%)	ALONE (%)	WITH ADULT (%)	WITH JUV. (%)	STATUS UNKNOWN* (No.)
Adult	All	N. States	271	59	18	23	--	11
		G. Coast	95	64	15	21	--	2
Juv.	1967	N. States	69	61	26	--	13	0
		G. Coast	4	100	0	--	0	0
	1968	N. States	145	87	13	--	0	3
		G. Coast	38	89	11	--	0	0
	1969	N. States	69	75	18	--	7	3
		G. Coast	29	66	34	--	0	0

Adult: Between Years in N. States: $X^2_4 = 6.442$, $P > 0.10$.

Between years on G. Coast: $X^2_4 = 3.999$ (approx) $P > 0.10$.

N. States vs. G. Coast: $X^2_1 = 0.739$, $P > 0.10$.

Juvenile: Between years, N. States (in fam.:not in fam.): $X^2_2 = 8.149$, $P < 0.05$.

Between years on G. Coast (1968: 1969): $X^2_1 = 5.711$, $P < 0.05$.

N. States vs. G. Coast in 1968: $X^2_1 = 0.182$, $P > 0.10$.

N. States vs. G. Coast in 1969: $X^2_1 = 0.991$, $P > 0.10$.

* - Not included in "Total Seen".

FIGURE 4.

Summary of group behavior of neck-banded adult blue geese throughout the year. Numbers in boxes are percentages of adults seen a minimum of three times that were recorded in each social status at each season (from Tables 4, 14 and 15 and Appendix A.8). Numbers associated with lines between boxes are percentages showing the new social status of those adults seen at both seasons (not necessarily observed three or more times, from Table 3 and Appendices A.27, A.30 and A.32). For convenience, lines from Summer, After Banding lead only to Fall in the Northern States rather than to both the Northern States and Gulf Coast as shown in Table 3. Similarly, lines to Summer at Nest Initiation originate only from Spring in the Northern States rather than from both Spring and Winter as shown in Appendix A.32. Numbers on the right side of the figure indicate sample sizes.

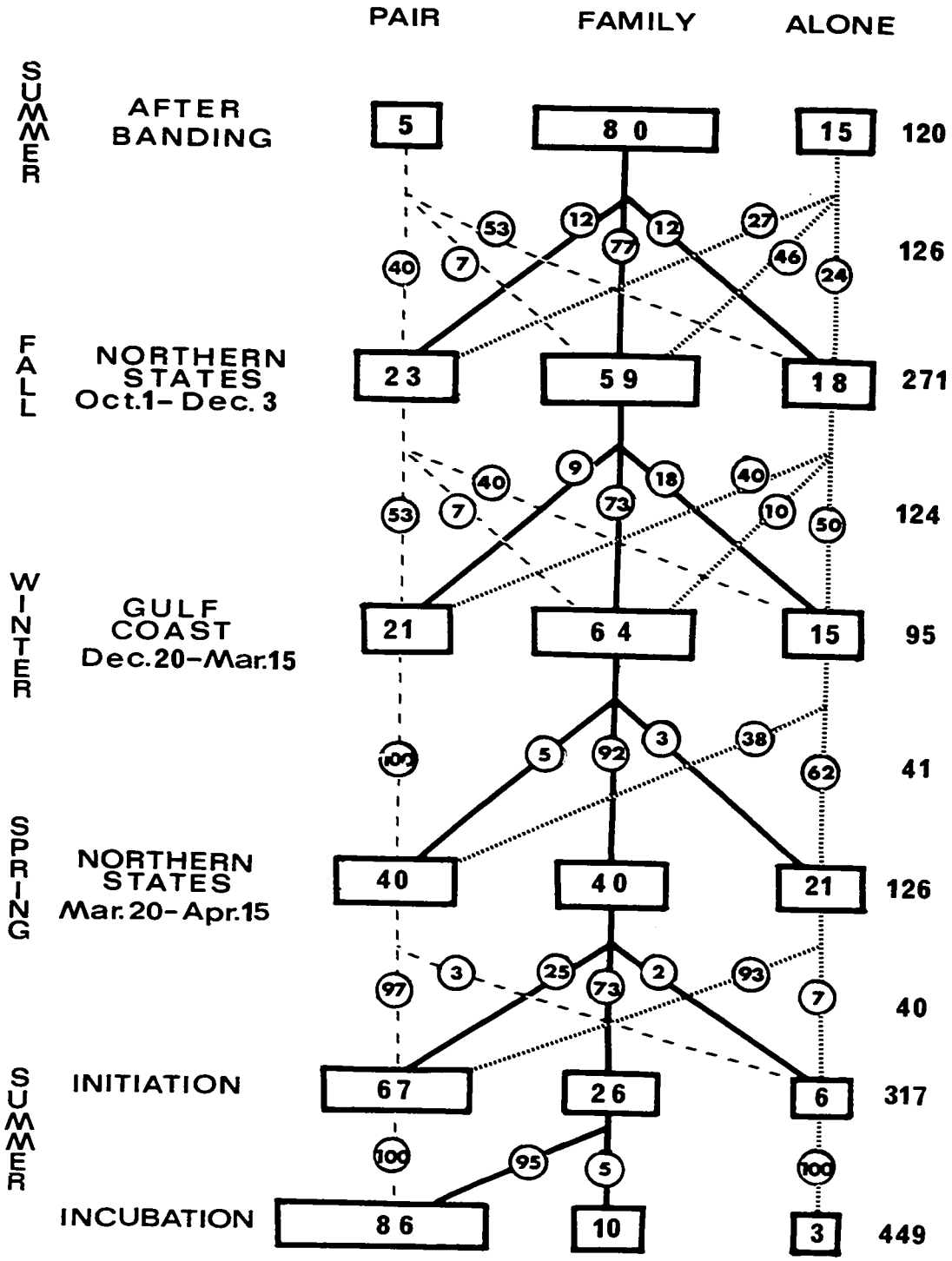
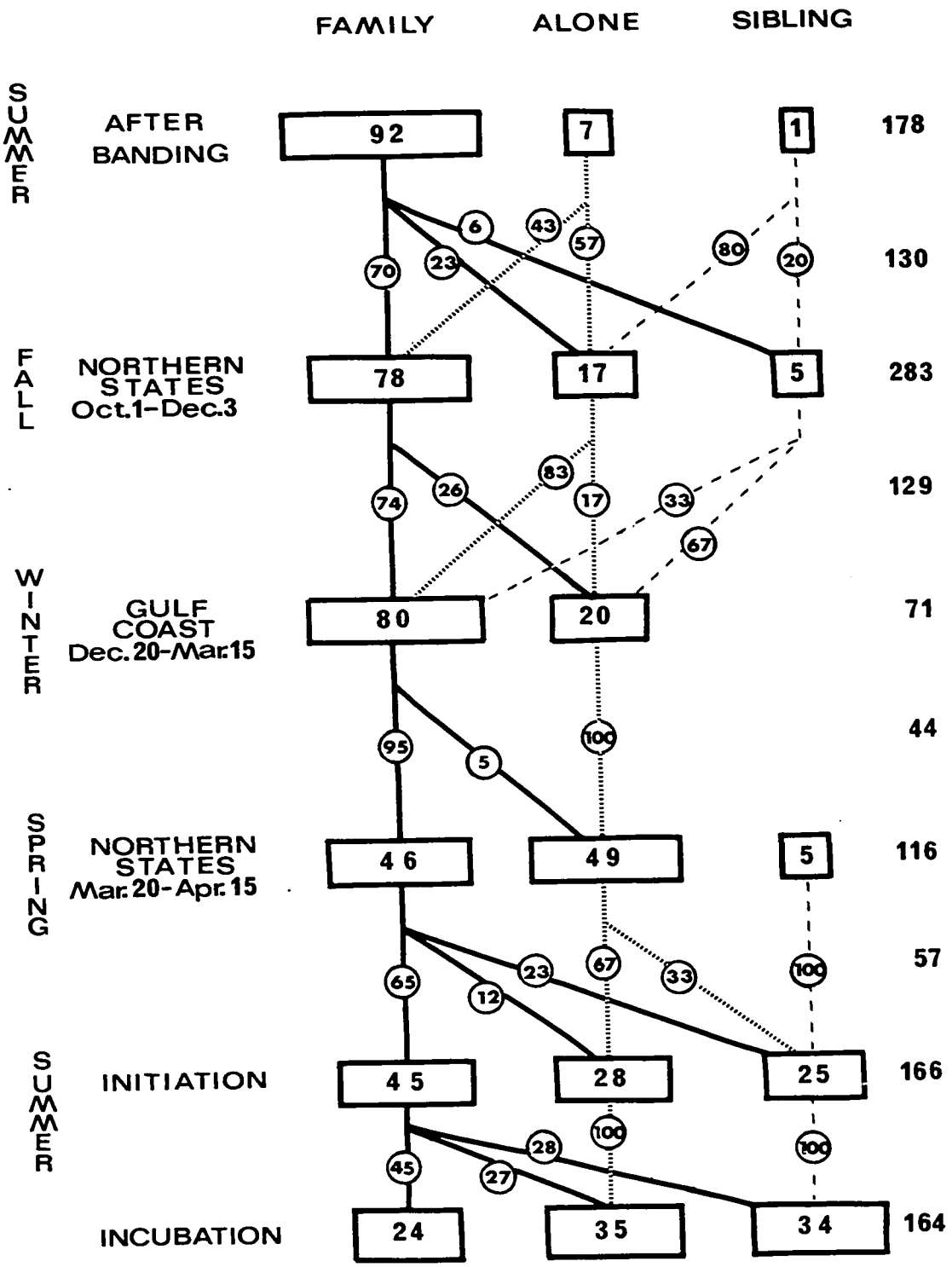

PAIR
FAMILY
ALONE
SUMMER
AFTER BANDING
5
80
15
120
53
12
77
12
27
40
7
46
24
126
FALL
NORTHERN STATES Oct.1-Dec.3
23
59
18
271
9
40
73
18
40
53
7
10
50
124
WINTER
GULF COAST Dec.20-Mar.15
21
64
15
95
5
92
3
38
62
41
SPRING
NORTHERN STATES Mar.20-Apr.15
40
40
21
126
3
25
73
2
93
97
7
40
SUMMER
INITIATION
67
26
6
317
95
5
100
INCUBATION
86
10
3
449

FIGURE 5

Summary of group behavior of neck-banded juvenile blue geese throughout the year. Numbers in boxes are percentages of juveniles seen a minimum of three times that were recorded in each social status at each season (from Tables 4, 14 and 16 and Appendix A.8). Numbers associated with lines between boxes are percentages showing the new social status of those juveniles seen at both seasons (not necessarily observed three or more times, from Table 3 and Appendices A.27, A.30, and A.32). For convenience, lines from Summer, After Banding lead only to Fall in the Northern States rather than to both the Northern States and Gulf Coast as shown in Table 3. Similarly, lines to Summer at Nest Initiation originate only from Spring rather than from both Spring and Winter as shown in Appendix A.32. Numbers on the right side of the figure indicate sample sizes.


FAMILY
ALONE
SIBLING
SUMMER
AFTER BANDING
92
7
1
178
6
43
57
80
70
23
20
130
FALL
NORTHERN STATES Oct.1-Dec.3
78
17
5
283
83
74
26
17
33
129
67
WINTER
GULF COAST Dec.20-Mar.15
80
20
71
100
95
5
44
SPRING
NORTHERN STATES Mar.20-Apr.15
46
49
5
116
67
23
33
100
57
65
12
SUMMER
INITIATION
45
28
25
166
100
28
100
45
27
INCUBATION
24
35
34
164

hunting mortality. The proportion of banded birds reported shot was higher in 1967 and 1969 than in 1968 ($P < 0.001$, Appendix A.15). Further, McConnell River blue geese were subjected to considerable stress and disturbance at Sand Lake National Wildlife Refuge in 1969. This undoubtedly contributed to separation of juveniles from adults. Unprecedented numbers of blue geese stopped at Sand Lake in the fall of 1969 and, judging by abundant neck band sightings, significant numbers were from the McConnell River population. Hunting pressure was heavy on geese flying out of the refuge on feeding flights and crippling losses were severe (Sherwood 1970). Large concentrations of lone goslings developed as a result of these conditions; for example, on 5 November 1969, 1079 juveniles (including five collared birds) and only 185 adults were counted in a single small field on the refuge. Several young birds showed evidence of gunshot wounds.

A small number of geese showed so much variability in their associations with other marked geese that they could not be assigned to any one status on the basis of a minimum of three sightings. Six juveniles and three adults were thus marked "status unknown" in Table 4. To give an example, two juveniles were each seen alone and with different juven-

iles once, and then together twice. These sightings could represent parts of families whose members were not all together when observed, or, they might have been temporary associations. Eight adults of Table 4 were never seen with other neck-collared geese but could have been with unmarked birds. In any case, the number of individuals was too small (1% of adults and 2% of juveniles) to seriously distort results of tabulations in this section, and were excluded.

Because temporary variations in the status of individuals carried potentially serious implications for estimates of productivity based on counts of families and other social units, it was important to quantify behavioral inconsistencies. Family behavior was tabulated to reflect day to day variations in their composition, not changes resulting from death or permanent separation of family members. Hence, only families and other groups with members absent but known to be alive were recorded as "not intact". In these cases, absenteeism was nearly always temporary and groups were subsequently seen back together. If family members disappeared and were not seen again during the count period ("fall" in the Northern States and "winter" on the Gulf Coast), mortality or permanent separation was assumed and the group

remnants were still considered to be intact families. Cases where all but one member of a family disappeared "permanently" were assumed to have resulted from the same causes. Case histories of families showing these patterns are given in Appendix B. The assumption of mortality or permanent separation was not always correct as members that had disappeared were sometimes back with family members when sighted at other locations at later dates; however, hunter returns showed that in some instances missing birds had been shot. In only six of 36 cases were "permanently" missing members seen again and in just three had regrouping occurred.

A large majority of marked families consisted of either one or two adults with one to four juveniles, infrequently as many as six. Very uncommonly, neck-banded yearlings accompanied adults and juveniles (Section 4.1) and in just two cases three adults were associated in a family. The status of families seen on three or more occasions in the Northern States or on the Gulf Coast is summarized in Table 5. Appendices A.16 and A.17 provide greater detail. It is apparent that family structure was far more stable on the Gulf Coast than in the Northern States. Nearly 85% of marked families were together for all sightings on the Gulf Coast while in the Northern States the figure was less than 25%. Differ-

TABLE 5

GROUP INTEGRITY OF MARKED BLUE GOOSE FAMILIES SEEN THREE OR MORE TIMES IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING, 1967-'68 TO 1969-'70.

NUMBER OF:	AREA	OBSERVATIONS (No.)	FAMILY ALWAYS INTACT (%)	FAMILY NOT INTACT EACH SIGHTING				
				ADULTS MISSING (%)	JUVENILES MISSING (%)	AD. + JUV. MISSING (%)	MEMBER IN DIFF. FAM. (%)	EXTRA BIRDS (%)
Different Families	N. States	123	21	13	23	43	3	4
	G. Coast	32	84	0	10	6	0	0
Observations of Families	N. States	585	55	17	23	3	1	1
	G. Coast	114	94	1	3	3	0	0

Families: Between Years in N. States - $X^2_6 = 6.976$, $P > 0.10$ (in different families, extras lumped).

Between Years on G. Coast - $X^2_2 = 0.250$, $P > 0.10$.

N. States vs. G. Coast - $X^2_1 = 42.362$, $P < 0.001$.

Observations: Between Years in N. States - $X^2_6 = 9.676$, $P > 0.10$.

Between Years on G. Coast - $X^2_2 = 1.190$, $P > 0.10$.

N. States vs. G. Coast - $X^2_1 = 59.910$, $P < 0.001$.

ences were highly significant in both 1968 and 1969. Only two marked families and nine individual geese were seen three or more times on the Gulf Coast in 1967, so no statistical tests were possible.

Nearly all cases of families listed as "not intact" were due to the absence of one or more members. Families were as likely to have had adults missing at least once as juveniles ($X^2_1 = 1.028$, $P > 0.10$). Mixing of birds between families was uncommon and never permanent. It did not occur at all on the Gulf Coast and involved just 7% of all families in the Northern States. All but one of the nine cases involved juveniles following other families.

Not only did temporary separation of members occur in a greater proportion of families in the Northern States, but it happened more frequently. Thus, at least one member was absent from families on 45% of observations in the Northern States but on only 6% of sightings from the Gulf Coast. These differences were highly significant. Cases of geese recorded with different families, or of unmarked birds with marked families, made up barely 2% of all observations

The contrast in group stability between the Northern States and Gulf Coast is further shown by changes in the social status of individual adults and juveniles seen in

these areas (Table 6 and Appendices A.18, A.19, A.20 and A.21). Nearly 50% of all adults and juveniles were recorded in a different status on at least one sighting in the Northern States while on the Gulf Coast over 90% were assigned to the same status for all observations. Of family geese, fully one half of adults and about 45% of juveniles were observed in another status in the Northern States but on the Gulf Coast 90% were with their family each time they were seen. Adults and juveniles were equally apt to have been separated on at least one occasion from families. Differences between areas were highly significant for both age groups. Results of statistical comparisons involving individuals appear in Table 7.

Although approximately 50% of geese from families were seen in a different status at least once, they were with family members for 80% of observations from the Northern States; family birds were together for over 95% of Gulf Coast sightings. Differences between areas were again highly significant but results for adults and juveniles were similar (Table 7).

Three families were observed on at least three occasions in both the Northern States and on the Gulf Coast in the same year; they also were intact more frequently in the

TABLE 6

VARIABILITY IN THE GROUP STATUS OF MARKED ADULT AND JUVENILE BLUE GEESE SIGHTED THREE OR MORE TIMES IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING, 1967-'68 TO 1969-'70.

A) ADULTS NUMBER OF:	AREA	ALL ADULTS			FAMILY ADULTS					PAIRED ADULTS				LONE ADULTS		
		OBSERVATIONS (No.)	ALWAYS SAME STATUS (%)	STATUS CHANGED (%)	OBSERVATIONS (No.)	IN FAM. (%)	WITH MATE (%)	ALONE (%)	ALL 3 STATES (%)	OBSERVATIONS (No.)	WITH MATE (%)	ALONE	WITH DIFF. AD. (%)	OBSERVATIONS (No.)	ALONE (%)	WITH AD. (%)
Different Adults	N. States	271	51	49	161	50	6	38	6	62	23	76	2	48	90	10
	G. Coast	95	92	8	61	90	7	3	0	20	90	10	0	14	100	0
Observations of Adults	N. States	1109	77	23	660	80	4	16	--	280	58	42	0.4	164	97	3
	G. Coast	326	98	2	211	97	2	1	--	62	97	3	0	53	100	0

B) JUVENILES NUMBER OF:	AREA	ALL JUVENILES			FAMILY JUVENILES						JUVENILE GROUPS			LONE JUVENILES			
		OBSERVATIONS (No.)	ALWAYS SAME STATUS (%)	STATUS CHANGED (%)	OBSERVATIONS (No.)	IN FAM. (%)	WITH SIB. (%)	ALONE (%)	ALL 3 STATES (%)	CHANGED FAMILY (%)	OBS. WITH JUV. (No.)	WITH JUV. (%)	ALONE (%)	OBS. (No.)	ALONE (%)	IN FAM. (%)	WITH JUV. (%)
Different Juveniles	N. States	283	52	48	220	44	7	43	5	2	14	29	71	49	94	2	4
	G. Coast	71	93	7	57	91	0	9	0	0	0	0	0	14	100	0	0
Observations of Juveniles	N. States	1072	80	20	846	77	4	19	--	0.5	46	74	26	180	97	2	1
	G. Coast	265	98	2	216	98	0	2	--	0	0	0	0	49	100	0	0

TABLE 7

RESULTS OF STATISTICAL TESTS INVOLVING ADULT AND JUVENILE BLUE GEESE FROM TABLE 6.

UNITS TESTED	COMPARISON BETWEEN	AGE	FAMILY BIRDS X^2	df	P	LONE BIRDS X^2	df	P	PAIRED ADULTS X^2	df	P
Individuals	Years-N. States	Ad.	2.731	2	ns	3.880	2	ns	3.580	2	ns
		Juv.	0.335	2	ns	1.586	2	ns	--	--	--
	Years-G. Coast	Ad.	0.460	2	ns	E values		1	2.220	2	ns
		Juv.	1.060	2	ns	E values		1	--	--	--
	Areas	Ad.	28.736	1	0.001	--	--	0.529	--	--	0.001
		Juv.	39.318	1	0.001	--	--	0.928	--	--	--
	Ad. vs. Juv. - N. States	Both	1.138	1	ns	--	--	0.691	--	--	--
	Ad. vs. Juv. - G. Coast	Both	--	--	1.096	E values		1	--	--	--
Observations	Years-N. States	Ad.	4.148	2	ns	6.942	2	0.05	2.488	2	ns
		Juv.	0.718	2	ns	3.647	2	ns	--	--	--
	Years-G. Coast	Ad.	0.366	2	ns	E values		1	E values		1
		Juv.	1.030	2	ns	E values		1	--	--	--
	Areas	Ad.	34.026	1	0.001	--	--	0.504	32.067	1	<0.001
		Juv.	45.963	1	0.001	--	--	0.593	--	--	--
	Ad. vs. Juv. - N. States	Both	1.493	1	ns	--	--	1.170	--	--	--
	Ad. vs. Juv. - G. Coast	Both	0.002	1	ns	E values		1	--	--	--

latter area than on waterfowl refuges in the Northern States ($P < 0.05$) (Table 8).

Individuals seen alone, young birds in juvenile parties and some adults in pairs had already become permanently separated from their families before they were first observed. Comparison of the proportion of geese in each social status after the regrouping process following banding (Tables 1 and 3) and then in the United States (Table 4) indicates that approximately 28% of adults and 19% of juveniles were no longer in families. (The difference between adults and juveniles probably stems from increased vulnerability of orphanned juveniles - see Section 6, Table 27.) These figures are probably conservative for juveniles since, as Table 3 also shows, 25% had left family members between post-banding and fall-winter observations. The latter figure includes geese seen just once in the United States; since they were evidently more vulnerable than juveniles in families, many did not live long enough to be recorded three or more times. Thus, figures for lone juveniles in Table 4 are probably too low. Similar comparisons suggest that less than 28% of adults actually changed from a family to a non-family status before they were seen in the United States since only 18% had left families after post-banding regroup-

TABLE 8

GROUP INTEGRITY OF MARKED BLUE GOOSE FAMILIES SEEN THREE OR MORE TIMES BOTH IN THE NORTHERN STATES AND ON THE GULF COAST IN THE SAME YEAR.

a) FAMILIES

AREA	No. FAM.	No. OBS.	FAMILY ALWAYS INTACT	FAMILY NOT INTACT EACH SIGHTING: ADULT MISSING	JUVENILE MISSING	AD. + JUV. MISSING
N. States	3	17	11	2	3	1
G. Coast	3	13	13	0	0	0

P = 0.42 (intact: not intact).

b) INDIVIDUALS IN FAMILIES

AREA	No. INDIVIDUALS		No. OBSERVATIONS WITH FAMILY		NOT WITH FAMILY	
	ADULT	JUVENILE	ADULT	JUVENILE	ADULT	JUVENILE
N. States	6	7	24	30	2	3
G. Coast	5	6	22	26	0	0

P = 0.076 (together: not together).

ing (Table 3). Better survival of lone adults than orphanned juveniles would cause relatively more nonfamily adults to be recorded a minimum of three times and appear in Table 4.

Lone adults and juveniles were less likely to have been recorded in a different status than family birds (adults: $X^2_1 = 22.682$, $P < 0.001$; juveniles: $X^2_1 = 38.597$, $P < 0.001$) in the Northern States and also a much lower proportion of total sightings of lone birds occurred in a wrong status (adults: $X^2_1 = 27.103$, $P < 0.001$; juveniles: $X^2_1 = 36.678$, $P < 0.001$) in the Northern States. Once separated from families, loners rarely formed new associations and none of these were long-lasting.

Marked juveniles usually remained together if adults disappeared from families. This tendency, together with a sighting of two neck-banded juveniles known to be siblings together at DeSoto National Wildlife Refuge (Section 3.1) suggests that most juvenile parties present in fall and winter blue goose flocks were brood remnants. Most juveniles in these groups were recorded alone at least once (70%) but

members were together about 75% of the time.

Adults seen in pairs without young in the United States may have been failed breeders when banded or have lost all their goslings before they were first sighted in the United States. These birds showed an even more marked tendency to occur in a "wrong" status than family adults (42% of observations in the Northern States vs. 20%, $X^2_1 = 48.247$, $P < 0.001$). Figures for family adults in Table 6 do not indicate the extent to which the pair itself was together since adults could have been with family members even though the other adult was missing. Similarly, the pair could have been together yet separated from their offspring - half of all sightings of families not intact were due to missing juveniles only. Comparison of behavior of marked pairs with and without families (Table 9 and Appendices A.22, A.23, A.24 and A.25) showed that the former were together more frequently than the latter in the Northern States but not on the Gulf Coast. It may have been that families of adults with relatively weak bonds were quickly split up in the stress of fall migration, or, that ties between unsuccessful breeders were not as strong as those uniting pairs with "family responsibilities". It is probable that the Triumph Ceremony is performed more frequently and intensely in large social groups, possibly reinforcing bonds between members

TABLE 9

GROUP INTEGRITY OF ADULT PAIRS OF BLUE GEESE, BOTH ACCOMPANIED BY, AND NOT ACCOMPANIED BY JUVENILES, OBSERVED THREE OR MORE TIMES IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING, 1967-'68 TO 1969-'70.

NUMBER OF:	WITH, OR WITHOUT JUVENILES	AREA	NO. OBS.	PAIR INTACT (%)	PAIR APART (%)	ONE WITH DIFF. AD. (%)
Different Pairs	Without	N. States	31	23	74	3
		G. Coast	10	90	10	0
	With	N. States	53	38	62	0
		G. Coast	26	96	4	0
Obs. Of Pairs	Without	N. States	140	58	41	1
		G. Coast	31	97	3	0
	With	N. States	252	72	28	0
		G. Coast	97	98	2	0

TABLE 10

RESULTS OF STATISTICAL TESTS INVOLVING ADULT PAIRS FROM TABLE 9.

UNITS TESTED	COMPARISON BETWEEN	WITH OR WITHOUT JUVENILES	CHI-SQUARE
Ad. Pairs	Years - N. States	Without	X^2_2=1.750, ns.
		With	X^2_2=3.430, ns.
	Years - G. Coast	Without	E values < 1, ns.
		With	E values < 1, ns.
	Areas	Without	P < 0.001
		With	P < 0.001
	Without vs. with -		
	N. States		X^2_1=1.214, ns.
	G. Coast		P = 0.968
Observations of ad. pairs	Years - N. States	Without	X^2_2=1.244, ns.
		With	X^2_2=2.960, ns.
	Years - G. Coast	Without	E values < 1, ns.
		With	E values < 1, ns.
	Areas	Without	X^2_1=14.925, P<0.001.
		With	X^2_1=27.315, P<0.001.
	Without vs. with -		
	N. States		X^2_1=7.305, P<0.01.
	G. Coast		P = 1.140

(cf. Raveling 1970:305).

It is evident that variability in the group status of individual geese during fall migration would introduce serious biases into the method of estimating productivity of blue goose populations by the prevalence of adult plumaged birds with juveniles and the size of families. In this study, family size and composition would have been recorded correctly for just 55% of observations in the Northern States. On 16% of sightings, family structure would not have been evident because no adults and juveniles remained together. Adults and juveniles from families would have been assigned to an incorrect status over 20% of the time and adults of pairs without juveniles were apart for 42% of observations. Behavior of geese on the Gulf Coast was far less variable; families and adult pairs were together more than 95% of the time. Behavioral inconsistencies, then, have less consequence for the group count technique in the latter area.

Why should family cohesion be so irregular in the Northern States in contrast to the near constant association of families on the Gulf Coast?

Blue geese were found in much larger concentrations on the Northern refuges than in the marshes or agricultural

areas of the Gulf Coast. Table 11 shows weekly population figures for Sand Lake, DeSoto and Squaw Creek National Wildlife Refuges from late September to late December. Figures for weeks during which observations were made are underlined. Table 12 lists population estimates for the two areas on the Gulf Coast where most neck bands were sighted. The latter were obtained from aerial surveys during the annual Mid-Winter Waterfowl Inventory conducted each January by the U.S. Fish and Wildlife Service in cooperation with states where the counts were made, while the former were from aerial or ground counts, often by the same personnel that conducted the Mid-Winter Inventories.

The largest refuge in the Northern States consisted of about 21,000 acres while the two Gulf Coast areas each covered several hundred square miles of suitable blue goose habitat. Individual flocks on the northern refuges were usually very large, sometimes numbering more than 75,000 while on the Gulf Coast blue geese were normally in smaller flocks of 5,000 to 10,000, rarely in excess of 20,000 birds, and were spread out over much of the available habitat. Hence, density was much lower on the Gulf Coast.

When feeding or loafing geese were frightened, the entire flock took off in near unison; disturbances fre-

TABLE 11

WEEKLY FALL BLUE GOOSE NUMBERS* ON THREE MAIN STUDY AREAS IN THE NORTHERN STATES FROM 1967 TO 1969. NUMBERS ARE UNDERLINED FOR WEEKS WHEN OBSERVATIONS OF MARKED GEESE WERE MADE.

YEAR	AREA	WEEKS														MEAN Nos./ No. of WKS. OBS. MADE
		SEPT.	OCTOBER			NOVEMBER						DECEMBER				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1967	Sand Lake	8	12	35	55	108	100	35	12	5	0	0	0	0	0	67/5
	DeSoto	0	1	8	7	25	50	80	90	90	70	50	30	7	0	50/1
	Squaw Creek	3	9	39	87	173	160	78	128	128	149	100	100	80	1	103/2
1968	Sand Lake	0	1	65	90	101	40	28	25	4	1	0	0	0	0	65/5
	DeSoto	0	1	2	1	20	100	80	122	150	90	90	40	0	0	60/2
	Squaw Creek	1	110	100	43	103	116	99	107	192	99	90	93	90	9	115/6
1969	Sand Lake	1	6	25	145	160	120	85	25	1	1	0	0	0	0	90/6
	DeSoto	0	0	1	40	80	165	180	400	150	70	40	0	0	0	290/2
	Squaw Creek	2	8	88	82	120	75	85	79	161	100	100	70	19	2	110/4

* - Data from refuge files, Sand Lake, DeSoto and Squaw Creek National Wildlife Refuges. Numbers are in thousands.

TABLE 12

NUMBERS OF BLUE GEESE WINTERING ON THE TWO MAIN GULF COAST STUDY AREAS FROM 1967 TO 1969. FIGURES ARE FROM MID-WINTER WATERFOWL INVENTORIES.

Year	Area	
	East Texas	Rice Prairies
1967	98,038*	74,432
1968	67,025	216,815
1969	54,050	198,297

* - This figure is adjusted. Geese wintering in one county of East Texas were included in totals for an adjacent area in 1967. The 1967 figure was calculated by maintaining the average ratio of numbers of wintering Blue Geese between the two areas as occurred in 1968 and 1969.

quently occurred so suddenly that normal preflight coordination of families (Raveling 1969c) was prevented. If the flock was large (as on the northern refuges) the effect was spectacular as the birds rose in a confused, clamoring mass. It is not surprising that social groups were frequently broken in the disorder. Often, large flocks split into two or more smaller groups under these circumstances. Other flocks on the refuge were commonly flushed by the same disturbance and considerable mixing of flocks followed as geese circled about before landing again.

Geese losing contact with the rest of their family must have had difficulty in relocating family members. Nonetheless, in the majority of cases contact of geese from marked families was re-established. Raveling (1969b) found that individual families of Canada geese (B.c. interior) habitually used the same roosting place at Crab Orchard National Wildlife Refuge, Illinois and that separated members rejoined there. A similar process may have occurred with blue geese at the northern concentration points since at Sand Lake little interchange of marked birds from concentrations of geese from different parts of the refuge was noted while food was still plentiful. As the food supply became depleted thorough mixing of sub-flocks occurred. Perhaps the

same roosting sites were maintained by families but this aspect was not studied. Geese separated from other members of their families show an appetitive searching behavior (Lorenz 1967:178, Fischer 1965:296). Several times in the Northern States lone geese belonging to families were seen walking rapidly through a flock of feeding geese. Their behavior was characteristic - neck stretched vertically, appearing "alert" and calling loudly. On a few occasions they were observed when contact with family members was re-established. The lone goose usually walked very fast or broke into a run, its neck becoming stretched horizontally, ending in a Triumph Ceremony (Cackling) (Fischer 1965) as it reached the bird(s).

By contrast, blue goose flocks on the Gulf Coast split less frequently when flushed since they were smaller, and in addition, there was less mixing with other flocks due to their greater spacing. The entire flock usually flew together to another field. Lynch (1970:6) has described how lost juveniles circling over such flocks may be joined by an adult and led back to the spot where the remainder of the "family" was located.

There is evidence that disturbances causing flocks to flush occurred more frequently in the Northern States

(Table 13). The major identified causes of disturbances were eagles and aircraft flying overhead, and human activity nearby. Since the northern observations were from protected areas, hunting was not an important factor for these tabulations although geese flying outside the refuges came under heavy gunning pressure. The hunting season was closed during most of the southern observation period. Disturbances caused by activities of the observers were omitted for analysis. Differences in rates of disturbance between the two areas were significant ($P<0.01$). A higher frequency of disturbances, together with greater difficulty in locating family members when separated, might explain the preponderance of families in the Northern States in which separation and rejoining occurred as opposed to the nearly constant association of families on the Gulf Coast.

A further reason is presumably a result of the seasonal sequence of observations. Observations on the Gulf Coast were made later in the year than those in the Northern States and most disruptions due to hunting had ceased by this time. Also, many families had stopped at least briefly in the Northern States. Thirty-six percent of marked families seen on the Gulf Coast had been sighted previously in the Northern States. This figure is a minimum since geese at several concentration points in the Northern States were

TABLE 13

RATE OF DISTURBANCES IN THE NORTHERN STATES AND ON THE GULF COAST IN 1969-'70 CAUSING BLUE GOOSE FLOCKS TO FLUSH.

LOCATION	OBS. TIME (HRS.)	ALL DISTURBANCES	RATE PER HOUR	DISTURBANCES NOT DUE TO OBSERVER	RATE PER HOUR
Sand Lake	43.5	180	4.1	127	2.9
Desoto	11.8	39	3.3	29	2.5
Squaw Creek	41.4	99	2.4	95	2.3
Σ N. States	96.7	318	3.3	251	2.6
East Texas	11.2	19	1.7	16	1.4
Rice Prairies	35.9	64	1.8	49	1.4
Σ Gulf Coast	47.1	83	1.8	65	1.4
Squaw Creek (Spring)	13.3	34	2.6	25	1.9

N. States vs. G. Coast (disturbances not due to observer):

$$X^2_1 = 7.311,\ P < 0.01.$$

not observed. Many individuals tending to stray from families were probably removed from the population or had become permanently separated from family members. Those families with weak bonds had likely ceased to function as social units before they reached the Gulf Coast. Families passing quickly through the Northern States would have been subjected to less disturbance under conditions in which family breakup was likely to occur. The overall effect would contribute to observations favoring families with relatively stronger ties on the Gulf Coast.

Evidence from geese sighted in both areas points to conditions causing severe disruption of family continuity in the Norther States (Appendices A.26, A.27 and A.28). Forty families of which two or more individuals were still together were seen on the Gulf Coast. Thirty-two additional families were represented by sightings of lone individuals, no longer with families with which they were associated in the Northern States. Of the former families, 62% were identical in composition, 27% were missing members and 15% had birds with them that were not seen in the Northern States.

Records of 99 adults and 86 juveniles were suitable for analysis. Seventy-five percent of adults were still with families, 7% had joined families (evidently temporarily absent

when the family was sighted in the Northern States) and 18% were either alone or not seen with other family members. Only 63% of juveniles were still in families in winter while 28% were alone or not seen with their families (differences between adults and juveniles were significant - $X^2_1 = 4.506$, $P < 0.05$). Nine percent had apparently rejoined families since fall observations. Geese missing from the 32 families of which just one individual was seen on the Gulf Coast might have been together although not observed so they could not be used.

Some cases of regrouping on the wintering grounds by geese separated in the Northern States were remarkable. An adult and juvenile were seen twice together (17 and 18 December, 1969) on the Rice Prairies. On 21 January and again on 10 March, 1970 these birds were sighted approximately 100 miles to the east but now they were with another marked adult and juvenile, and comprised a close-knit family of four. The latter two geese had been observed together on 14 November at DeSoto National Wildlife Refuge. It is probable that this family had been separated for more than two months.

Very few neck-collared geese moved between wintering areas on the Gulf Coast in the same winter during the course of this study. One of the few other groups to do so (from East Texas to the Rice Prairies) was also composed of an adult

and a juvenile. Loss of Triumph Ceremony partners evidently results in long-lasting searching behavior, causing geese to move long distances (cf. Lorenz 1967:178). A strong tendency for individuals to visit the same wintering location in successive years would facilitate the recontact of geese separated farther north. Sixty eight of 77 (88%) blue geese seen in two winters were in the same area, in a few instances using precisely the same field.

3.5 BEHAVIOR OF FAMILIES IN SPRING

Observations were made during spring migration in the Northern States to gather information on pairing behavior (Section 4.2) and persistence of family structure. Table 14 shows the status of adults and juveniles sighted in spring. Due to the short time available for spring observations, few duplicate sightings of families were made so geese seen just once were included in tabulations in this section. A higher proportion of adults was seen in pairs and fewer were in families during spring observations in comparison with winter sightings but lone adults were found in similar ratios. Significantly greater proportions of juveniles were alone in the spring of 1969 and fewer were in families than in winter.

TABLE 14

GROUP STATUS OF MARKED ADULT AND JUVENILE BLUE GEESE SIGHTED DURING SPRING MIGRATION IN 1969 AND 1970.

AGE	YEAR	TOTAL SEEN (No.)	IN FAMILY (%)	ALONE (%)	WITH ADULT (%)	WITH JUVENILE (%)
Adult	1969	31	29	13	58	--
	1970	95	43	23	34	--
Juvenile	1969	23	43	49	--	8
	1970	93	46	49	--	4

Adults - Between Years: $X_2^2 = 5.867$, $0.10 > P > 0.05$.

- vs. Winter: $X_1^2 = 13.63$, $P < 0.001$.

1. In Family: $X_1^2 = 12.876$, $P < 0.001$.
2. Paired: $X_1^2 = 9.429$, $P < 0.01$.
3. Alone: $X_1^2 = 0.898$, $P > 0.10$.

Juveniles - Between Years: $X_2^2 = 0.729$, $P > 0.10$.

vs. Winter, 1969: $X_1^2 = 15.079$, $P < 0.001$.

1970: $X_1^2 = 3.288$, $0.10 > P > 0.05$.

These results could be due to normal breakup of families during late winter, causing more adults to be in pairs and more juveniles to be alone than in fall or winter, particularly since proportions of both adults and juveniles in each status were similar between fall and winter observations in these years (Section 3.4) and since little (legal) hunting mortality had occurred between winter and spring sightings.

However, ten of the 14 families seen on the Gulf Coast in winter and again in the Northern States in spring were identical in composition, indicating that little breakup had occurred (Appendix A.29). Thirty seven of 44 (84%) adults and juveniles seen in families in winter were still together in spring (Appendix A.30 and A.31). Examination of the four families in which changes in composition were noted also supports the view that family integrity is normally maintained during spring migration. Only one changed group, consisting of one adult and one juvenile in winter but represented by the juvenile alone in the spring might have disintegrated due to normal causes, possibly as a result of pairing of the adult. Since the

adult was not seen in spring, it was just as likely that artificial separation of the adult and juvenile, or death of the adult, had occurred or, that the birds were just temporarily separated. Just two of 17 families last sighted in fall were still intact in spring but these groups had been subjected to considerable hunting and other disturbances prior to spring observations.

If little disintegration of families occurred between winter and spring, why should the proportion of lone juveniles and adults in pairs without young be higher during spring observations? Part of the difference may have been an artifact of the way spring observations were tabulated. As previously mentioned, families and individuals seen just once were included in Table 13, because of small spring samples of birds seen three or more times. Nine of the 13 groups seen more than once, showed changes in composition. Hence, many individuals counted as alone could have been temporarily separated from family members, resulting in an underestimate of juveniles in families and an overestimate of lone juveniles. This ratio was similar to the proportion of families in which temporary separations occurred in the Northern States in fall ($P = 0.627$), but was greater than that on the Gulf Coast in winter ($P = 0.002$). Although the

rate of disturbances in spring did not differ from winter ($X_1^2 = 0.346$, $P > 0.10$) or fall ($X_1^2 = 0.306$, $P > 0.10$), flock size was larger and was similar to that of fall. An average of 71,000 blue geese were present at Squaw Creek National Wildlife Refuge for the three weeks of observations in the spring of 1970. Evidently, blue goose families in large concentrations lose contact significantly more frequently than in smaller flocks, even with a similar rate of disturbance.

A further possible reason for the high numbers of lone juveniles in spring could have been due to the presence of numbers of juveniles orphanned during fall in the Northern States that did not migrate to the Gulf Coast. Considerable numbers of blue geese wintered in Kansas and Missouri in 1968-'69 (129,000) and 1969-'70 (91,000). It is possible that juveniles deprived of parental guidance did not possess a strong urge to migrate to the Gulf Coast and might have tended to winter in the northern flocks more than juveniles with parents. Unfortunately, there are apparently no age-ratio data from these wintering flocks to determine whether they had a higher proportion of juveniles than Gulf Coast flocks. Arguing against this hypothesis is the sighting of 20 lone juveniles previously seen alone on the Gulf Coast

as opposed to only eight seen during fall in the Northern States. The possibility also exists that families in some areas of the Gulf Coast where few observations were made had a higher incidence of breakup than those in areas where more observations were obtained and that higher numbers of juveniles were alone in the former areas than figures of Section 3.4 for the Gulf Coast indicate. Since winter observations were concentrated on the Rice Prairies, an area of heavy hunting pressure, the latter explanation seems unlikely. Similar explanations might apply to the higher incidence of adult pairs without juveniles noted in the spring.

3.6 BEHAVIOR OF FAMILIES IN SUMMER

The status of collared adult and young geese (now called yearlings) seen on the breeding ground is set out in Tables 15 and 16. The summer was divided into two periods - the interval spanning arrival of geese at the colony and the time when most nests had been initiated, and the period from onset of incubation at most nests until observations ceased approximately five weeks following the hatch. The proportions of adults in each status soon after arrival at the McConnell River were similar each year but differed from those in winter and spring; fewer were in families or alone and

TABLE 15

GROUP STATUS OF NECK-BANDED ADULT BLUE GEESE IN THE SUMMER FOLLOWING BANDING AT McCONNELL RIVER, N.W.T., 1968 - 1970.

PERIOD	YEAR	TOTAL SEEN (No.)	WITH FAMILY (%)	WITH MATE (%)	ALONE (%)	OTHER (%)
Initiation	1968-70	317	26	67	6	1
Later	1968	99	20	75	5	0
	1969	236	6	91	3	1
	1970	114	9	89	2	0

Initiation - Between years: $X^2_6 = 2.998$, $P > 0.10$.

- vs. Winter: $X^2_2 = 64.881$, $P < 0.001$.

1. In family: $X^2_1 = 46.204$, $P < 0.001$.
2. Paired: $X^2_1 = 64.880$, $P < 0.001$.
3. Alone: $X^2_1 = 7.528$, $P < 0.05$.

- vs. Spring: $X^2_2 = 32.994$, $P < 0.001$.

1. In Family: $X^2_1 = 11.658$, $P < 0.001$.
2. Paired: $X^2_1 = 28.771$, $P < 0.001$.
3. Alone: $X^2_1 = 17.099$, $P < 0.001$.

Later - Between years: $X^2_6 = 19.392$, $P < 0.05$.

TABLE 16

GROUP STATUS OF NECK-BANDED YEARLING BLUE GEESE DURING THE SUMMERS OF 1968 TO 1970 AT McCONNELL RIVER, N.W.T.

PERIOD	YEAR	TOTAL SEEN (No.)	WITH FAMILY (%)	WITH SIBLING (%)	ALONE (%)	OTHER (%)	CHANGED STATUS (%)
Initiation	1968	41	66	10	24	0	0
	1969	45	64	22	11	2	0
	1970	80	23	35	39	3	1
Later	1968	37	43	32	22	3	0
	1969	57	25	47	25	3	0
	1970	70	14	24	51	6	4

Initiation - Between years: $X^2_4 = 14.367$, $P < 0.01$.

	1969			1970		
	X^2	d.f.	P	X^2	d.f.	P
vs. Winter	10.12	2	<0.01	21.45	2	<0.001
1. In Family	6.36	1	<0.05	16.46	1	<0.001
2. With Sibling	--	--	0.002	--	--	<0.001
3. Alone	0.015	1	>0.10	0.296	1	>0.10
vs. Spring	11.38	2	<0.01	29.93	2	<0.001
1. In Family	3.124	1	0.10-0.05	9.568	1	<0.001
2. With Sibling	2.023	1	>0.10	28.34	1	<0.001
3. Alone	11.05	1	<0.001	1.440	1	>0.10

Later - Between Years: $X^2_4 = 21.490$, $P < 0.001$.

more were in pairs. This pattern had progressed from observations in spring migration when more adults were also in pairs unaccompanied by young birds than in winter (Section 3.5). Similarly, fewer yearlings were still with parents and more were with siblings when they were first seen after arriving at the McConnell River than on the Gulf Coast in winter and during the spring migration of 1970.

From the preceding it is apparent that breakup of families was under way when geese were first observed in summer. It is possible that some family parties disintegrated during the northward migration. Copulation evidently occurs at staging sites on Hudson Bay (since it is rarely observed on the breeding ground); Fischer (1965:271) described how captive adult greylag geese drove yearlings from the family party at this stage. In comparison with the fall-winter period, relatively fewer yearlings were sighted in summer (27%) than were adults (48%) and even two-year-olds (30%). (These ratios were not tested due to heterogeneity between years in proportions of the banded sample sighted in each time period.) Data presented in Section 4.3 (Table 21) also indicate that large numbers of yearlings were not seen in summer. Thus, many yearlings not seen might have left families during spring migration and not returned to the

near vicinity of the nesting colony. In 1970 flocks made up almost entirely of yearlings arriving from the south continued to fly over the colony up to two weeks after breeders had arrived, also suggesting that family connections had been severed farther south. However, these birds could have been orphanned in fall and winter, and, lacking leadership of adults "hurrying" north to breed, might have arrived late in the season. Also, yearlings of some families left their parents very soon after arrival at the McConnell River and since many adults were not seen until late in the nest initiation period, an unknown proportion of yearlings undoubtedly arrived at the McConnell River with families but were separated as nests were quickly established.

Summer observations of geese sighted in families in winter on the Gulf Coast and during spring migration in the Northern States indicated that families remained intact until they arrived back at the breeding ground in early summer. Thirty eight of 40 (95%) of adults not yet nesting were still with yearlings and 37 and 57 (65%) yearlings were still with their parents (Appendix A.32). Parents of the 20 yearlings no longer in families were not seen, however, and could have had nests at this time. Thirteen of the latter were with siblings and the other seven were alone.

The full sequence of family breakup has not been witnessed. Several observations were made in 1968 of an adult pair with two yearlings in which the female was neck-banded. On 7 June the family was seen standing on a small snow-free area a few yards from the adults' 1967 nest site. The gander was observed threatening and apparently attacking the yearlings on 8 June. The latter retreated about 25 m and stood together for several minutes. On 10 June the female was making her nest and the two young birds were not visible. There might have been eggs in the nest but incubation had not commenced.

Marked variation between pairs and families, manifested in fall and winter in their ability and, or, proclivity to stay together, was particularly pronounced in the length of time yearlings stayed with adults at the nest. In contrast to the above example, other yearlings were still with their parents near the end of incubation, and, in one case, a yearling was with its marked parents and their newly-hatched brood on two of the four days it was seen by B. C. Lieff from his observation tower. The yearling was later captured in a banding drive with its parents but since it had completed its summer molt, it flew out of the banding pen. After the adults had been examined and placed in a holding pen, however, the yearling, who had been standing about 100 m

away, flew again and rejoined them there and when the geese were released the yearling accompanied its parents on foot.

The foregoing examples were extreme. The majority of yearlings appeared to leave the company of the parents soon after incubation had begun. Until separation occurred, yearlings were frequently seen participating in joint attacks with their parents against neighbouring geese near their parent's nest (also noted by Cooch 1958:46-47). It is unclear whether yearling blue geese are usually driven physically by the adults from the nesting territory. It seems likely that yearlings often leave the adults to feed since there is little food available in the nesting colony during the summer. Broods were seen feeding on the periphery of the colony and later back with their parents at the nest. For example, a brood of four marked yearlings was not present with their nesting parents on 12 and 19 June 1970 and on 22 June was seen about 3 km away, feeding in a sparsely occupied part of the nesting colony. On 23 June the entire family was observed at the nest but on 27 June the four yearlings were not present, nor were they observed again during the summer. It is possible that yearlings left their parents for progressively longer and more frequent feeding periods, until they no longer returned to them at the nest.

Brood mates stayed together after separation from their parents. In just one case were yearling siblings not together during the summer although others were apart for brief periods. If just one offspring remained, it invariably was alone, although usually associating loosely with other yearlings and non-breeders in flocks outside the colony. There was no evidence that yearlings formed pairs during the summer as reported for Canada geese (reviewed by Raveling 1969a:316). If yearlings were still with adults when the latter's nest was destroyed, or, if adults did not breed, families remained intact. A small number of families with just one adult were seen during the summer, suggesting that if one of a pair was killed, the survivor did not always re-pair but retained association with its yearlings.

There was considerable variation between years in the proportion of birds remaining in families during the incubation period. In 1968 a disastrous flood destroyed more than half the clutches in the nesting colony in mid June. Consequently, many families were still together later in the summer (Tables 15 and 16). By contrast, the 1970 breeding season was a very successful one. Although nesting began later than normal (5 June), the spring thaw was rapid and all pairs had commenced nesting within a nine day period.

Family breakup occurred quickly resulting in a high proportion of yearlings being recorded with siblings or alone early in the summer. In 1969, conditions were intermediate. Nesting was late (6 June) and early June was very cold, severely delaying the opening of nesting habitat. The nest initiation period spanned at least 16 days. Nonetheless, most adults nested successfully (although average clutch size was low). Throughout the nest initiation period many families were observed together but later in the summer the proportion of yearlings with adults had dropped considerably and more were in sibling groups.

Nearly half of the yearlings seen after incubation started in 1970 were alone, substantially more than in the other two years. This probably reflected the high fall and winter hunting mortality as well as disruption of families at Sand Lake National Wildlife Refuge experienced by geese in 1969-1970 (Section 3.4).

There has not been a known case of a collared adult pairing with a new bird while its mate was still alive, despite the frequent temporary separations which occurred during fall and winter. What happens, however, when a goose's mate dies? Judging by the low proportion of lone adults in summer it would seem that most adults re-paired

before the next breeding season. Year to year behavior of pairs in which both members were neck banded was examined to pursue this question further (Table 17). Since these birds were banded as adults, most were probably paired longer than indicated. In most cases there was no proof that the original mates of geese later recorded paired with different birds had died, but they were not seen again. Approximately 40% (18 of 42) of geese that lost mates were alone when seen the next year. There is an indication that when pairs of longer standing were broken, the survivor was less apt to re-pair but due to disfiguration of older bands, this sample was small. Only four of the adults remaining alone in summer were sighted in subsequent summers and all had re-paired. One of these birds, a female, was alone in two successive summers. She laid eggs (probably infertile) each year but was seen alone after the hatch. In the fourth summer she was paired and nested in the same vicinity.

3.7 DISCUSSION

Neck bands did not disrupt established bonds among members of blue goose families whose composition before marking was known. However, since approximately 40% of adult blue geese observed without their old mates in summer had not re-

TABLE 17

YEAR TO YEAR CONSTANCY OF NECK-BANDED PAIRS OF BLUE GEESE.

YEARS AFTER BANDED	SAME MATE	DIFFERENT MATE	ALONE
1-2	170	22(11%)	13(6%)
2-3	52	2(3%)	4(7%)
3-4	10	0	1(10%)
4	4	0	0

paired, collars may have inhibited formation of new pair bonds. Fewer wild female black brant (Branta bernicla nigricans) with neck bands had brood patches than unmarked birds (Lensink 1968) suggesting that collars may have interfered with pair formation. Kear (1970:361,387), however, has stated that remating is normally slow in most Anserinae, although she did not indicate the time involved. In contrast, observations of Canada geese (Sherwood 1966:122, R. N. Jones, pers. comm.) have shown that in some instances new pair bonds were developed within hours. Many workers have reported that neck collars did not noticeably affect behavior of geese for extended periods (reviewed by Raveling 1969a:313) although, as Lensink (1968:418) noted, adequate controls were often lacking.

Color marking of other birds, particularly in the head region, upsets individual recognition (Goforth and Baskett 1965, Guhl and Ortman 1953). The latter authors and Ramsay (1951) concluded that individual recognition in chickens and domestic waterfowl depended on several factors including size, shape, color, and voice and that to be interrupted, modification of features had to be pronounced.

Although neck collars altered some visual features, auditory cues were unaffected and were probably extremely important in effecting reunification of blue goose

families (cf. Ramsay 1951:16). Heinroth (1911:615-616) found that greylag geese responded to vocalizations of family members although they were out of sight.

The possible effects of catching and banding geese on the maintenance of social groups has concerned several waterfowl workers. Scott, Boyd and Sladen (1955:73) released pink-footed geese (Anser brachyrynchos) in groups after capture by drive-trapping. They believed that most families were eventually reunited although they noted that some goslings did not locate their parents and formed "creches". Cooch (1955:62-63) released drive-trapped blue geese individually as they were banded and estimated that approximately 90% of families re-formed, a figure very close to that found from detailed observations following banding drives in the present study. Miller and Dzubin (1965) discussed disruptive effects on goose families of banding during migration by cannon-netting and Raveling (1969a:308-309) found that although marked Canada goose families usually separated when released, they were soon reunited at habitually used roosting sites. Blue geese showed analogous behavior at the McConnell River; flocks exhibited a strong tendency to head for their customary feeding areas after banding. Occasionally some birds did not return immediately to these areas and regroup-

ing was initially prevented; however, geese continued to mix and regroup for several days following banding drives.

Adoption of young blue geese into unrelated families was most apt to occur within the first week after hatching before individual bonds between family members had developed. Heinroth (1911) stated that prospects of successfully introducing incubator-hatched greylags into families were best when goslings were only a few days old. Brood adoption in Canada geese persists longer, occurring most commonly during the first three weeks but as late as the fourth (Martin 1964: 24, Sherwood 1966:124-127). The latest case of adoption of a blue goose gosling under normal circumstances at the McConnell River took place about three weeks after hatch. Sherwood (1966:129) stated that parents could recognize their offspring within two to three weeks of hatching but that goslings did not recognize their parents until they were five to six weeks old. Collias and Jahn (1959:496), however, found that both goslings and adults attacked strange goslings at an age of about one week in Canada geese and Fischer (1965:261) observed rare attacks of sibling greylags on strange goslings at this age. Collias and Collias (1957: 392) noted that aggression in incubator-raised ducklings did not appear until the third or fourth day and speculated

that this delay permitted bonds within the brood to form.

Among blue geese at the McConnell River, mixing of goslings between adult pairs was an infrequent occurrence. Brood adoption is common in several populations of Canada geese from the southern portion of their breeding range although it has not been observed in others (see review in Raveling 1969a:314). Some pairs lost all their goslings to more dominant geese, resulting in an artificially higher average brood size (e.g., Sherwood 1966:124-132) and raising serious implications for the group count technique. Counts of broods in migrating or wintering flocks of many species of arctic-nesting swans and geese in North America and Europe have shown that broods larger than expected on the basis of known clutch sizes are uncommon (e.g., Boyd 1954: 74-75, Dzubin 1965:529 , Hanson 1965:152-154, Lynch 1970:4). While this does not preclude the possibility of brood mixing, loss of whole broods through adoption is apparently infrequent.

Observations of most species of swans and geese with distinct juvenile plumages have indicated that adults and juveniles associate in apparent families in winter. In the black brant, however, most families apparently disintegrated at fall staging areas in Alaska (Jones and Jones 1966).

Martin (1964:9-10) and Sherwood (1967:341-350) marked families of Canada geese on breeding areas and observed some returning intact the next spring but day to day observations in winter were not made. Raveling (1969a) was able to follow six individually marked Canada goose families for extended periods during the winter and found that members were together for 96% of all sightings (p. 310), a figure remarkably close to that for blue goose families on the Gulf Coast (94%). Further, Raveling (1969a:310-313) also found that siblings remained together after death of their parents and that lone juveniles and adults did not form new associations during winter. It is possible, however, that his method of catching isolated families or birds attracted to baited trapping sites resulted in the marking of mostly dominant, tightly-knit groups that might normally be separated less frequently than other families (Raveling 1970: 303). It would be interesting to know if Canada goose families in large concentrations in other wintering areas of southern Illinois or fall staging sites in Wisconsin showed a pattern of breakup and regrouping characteristic of blue geese in fall in the Northern States.

There is little direct information on persistence of family parties on spring migration. Schweinsburg (pers.

comm.) found that whistling swan (Cygnus columbianus) families disintegrated during spring migration in North Dakota due to intra-family aggression. Breeding ground studies have shown that some adults and juveniles of several goose species were still together on arrival in late spring: Ross' geese (Ryder 1967:32), white-fronted geese (Barry 1968:114) and some races of Canada geese (see Raveling 1969a: 310 and other references in Raveling 1967:47). Few yearlings of arctic-nesting Canada geese, however, were still with adults at this time (Mickelson 1970:18, C. D. MacInnes and B. C. Lieff, pers. comm.). Barry (1968:94) noted that although some young A. caerulescens still accompanied adults when they arrived at the Anderson River, N. W. T. colony (western arctic), most yearlings "pass through one or two weeks later". A majority of marked blue goose yearlings were still in families on arrival at the McConnell River, an eastern population. Interestingly, more families of the eastern Atlantic (Branta bernicla hrota) than that of black brant (western) were still together at this time (Barry 1968:72). Reasons for a possible relationship between eastern and western populations of more than one species and persistence of goose families are unknown.

Yearling blue geese left adults in the early stages of

incubation at McConnell River although a few stayed with their parents at the nest for longer periods. Relatively more yearling white-fronted geese apparently remain near the nest throughout incubation; their habit of distracting predators from the vicinity of their parents' nest is beneficial to the adults (Barry 1968:110). Since white-fronts are not colonial nesters, there is presumably more food for the yearlings around the nest site than for yearling blue geese in a colony situation. Sherwood (1967:350-351) and Martin (1964:11-12) reported that yearling Canada geese were driven away by their parents as the latter established nesting territories. Broods also disintegrated as yearling males tended to disperse farther than females. Many yearlings rejoined their parents and new brood before fall migration, however (Sherwood 1967:351, Martin 1964:28-29). Fischer (1965:271) stated that semicaptive young greylags were driven from the family party one by one in the spring by attacks from parents and even siblings and cohesion among brood mates was thus also lost. This was not the case for blue geese in this study; siblings remained together after separation from adults.

4. BEHAVIOR OF PREBREEDERS

4.1 FALL AND WINTER

Very little is known of the behavior of young geese from the time they leave their parents until they first breed. Five hundred and thirty different marked yearlings have been sighted during fall and winter (Table 18). Only 73 (14%) birds were seen on three or more occasions, providing data on day to day variations in status. The single observations provide useful information on the important question of how many yearlings were involved in old or new associations or which appeared to have no association with other geese, although there is the risk that individuals recorded just once really belonged in another status (13 of 73 (18%) yearlings seen three or more times were recorded in at least two different categories).

The status of yearlings at each season is diagrammed in Figure 6. In fall and winter most yearlings were alone (Table 18). In 1967 and 1968 a large number were recorded as "status unknown" due to difficulty in determining the social status of marked individuals within the large and

TABLE 18

GROUP STATUS OF MARKED YEARLING, TWO AND THREE-YEAR-OLD BLUE GEESE SIGHTED IN THE NORTHERN STATES (FALL) AND ON THE GULF COAST (WINTER), 1967-'68 TO 1969-'70.

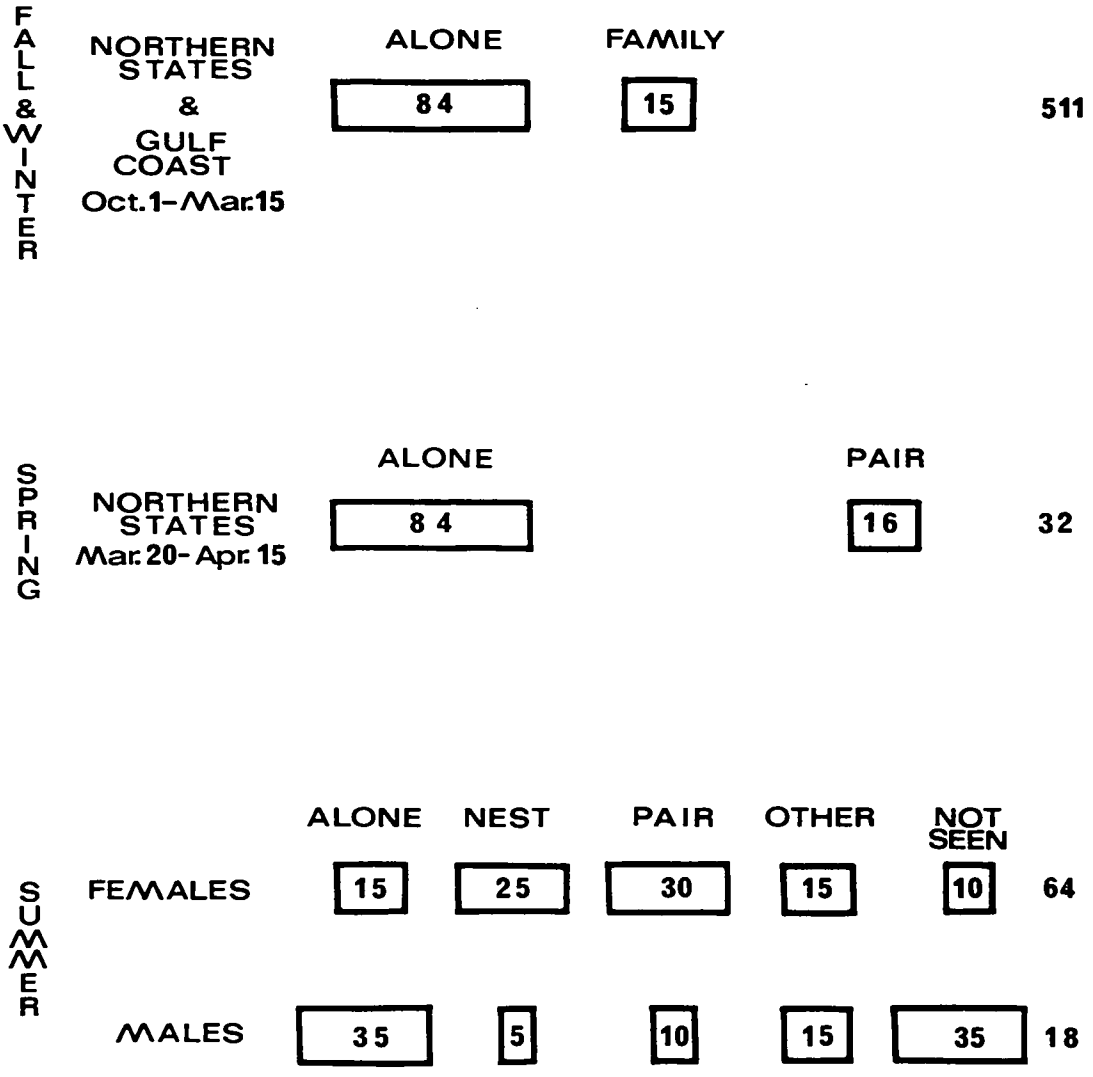
AGE	YEAR	TOTAL SEEN (No.)	ALONE (%)	IN ORIG-INAL FAM. (%)	WITH SIBLING (%)	WITH MATE (%)	WITH NEW FAMILY (%)	STATUS UNKNOWN (%)
1	1967	119	36	3	2	1	0	58
1	1968	180	40	9	6	1	0	44
1	1969	212	67	13	8	1	0	11
2	1968	137	34	0	3	1	1	60
2	1969	47	62	0	0	4	2	29
3	1969	71	47	0	0	6	6	41

Between Years - yearlings (alone + status unknown: in original family: with siblings) : $X^2_4 = 14.621$, $P < 0.01$.

- 2-year-olds (alone + status unknown: all others) : $X^2_1 = 0.765$, $P > 0.10$.

FIGURE 6

Summary of group behavior of neck-banded yearling blue geese throughout the year. Numbers in boxes are percentages of yearlings that were recorded in each social status in each season (from Tables 18, 19 and 20). Numbers on the right side of the figure indicate sample sizes.


FALL & WINTER
NORTHERN STATES & GULF COAST
Oct. 1 - Mar. 15
ALONE
84
FAMILY
15
511
SPRING
NORTHERN STATES
Mar. 20 - Apr. 15
ALONE
84
PAIR
16
32
SUMMER
ALONE
NEST
PAIR
OTHER
NOT SEEN
FEMALES
15
25
30
15
10
64
MALES
35
5
10
15
35
18

densely packed fall and winter flocks. In order to reduce this number, special effort was made to watch more closely prebreeders sighted in 1969. Nearly all yearlings that would have been classed as status undetermined were found to be alone; the number tallied as associated with unmarked birds remained very small. If, as seems likely, most of the yearlings of uncertain status in the two other years were also alone, the proportion in this category varied from 79% (1969) to 94% (1967). The latter figure is likely too high since not all adults were collared in the 1967 banding drives; consequently, some yearlings in "status unknown" in 1967 may actually still have been with unmarked parents. This would explain the low proportion recorded in families or with siblings (5%) as compared to 14% in 1968 and 19% in 1969.

Fifteen percent of yearlings were still with members of their family. In some instances families apparently did not break up, particularly in the extremely poor breeding summer of 1968 when many adults either did not breed or lost their nests before yearlings left the family party. In other cases, yearlings were definitely not with adults during the nesting and brood-rearing period and must have joined them in late summer or during fall migration. There have been just three

examples of yearlings with parents and their new young-of-the-year.

The association of yearlings with siblings illustrates that strong bonds persisted between brood mates after separation from the adults. Other marked yearling siblings were often seen alone at different locations, or with just some of their brood mates. It was unclear whether separation had occurred artificially or was due to normal behavior. There was no evidence that yearlings were associated in pairs during fall and winter.

The status of neck-collared two and three-year-olds is also set out in Table 18. Three two-year-olds were still with siblings but none still accompanied their parents. There was a slight increase over yearlings in the proportion seen with unmarked birds - either with apparent mates, or, in three cases, with mates and offspring. The number of geese assigned to these categories was almost certainly too low, however. Status determined on the basis of one sighting resulted in an underestimate of geese in groups because some of the time they were apart from members of their group while lone birds were recorded incorrectly with a group less frequently. Also, despite more intense efforts in 1969, over 25% of two-year-olds still could not be con-

fidently assigned to a definite status (as opposed to 11% of yearlings in 1969). Since the status of lone birds was usually more readily apparent after close observation than geese with unmarked companions, some of the two-year-olds of uncertain status in 1969 could have been paired. This is made more likely by the strong tendency for neck-banded young blue geese to pair with unmarked birds; just five of 180 geese marked as goslings and later seen paired were with other marked geese.

4.2 SPRING

Observations during spring migration in Missouri and South Dakota revealed differences from fall and winter in the status of prebreeders. Although the number of sightings was small, there clearly appeared to be more geese associated in pairs from each age class (Table 19). Further, active courtship and pairing behavior was observed involving neck-collared yearlings. Five of 32 (16%) marked yearlings were seen paired with or courting unmarked geese in contrast to four of 511 (1%) during fall and winter. A similar pattern held for two and three-year-olds. Correlated with this was an apparent reduction in the proportion of prebreeders which were alone (and of undetermined status) and a notable absence

TABLE 19

GROUP STATUS OF MARKED YEARLING, TWO-YEAR-OLD AND THREE-YEAR-OLD BLUE GEESE IN THE SPRING OF 1969 AND 1970.

AGE	TOTAL SEEN (No.)	ALONE (%)	WITH MATE OR COURTING (%)	STATUS UNKNOWN (%)
1	32	69	16	16
2	8	25	25	50
3	6	33	67	0

Yearlings - spring vs. fall-winter (alone: with mate: with family or sibling): $X^2_2 = 25.877$, $P < 0.001$.

of yearlings with parents or siblings. Possibly, an increase in sexual motivation at this time resulted in yearlings leaving the company of other members of their family.

Two different male yearlings were observed engaging in courtship display. Their behavior closely resembled the colorful descriptions of A. anser by Heinroth (1911) and Fischer (1965:275-276). The behavior of the two males corresponded to the second phase of courtship of Fischer (p. 275-276) whereby they showed a characteristic display behavior (Imponierverhalten) consisting mainly of enlargement of the body contours, adoption of an exaggerated erect posture and tenacious, close following of the female, though the extreme aggressiveness described by Fischer (1965:276) was not observed. That such behavior was not necessarily indicative of imminent compatability leading to pair formation between male and female blue geese is shown by the histories of the two males. One snow phase gander was alone on 31 March 1970 and again on 3 April but later in the day was observed closely following a female snow goose in a typical displaying attitude. However, the male was alone once more on 5 and 9 April and when seen on 10 June at the McConnell River it was still alone. The other male, also a snow, was alone in Texas on 5 March but was seen twice on 3 April in Missouri courting

a female snow on a pond used for loafing and roosting. It was present at the same location on 6 April but this time was "shadowing" a blue phase female as it swam among the closely spaced geese on the pond. On 8 April the male was alone, looking unalert and inconspicuous in comparison to his appearance on the previous two occasions.

In contrast to males, females at this stage in pairing showed few outward signs of their disposition toward courting males. According to Fischer (1965:275), it is only when a female greylag goose permits a male to approach her without fleeing that the male assumes the courtship display behavior. Three different marked yearling females were observed in close association with displaying males. One female snow had been observed on 20 November at Squaw Creek National Wildlife Refuge and later on 30 January in East Texas, alone on both occasions. Another yearling female was alone on 13 November at DeSoto National Wildlife Refuge but was found paired to a neck-collared three-year-old snow gander on 3 April. This pair nested at the McConnell River approximately two months later but deserted their nest after one egg had been laid.

Another apparent form of courtship described by Cooch (1958:18-22) involved aerial chases of females by two or

more males. These "chase flights" could be seen at nearly any time of the year although they were most conspicuous during late winter on the Gulf Coast and on spring migration. Some were noted even after arrival at the breeding grounds. Many flights were noted on 15 March 1970 in a large flock of geese gathered near Anahuac National Wildlife Refuge in East Texas. On this date many geese departed on the northward migration and animated chase flights were seen involving geese flying more or less in company with flocks disappearing high to the north. Chase flights also occur in late winter in brant as well as white-fronted, pink-footed and greylag geese (H. Boyd, pers. comm.) although this behavior was not mentioned by Heinroth (1911), Lorenz (1959) or Fischer (1965) in semicaptive greylags. The familiarity of all individuals in these flocks (Lorenz 1959:207) and their year round attachment to a particular area may have been responsible for its absence. The exact context of these flights is unclear and in my opinion they do not constitute a normal part of courtship activity as indicated by Cooch (1958:20). An account of this behavior will be presented elsewhere. The flights probably do give a rough indication of the general level of sexual motivation in blue geese, however, and their frequency might correspond to the incidence

of courtship and pairing.

4.3 SUMMER

An analysis of behavior on the breeding grounds of age classes in which not all individuals are sexually mature presents difficult practical problems. It is known that most subadult blue geese do not normally frequent the breeding colony but instead are usually found in loose flocks adjacent to and sometimes considerable distances from the main nesting areas (Cooch 1958:23, and personal observations). In 1967 and 1969 flocks of nonbreeders were seen up to 50 km from the colony during surveys by helicopter (C. D. MacInnes and R. N. Jones, pers. comm.). Since most observations in this study were made in the colony and on its periphery, many subadults were not seen during the summer. The proportion of these age-classes that were seen probably varied from year to year. Further, evidence presented in this section indicates that part of this segment, particularly males breeding for the first time, had likely paired during spring migration with geese from other breeding areas and accompanied them to different colonies. Hence, it was extremely difficult to judge how representative the observed samples of subadults were.

The status and sex ratio of those marked two, three and four-year-olds observed on the breeding ground is shown in Table 20. The sex of some individuals could not be determined in the field and was not recorded at banding. The proportion known to have nested increased from just over 20% of two-year-olds to nearly 90% of four-year-olds. Approximately 30% of both two and three-year-olds appeared to be paired but apparently did not breed. The proportion of birds in these age-classes with apparent mates more than doubled from that in late March and early April while on spring migration (classed as yearlings and two-year-olds respectively in Table 19) and indicates that considerable pairing took place during the remainder of the northward migration and possibly after arrival on the breeding grounds. Just 26% of two-year-olds and 14% of three-year-olds were judged to be definitely alone although others (12% and 7% respectively), seen in small flocks of nonbreeders, may have been unpaired. In one exceptional case a three-year-old snow male still accompanied a neck-banded adult female blue goose in 1969. This family had been seen in the same area on the edge of the nesting colony in 1967 and 1968, accompanied then by an unmarked adult blue. In 1970 the female nested in this area with an unmarked snow gander.

TABLE 20

GROUP AND BREEDING STATUS, AND SEX RATIO OF NECK-COLLARED TWO, THREE AND FOUR-YEAR-OLD BLUE GEESE OBSERVED IN SUMMER AT McCONNELL RIVER, N.W.T. FROM 1968 TO 1970

AGE	TOTAL SEEN			NESTED			PAIRED			ALONE			OTHER NON-BREEDERS		
	TOTAL	♀	♂	TOTAL	♀	♂	TOTAL	♀	♂	TOTAL	♀	♂	TOTAL	♀	♂
2	162	64	18	36	25	4	53	24	6	42	7	4	31	8	4
3	71	37	9	33	26	4	21	9	--	10	2	4	7	--	1
4	19	13	2	17	12	2	1	1	--	0	0	0	1	--	--

In studies of population dynamics, it is customary to base calculations of population parameters on the number of productive females in each age class. It is important to determine the ages of first breeding and the proportions of individuals doing so. When just females were considered, the proportion that nested at 2, 3 and 4 years of age was approximately 25%, 50% and 90% respectively. Close to 35% of both two and three-year-old females were paired but did not nest while those seen alone came to about 20% and 10% respectively. The preceding figures were calculated from adjusted totals for each sex which were obtained by multiplying the observed sex ratio by total geese observed in breeding and nonbreeding categories (see Appendix A.33).

I attempted to estimate the size of the segment of each subadult age class that was not seen at the McConnell River each summer in order to gain a closer approximation of the proportion of females actually breeding. This was done by comparing between fall-winter and summer the ratios of neck-banded yearlings, two and three-year-olds to adults recorded in frequency counts (see Appendix A.34) on the assumption that all adults returned to the McConnell River colony. Results appear in Table 21. Tabulated values close to 1.0 indicate that the particular neck band class made up a

TABLE 21

COMPARISON OF RATIOS OF NECK-COLLARED BLUE GEESE OF EACH SUB-ADULT AGE CLASS TO MARKED ADULTS, FROM NECK BAND FREQUENCY COUNTS TAKEN IN FALL-WINTER AND SUMMER (AND SHOWN IN APPENDIX A.34). SUMMER RATIOS ARE EXPRESSED AS THE PROPORTION OF FALL-WINTER RATIOS.

	YEAR OBSERVED					
	BANDED AS GOSLINGS				BANDED AS ADULTS	
YEAR BANDED	YEARLINGS	2 YEARS	3 YEARS	4 YEARS	1969	1970
1966	--	--	0.63	0.51	2.59	1.62
1967	--	0.37	0.29	--	1.18	1.12
1968	0.45	0.77	--	--	0.76	0.95
1969	0.84	--	--	--	--	0.88

similar proportion of collars from counts in summer and in winter; low numbers indicate that the band class was relatively less common in summer and high numbers that they were recorded more frequently. There was little agreement between years in the relative frequency with which marked yearlings, two-year-olds and three-year-olds were seen between the fall-winter period and summer. Although some year to year variation in the proportion of these age classes that were sampled in the close vicinity of the breeding colony would be expected, the magnitude of fluctuation indicated in Table 21 seems improbably high. The assumption that most collared adults returned to the McConnell River might be misleading as some widowed ganders probably followed new mates to different colonies (neck-banded adults have been reported in three other colonies). Over or under-representation of any adult neck band class in either fall-winter or summer would have affected ratios for all classes; for example, the relative abundance of adults banded in 1966 was more than 2.5 times higher in counts from the summer of 1969 than the fall and winter of 1968-'69. Differential mutilation of collars between age classes from any given year could also have altered relative ratios.

Despite the lack of precision of this approach, it is

evident that a substantial proportion of each subadult age class was not seen at the McConnell River each summer. This could have caused figures for females in Table 20 to be too high. However, except for goslings banded in 1967 and observed in 1969 as two-year-olds and 1970 as three-year-olds, most of this deficit can be explained by absent males, assuming that the sex ratio of live birds of these ages was equal. A rough approximation of the proportion of females not seen in summer can be obtained by subtracting missing males from all missing birds of each age class (Table 22). The maximum figure for missing females was just 10%, resulting in only minor corrections for the proportion of females indicated as breeding in Table 20.

The preponderance of females in each age class of the marked sample was striking. Overall, 80% of the two, three and four-year-old geese sighted during the summer were females. The proportion of females among breeding birds of these age classes was approximately 85%. If 30 additional geese (all females that were recaptured at banding and presumed to have bred (Cooch 1958:190) are added, this figure becomes 90%. Two and three-year-olds paired but not breeding had a similar sex ratio to breeders but that of lone birds was nearly equal; 75% of all nonbreeders were females.

TABLE 22

CORRECTED ESTIMATES OF THE PROPORTIONS OF NECK-BANDED TWO, THREE AND FOUR-YEAR-OLD FEMALE BLUE GEESE THAT BRED AT THE McCONNELL RIVER, N.W.T., 1968 TO 1970.

AGE	TOTAL ♀♀ OBSERVED	% ♀♀ BRED OF OBSERVED	TOTAL ♂♂ + ♀♀ MISSING (%)[a]	% MISSING DUE TO ABSENT ♂♂[b]	% ♀♀ MISSING	% ♀♀ BRED
2	121	26	43	33	10	23
3	55	53	44	35	9	48
4	17	88	49	44	5	85

a - Obtained by averaging values for each age class from Table 21.

b - Calculated from the overall observed sex ratio

Other considerations make emigration of males appear likely. McConnell River blue geese in spring were still well mixed with birds from other breeding colonies; the mean ratio of blue to snow phase geese in spring flocks in Missouri and South Dakota from 21 March to 22 April, 1970 was 47% blue phase while at the McConnell River colony it was 26%. Alternatively, it is possible that males suffered higher mortality than females or that many neck-banded males were unsuccessful in obtaining mates.

Although there was a tendency for a higher proportion of female than male two-year-olds (25% vs. 14%) and three-year-olds (53% vs. 25%) to have bred, differences were not significant ($X_1^2 = 2.630$, $P > 0.10$ and $X_1^2 = 3.831$, $0.05 > P > 0.10$, respectively). Additionally, many males that apparently emigrated probably bred while those not obtaining mates in late winter or spring might have tended to return to their natal colony. The result would be a trend for nonbreeding males to be present at the McConnell River.

Five different two-year-olds (two males, 2 females, one unsexed) observed in the nesting colony with unmarked mates (age unknown) acted very much like nesting pairs. Each pair seemed to hold and defend a territory but nests were not found. One pair was observed four times during the incuba-

tion period in 1969. It was first seen on 18 June. On 20 June, both geese fed and rested in a restricted area about 25 m in diameter for over 30 minutes; twice during this time they charged neighboring pairs, engaging in a Triumph Ceremony after each attack. The pair was seen at the same location on 22 and 23 June but on 29 June just the marked male was observed, this time about 50 m from the usual location. The male could not be located on 5 July, when the first goslings were hatching in the colony. Yearling and two-year-old Canada geese were reported by Martin (1964:33-36) and MacInnes (1966:544-546) engaging in similar behavior. Martin found that most of these pairs did not maintain their territories through the entire incubation period but they often used the same territory for nesting the following summer. None of the above marked two-year-olds were found at nests in subsequent summers at the McConnell River. Two other pairs involving two-year-olds were seen on more than one occasion apparently holding and defending "nesting territories" but at different locations on different days. The holding of "nesting" territories during the breeding season, then, does not always imply a nesting attempt as has also been pointed out by Wood (1965:243-244) for Canada geese.

Clutch sizes of two, three and four-year- old females

are shown in Table 23 along with average clutch sizes of females banded as adults the same year. Two-year-old females had significantly smaller clutches than three and four-year-olds or adults. Clutch sizes of three and four-year-olds were not different from that of adults, nor were they different from each other.

In addition to having smaller clutches than adults, two-year-old females seemed more prone to lose nests through desertion and predation. Of seven such nests that were visited twice or more during incubation, four lost all eggs. It was also noticeable that two-year-olds usually went farther away and stayed away longer when their nests were visited. This tendency, of course, made their eggs vulnerable to predation by herring gulls and parasitic jaegers. Both of these species frequently followed people walking through the blue goose colony, descending quickly on nests as pairs of geese moved away due to the investigator's approach (cf. MacInnes and Misra 1972).

During the first summer in which marked two-year-olds were present in the population, most nests were found in an area of low nesting density, apparently sub-optimal breeding habitat. However, in the subsequent two years this pattern did not hold; nest sites of several two-year-olds were found

TABLE 23

CLUTCH SIZES OF NECK-BANDED TWO, THREE AND FOUR-YEAR-OLD FEMALE BLUE GEESE BREEDING AT THE McCONNELL RIVER, N.W.T. FROM 1968 TO 1972 AND COMPARISON TO ADULT CLUTCH SIZES FROM SAME YEAR.

	KNOWN AGE						ADULT[a]			
	CLUTCH[b]				MEAN	STANDARD ERROR	MEAN	STANDARD ERROR	F	P
AGE	2	3	4	5						
2	3	9	0	0	2.75	0.452	3.41	0.133	5.096	<0.05
3	2	7	3	3	3.47	0.256	3.17	0.161	0.983	>0.25
4	0	3	3	1	3.71	0.295	3.43	0.852	0.563	>0.25

2 vs. 3-year-olds: $F = 5.356$, $P < 0.05$.

2 vs. 4-year-olds: $F = 12.307$, $P < 0.01$.

3 vs. 4-year-olds: $F = 0.341$, $P > 0.25$

a - Average clutch size of adult females banded in the same years as known-age females.

b - Only clutches presumed to be complete were used.

in some of the densest breeding areas. In some years considerable nesting habitat within the main part of the McConnell River colony may have offered inferior nest sites due to excessive wetness in the first part of the nest initiation period, yet have been filled in by breeding pairs as water levels dropped. Later, during the incubation period, these same areas might have had high breeding densities and appeared at that time to have been good nesting habitat. Also, some females breeding for the first time could have been mated to older, experienced ganders which were capable of defending desirable nesting sites against rival geese.

4.4 DISCUSSION

Due to the paucity of winter sightings of marked birds, most information on the status of yearlings and older prebreeders in the nonbreeding season is indirect and speculative. Lynch and Singleton (1964:155) found that adult-plumaged blue geese unaccompanied by juveniles averaged two birds per group and speculated that yearlings might still have been associated with siblings or in newly formed pairs. Also, Boyd (1954:74) and Lynch (1970:11), commenting on the presence of three or more adult-plumaged geese in a small proportion of families, suggested that such cases might

have represented polygamy or continued association of yearlings with parents. Lebret (1958:287) thought that immature white-fronted geese "tend to congregate in groups which are far greater than the average size of a family".

Both Sherwood (1967:350) and Martin (1964:28-29) found that marked Canada goose yearlings commonly rejoined their parents and new broods prior to fall migration while others remained associated in sibling groups. During the winter Raveling (1969a:311) found yearlings in families (15%), with siblings (8%), in mated pairs (4%), and most commonly, alone (73%). Raveling's results were very similar to those for blue geese from this study.

Only two families containing three adults were noted in the course of the present study. Although the exact nature of relationships among the adults was unknown, in one case polygamy was definitely not involved. A marked adult which arrived at the McConnell River in 1970 in company with two other collared adults and a yearling was seen later in the summer paired to an unmarked bird. Most cases of families with more than two adults and parties of adult-plumaged blue geese encountered in fall and winter flocks should be interpreted as geese bound by persistent parent-young or sibling-sibling ties. There was no indication that other functional

groupings developed. Orphanned juveniles sometimes formed loose aggregations, but they lacked stability.

Individuals of other species of Anser appear to form pairs first during their second winter (e.g. Boyd 1954:77-79, Scott et al. 1955:79). Similar inferences have been made about Canada geese although it is known that yearlings in several southern populations pair in their second summer on the breeding grounds (reviewed by Raveling 1969:316). This may not be true in arctic populations, however. The migration of the former is relatively short and they spend much longer periods on the breeding ground (e.g., Sherwood 1965: 34) than do more northerly breeders. This includes most of the spring pairing period when northern populations are still in migration. Pairing in blue geese conforms to that of other Anser; courtship involving yearlings was not noted until late winter and spring. The resulting intercolonial pairing is presumably correlated with lack of striking geographical variation in blue geese.

Most information on age of first breeding in geese has come from numerous nesting studies of southern races of Canada geese. Young Canada's appear to breed at an earlier age on the average than blue geese. About one-third of B.c. maxima and moffitti bred as two-year-olds in wild flocks

(Brakhage 1965:756, Craighead and Stockstad 1964:60, Martin 1964:14-15) although Sherwood (1967:351-352) found 75% breeding at two years. (Fewer young birds bred in captive or semi-captive flocks, Craighead and Stockstad 1964:61-62, and others). All three-year-old females bred in the latter study while Brakhage found that 70% nested. The sex ratio of breeding two-year-old Canada geese was about equal (Craighead and Stockstad (1964:61) or was more heavily weighted to males (Brakhage 1965:756); in the latter study 10% of males bred as yearlings.

The scant breeding age data for Anser have been determined indirectly. Cooch (1958:26-30) concluded that although most two-year-old female blue geese captured on the breeding grounds were reproductively mature, most did not nest until the following year; he also thought that males bred later than females (p. 29). The probable breeding status of emigrating two-year-old males, however, makes the latter point questionable. Calculations based on winter productivity appraisals (e.g., Lynch 1966:4) suggested that considerable numbers of two-year-old female blue geese must have nested in some years but that the proportion doing so apparently varied between years. Boyd's (1957:85) observations showed that most two-year-old white-fronted geese were

paired in winter but none were accompanied by juveniles; also, only three of eight three-year-olds had broods but 75% of those in their fourth year were successful breeders. First breeding in white-fronted geese thus appears to be at a somewhat later age on the average than in blue geese.

Information on the effects of age on productivity in geese is scarce. As in this study, Brakhage (1965:760-761) found that clutch size and nesting success increased with age in Canada geese but at the McConnell River clutches of two-year-old Canada geese were smaller in only one year of six (C. D. MacInnes, pers. comm.).

5. THE GROUP COUNT TECHNIQUE

5.1 RESULTS

Direct field appraisals of autumn and winter flocks, utilizing the presence of well defined social units, perhaps offer the most practical potential method to date of measuring reproductive success of many Anserini. Information can usually be gathered without need for expensive trips to remote breeding areas, before significant hunting losses have occurred, and without biases associated with age ratios obtained from live-trap and hunter kill samples (Boyd 1959, Raveling 1968:87). Aerial photography (Heyland 1972) also shows excellent possibilities.

Are group counts sufficiently accurate to provide information of practical value in managing numbers of geese? By the time fall and winter counts were conducted, approximately 20% to 25% of blue geese were no longer in families (Section 3.4). Also, although it was found that there was little interchange of marked individuals among families or attachment of orphans to unrelated groups (Section 3.1), the fact that adults and juveniles were apart from their

families on approximately 20% of all fall observations in the vicinity of National Wildlife Refuges in the Northern States (Section 3.4) introduces serious errors into group count data in these areas. In the Gulf Coast winter quarters, however, family members were together for more than 95% of sightings, causing only insignificant biases to estimates in the latter areas.

Lynch and Singleton (1964:147) recorded group size at times when functional groups within larger flocks seemed most apparent - as flying geese alight, or when they depart from a settled flock. Geese flying short distances were also considered suitable provided that groups did not merge. They stressed that only flocks behaving in an unexcited manner should be sampled since social units frequently coalesce temporarily if disturbed. Raveling (1968), however, found the latter two methods to be inaccurate in determining the correct status of marked Canada geese in wintering flocks in Illinois.

In 1968 and 1969 all neck-banded blue geese observed landing, taking off and in flight in undisturbed circumstances were tallied as in average group counts to test the accuracy with which the status of birds at the time of observation was recorded. For example, a juvenile temporarily

separated from its family and seen landing by itself was considered a correct tally; however, if the family was present but the juvenile landed either before or after other family members, or, if it landed with unrelated geese, it was scored as incorrect. Flying geese frequently presented problems in scoring since groups and individuals often merged temporarily in flight only to separate again. These cases were counted both as correct and incorrect.

Results appear in Table 24. Figures for 1968 and 1969 were similar so were combined ($X^2_1 = 1.2826$, $P > 0.10$). Counts of landing geese were most accurate, followed by those of birds taking off and in flight. Individuals and groups frequently took off together or joined in flight, regardless of relationship. Unrelated geese might separate in flight or continue to fly along together and even prepare to land as a group. Just before touch-down, however, distinct social units usually veered away from the others or continued to glide past other geese to land separately. Raveling (1969:88-89) reported similar results with Canada geese.

Marked geese were scored incorrectly more frequently in the Northern States than on the Gulf Coast for each method although differences were significant only for take-off ($X^2_1 = 4.474$, $P < 0.05$). As previously pointed out, blue goose flocks

TABLE 24

ACCURACY OF AVERAGE GROUP COUNT TECHNIQUE IN DETERMINING THE STATUS OF MARKED BLUE GEESE OF KNOWN SOCIAL STATUS. DATA FROM 1968-'69 AND 1969-'70, AND FROM NORTHERN STATES AND GULF COAST ARE COMBINED.

GROUPS	1. TAKE-OFF			2. FLYING			3. LANDING		
	TOTAL	SCORED		TOTAL	SCORED		TOTAL	SCORED	
		RIGHT	WRONG[a]		RIGHT	WRONG[a]		RIGHT	WRONG[a]
JUVENILES:									
Alone	27	18	9[c]	15	13	2	13	12	1
Family	98	89	9[b3]	52	42	10	55	55	0
YEARLINGS:									
Alone	19	18	1	9	6	3	7	4	3
Family	9	8	1	4	4	0	11	8	3
ADULTS:									
Alone	22	18	4	1	1	0	6	6	0
Paired	36	34	2[b2]	4	2	2	10	10	0
With Ylgs.	8	7	1	3	3	0	7	5	2
Family	89	79	10[b5]	42	31	11	44	44	0
TOTAL	308	271 (88%)	37	130	102 (78%)	28	154	145 (94%)	9

1-2-3 : $X^2 = 16.014$, $P < 0.001$.

1-2 : $X^2 = 6.563$, $P < 0.05$.

1-3 : $X^2 = 4.338$, $P < 0.05$.

2-3 : $X^2 = 15.324$, $P < 0.001$.

a - Unrelated birds appeared to be part of the group, or singles were recorded with other geese, except in cases marked b.

b - Members of group took off at different times such that they would be tallied separately, b2 = 2 birds, etc.

c - Two siblings took off at different times.

in the Northern States were large and disorganized in comparison to the smaller, more relaxed concentrations on the Gulf Coast and it was difficult to observe geese under proper conditions to conduct group counts (Lynch and Singleton 1964: 147). Geese in large concentrations seemed to lose their characteristic wariness (cf. Hanson and Smith 1950:126-127); whole flocks often landed practically en masse in grain fields in the northern refuges rather than cautiously circling before landing and sorting out into component social units in the process.

While there were no differences between age-classes in the proportion of correct scores ($X^2_1 = 2.263$. $P > 0.10$), single juveniles were classified incorrectly more often than juveniles in families ($X^2_1 = 10.015$, $P < 0.001$). This was due to their tendency to fly with other geese at take-off more than family birds, particularly in the Northern States.

Sixty two of 74 geese classified incorrectly were recorded in groups with unrelated birds, resulting in overestimation of average group size. The remainder (16%) were from groups that took off or landed asynchronously and were scored as two separate units, lowering average group size.

Many misclassifications altered estimates of family size and proportion of successfully breeding adults. Six of 12 collared juveniles (12% of all lone young birds) scored incor-

rectly were recorded with non-family adults and two others were with families. Only three of 22 non-family birds in adult plumage (2% of total) recorded incorrectly were tallied with lone juveniles. Thirteen of 21 family adults counted incorrectly (7% of total) were with lone juveniles or other families.

Not all errors in classification listed in Table 24 involved estimates of productivity parameters. For example, lone adults were sometimes recorded incorrectly with other adults but it was only when they were counted with juveniles or families that estimates of the proportion of productive adults or of average brood size were affected. In order to estimate the magnitude of inaccuracy contained in figures contained from average group counts, these errors (see Appendix A.35) were applied to a hypothetical population of 100 juveniles, 100 adults, 50 yearlings and 35 two-year-olds (totalling 185 geese in adult plumage). The social status was worked out on the basis of figures from Tables 4 and 18. Results appear in Table 25.

The most serious errors resulted from family birds temporarily absent from the remainder of the family and were much larger in the Northern States than on the Gulf Coast (Table 6). Errors associated with the group count technique were generally smaller. Those causing an overestimation of family size and the proportion of geese that were members of families were larger than the reverse and therefore tended to

TABLE 25

ERRORS IN PARAMETERS OF PRODUCTIVITY OF BLUE GEESE FROM AVERAGE GROUP COUNTS DUE TO DAY TO DAY BEHAVIORAL INCONSISTENCIES[a] AND TO MISCLASSIFICATIONS DURING AVERAGE GROUP COUNTS.[b]

AREA	CATEGORY	HYPOTHETICAL POPULATION		AT TIME OF COUNTS DUE TO BEHAVIOR		AFTER GROUP COUNTS							
						LANDING GEESE		% ERROR (FAM.)	AT TAKE-OFF		% ERROR (FAM.)	BOTH LANDING AND TAKE-OFF		% ERROR (FAM.)
		FAM.	NON FAM.	FAM.	NON FAM.	FAM.	NON FAM.		FAM.	NON-FAM.		FAM.	NON-FAM	
N. States	Juveniles	80	20	60	40	60	40	-25	72	28	-10	66	34	-17
	Ad. Plum.	60	125	45	140	56	129	- 7	47	138	-22	51	134	-15
	TOTAL	140	145	105	180	116	169	-17	119	166	-15	117	168	-16
G. Coast	Juveniles	80	20	78	22	78	22	- 2	74	26	- 7	76	24	- 5
	Ad. Plum.	60	125	58	127	67	118	+12	55	130	- 8	61	124	+ 2
	TOTAL	140	145	136	149	145	140	+ 3	129	156	- 8	137	148	- 2

a - From data tabulated for Table 6.

b - From Appendix A.35.

counteract the effects of the "behavioral inconsistencies" from Table 6 noted above. This was particularly true of juveniles tallied at take-off in the Northern States and landing adults on the Gulf Coast. The paradoxical result was that the less accurate counting method (take-off) would have yielded more accurate figures for numbers of geese in families in the former areas. On the Gulf Coast, counts incorporating equal numbers of geese landing and taking off would have produced best results.

Reliability of figures for group counts suffered from small samples, however, and results in Table 25 should be regarded as tentative. For example, one marked nonfamily adult of 15 was recorded as part of a family on the Gulf Coast when landing. When the resulting correction factor of 7% was applied to the 127 nonfamily adults in the hypothetical population, the proportion of family adults was overestimated by 12%. Accuracy of figures in Table 25 would also be subject to year to year fluctuation in the proportion of prebreeders in adult plumage (yearlings and two-year-olds) in the population. Low numbers, resulting in fewer of the latter classified in families would provide less "compensation" for family adults temporarily alone while the reverse could "overcompensate" (especially on the

Gulf Coast). The rate of error might also change; relatively fewer lone juveniles might be mistakenly recorded with nonfamily adults when lower numbers of the latter were in the population.

It is concluded that average group counts in the Northern States would not give results of sufficient accuracy to be of value in estimating breeding success of the preceding summer. On the Gulf Coast counts of landing geese or those including birds both landing and taking off recorded the social status of geese with sufficient accuracy to be suitable for this purpose, while counts at take-off were somewhat less accurate. More research is required to investigate effects of varying population structure on rates of error of the group counts and to provide larger samples from which to estimate sizes of errors. Other factors such as the effects of sizes of concentrations should also be studied. Additional problems stem from splitting of families before group counts are conducted as previously indicated. If it can be assumed that the proportion of geese no longer in families is roughly similar from year to year (as indicated in Table 4), results would still be a valuable index to production.

Group counts were made during the fall and winter of

1968-'69 and 1969-70 to provide a means of comparing the social status of unmarked with collared geese. Predominantly landing geese were counted. Raw figures usually indicated that considerably more unmarked juveniles were alone than neck-banded birds (whose status had been determined on the basis of at least three sightings). This was particularly evident in the Northern States (Table 26). Figures for unbanded juveniles were corrected to compensate for family juveniles temporarily alone, lone young-of-the-year mistakenly recorded with families, and errors of classification from group counts as in Table 25 and Appendix A.35. Figures for marked juveniles were also altered to allow for those birds that apparently did not recontact members of their families following banding drives (5% in 1968 and 11% in 1969, Table 1). But, since 4% of these juveniles later regrouped into families (Table 3), the proportion of lone neck-banded juveniles was reduced by 1% in 1968 and 7% in 1969.

The resulting figures are in rough agreement and offer further assurance that group counts of landing birds accurately reflect the proportion of juveniles actually in families, and thus of family size. Unmarked geese tallied in average group counts represented portions of several breed-

TABLE 26

COMPARISON OF THE PERCENT OF JUVENILES RECORDED ALONE FROM NECK-BANDED BLUE GEESE, AVERAGE GROUP COUNTS OF UNMARKED GEESE FROM THE SAME AREAS DURING THIS STUDY, AND FROM REGULAR MID-WINTER COUNTS BY J. J. LYNCH FROM APPROXIMATELY THE SAME AREAS.

YEAR	AREA	UNCORRECTED			CORRECTED[d]		
		NECK-BANDED	GROUP COUNTS[a,b]	LYNCH[c]	NECK-BANDED	GROUP COUNTS[a]	LYNCH
1968	N. States	13	31	--	12	17	--
	G. Coast	11	15	5	10	9	0
1969	N. States	25	29	--	18	13	--
	G. Coast	34	23	10	27	19	5

a - From Table 4.
b - Totals from counts on Gulf Coast were adjusted to reflect relative proportions of neck-banded juveniles sighted in the two areas.
c - From Lynch (1969: Tables 2, 4, and 8; 1970: Tables 5, 6, 11, 12, 17 and 18). These figures were adjusted as in b.
d - See text for explanation.

ing populations. The proportion of juveniles which had become separated from families and appeared alone in the Northern States might have differed between these populations if, due to differences in the timing in autumn migration, they had been exposed to the disruptive influences of the large flocks for different lengths of time. On the Gulf Coast the number of lone young might also have varied between geese from different populations if relatively more or less time was spent during fall migration in the Northern States.

Proportions of lone juveniles compiled by Lynch (1969, 1970) in the course of his mid-winter appraisals in the same areas of the Gulf Coast differed substantially from those found in this study. The primary purpose of the latter counts was for comparison with figures for neck-banded geese as already mentioned. Groups were followed nearly to the point of touchdown when separation of social units was most apparent. Counts conducted in this manner, however, are slower and more tedious. In normal counts geese are recorded somewhat sooner as flocks prepare to land. More geese can be tallied in a given time period but, also, more misclassifications are made.

Although the regular mid-winter counts (Lynch 1969, 1970) selected for comparison were from the same general

wintering vicinities as my own, they probably sampled different goose flocks exposed to different gunning pressure, and containing different proportions of lone young. A dramatic example occurred on 13 December 1969 in East Texas. Flocks of geese flying into Anahuac National Wildlife Refuge from the south, an area of nearly solid coastal marsh, were counted as they landed on a loafing pond. Just 5% of juveniles were tallied alone. Presently, geese began to arrive from the north where they had evidently been feeding in fallow rice fields. More than 20% of these juveniles were strays. It is probable that geese using agricultural fields had sustained heavier hunting pressure than geese from the less accessible marsh areas. Since most collars were observed in fields from former locations, figures for orphan young were probably inflated.

Even assuming that misclassifications in regular group count procedures occurred as indicated in Table 25, average brood size was overestimated by only 0.14 (9%) and 0.24 (14%) goslings per family in 1968 and 1969 respectively. Errors of this magnitude are probably unimportant in assessing year to year variation in productivity.

5.2 DISCUSSION

Although evidence has been lacking on the true nature

of family behavior of wild geese (Boyd 1953:88), the concept that families remain together in the non-breeding season has been used by many workers in gathering productivity data (reviewed by Lynch and Singleton 1964:145). This study, and that of Raveling (1969a), have demonstrated the day to day persistence of blue and Canada goose families throughout the winter. It has also been shown that brood mixing, reported for several populations of Canada geese, and adoption of orphans into families does not present problems for family counts in blue geese.

Lynch et al. (1960:17-23) found that average group size varied directly with percentage young in Gulf Coast blue and white-fronted goose flocks and might in itself be used as an index of annual productivity in these species and perhaps for others in which distinctive juvenile plumage does not persist into winter. Phillips (1916), Elder and Elder (1949) and Hanson and Smith (1950:152-153) had also suggested that this method might be used for one such species, the Canada goose. Concern has been expressed, however, that pseudogroups of prebreeders and attachment of yearlings to families would prevent accurate determination of family size (Hewitt 1950:307, Higgins 1968:19-20, Lebret 1956:287 and Sherwood 1967:352-353).

Nonetheless, observations of marked birds led Raveling (1968) to conclude that group counts offered hope for accurate determination of productivity of Canada geese although association of yearlings with siblings, mates, or old families presented problems for estimating true age structure in winter flocks. Results from this study indicated that while some yearling blue geese were still associated with their parents or siblings, the majority were alone. In any case, few groups were larger than two birds and hence would not often be confused with family-sized parties.

It is apparent that autumn counts of blue geese in and around National Wildlife Refuges in the northern United States are inappropriate for obtaining detailed data on population structure, both because of frequent temporary dissociation of family members, and a greater danger for errors of classification (particularly of geese at take-off) than on the Gulf Coast. Further, Higgins (1968:19-20) found that average group size was not related to percent young in fall flocks of blue geese at Sand Lake National Wildlife Refuge, although he counted flying groups, the least accurate method. It is possible that counts of flocks away from refuges might yield valid information. Early arriving geese, before flocks have become too large and disorganized, would presumably contain fewer tempor-

arily split families but the tendency of failed breeders and subadults to migrate earlier than successfully reproducing birds (Cooch 1961:82) could bias estimates of the proportion of productive adults.

The recent and growing tendency of blue geese to interrupt their fall migration in the northern United States (Cooch 1964:128) presents troublesome sampling problems for winter productivity appraisals. Blue geese from different breeding colonies stop off in the Northern States in varying proportions, and some variation in the pattern of stopover of geese from the same colony in different years is also probable, depending on spring phenology on the breeding ground and thus of breeding success (Cooch 1961:81-82). The proportion of families already split up before average group counts are conducted on the Gulf Coast would vary with location and season. Early counts, prior to heavy hunting mortality, would be more accurate than later counts. Counts from the eastern Gulf Coast where hunting pressure is likely lighter than farther west, and additionally, where wintering populations tend to stop less frequently and for a shorter time in the Northern States (Cooch 1961:84) would be more accurate than those from, for example, the Rice Prairies where hunting pressure is more severe and where populations have usually stopped for extended

periods in the Northern States. Final interpretation of Gulf Coast productivity counts for the entire wintering population is thus made difficult.

It is questionable if results of great accuracy are required for management purposes although figures should be quite precise. Changes in numbers or productivity in the order of 10% to 15% are probably sufficient to indicate desirable management procedures. Perhaps the best opportunity for obtaining this information would be at early fall staging areas on the lower Hudson and James Bay coasts (Hewitt 1950). Certainly, counts here could be made before significant hunting mortality had occurred. More research on methods of obtaining productivity data by counts of social groups is clearly needed if the utility of the long standing set of winter blue goose productivity records is to be maintained.

A study employing neck-banded samples of blue geese from several breeding colonies would provide valuable information on the degree of mixing between different populations, unbiased by differences between areas in hunting pressure and reporting rates of marked geese shot by hunters. Such information could permit refinement in the interpretation of productivity data, leading to possible management procedures for individual populations or groups of populations.

6. CONCLUDING DISCUSSION:
THEORETICAL ASPECTS OF FAMILY BEHAVIOR

The bonds uniting blue goose families are extremely durable, and although members were repeatedly separated in and around waterfowl refuges in the northern United States, most families showed persistent regrouping. Fischer (1965: 296) concluded that the closely knit family structure of geese is based on an independent "attachment drive" (Bindungstrieb) which is outwardly manifested in one of the two elements of the Triumph Ceremony, namely Cackling. Thus, Cackling is the bond uniting family members (Lorenz 1966:176). Separation of individuals from group members in Fischer's semicaptive flock of greylags caused continued searching for Triumph Ceremony partners; eating, sleeping, preening and other normal behaviors were neglected (Fischer 1965:296,301; Lorenz 1959:216; 1966:207).

Such extreme behavior implies considerable survival value for family unity. Fischer (1965:301) concluded that the main function is protection of the young from predators. Certainly, inexperienced goslings must be led through many

dangerous situations by the experienced adults, thereby learning "safe behavior" as well as locations of traditional migration stopover and wintering areas, good feeding and roosting locations, as indicated by evidence given in Section 3.4 on the high incidence of return of individuals to the same localities in winter.

Fischer (1965:258-260, 271) showed that greylag goslings deprived of social contact were lowest in rank order and avoided all other geese when introduced into the flock. In later life they did not pair. Juveniles receiving the benefit of extended parental leadership are probably better adjusted socially than those orphanned early in their first year. As a result, they are apt to be more successful in obtaining mates, more aggressive (dominant), and more successful in rearing offspring.

While in the family party juveniles share the same status as their parents (Boyd 1953:111, Fischer 1965:263-264, Hanson 1953:14 and Raveling 1970:297). Families are dominant over adult pairs or single birds and larger families are superior to smaller families in conflict situations (Boyd 1953:110, Hanson 1953:14, Jenkins 1944:35 and Raveling 1970:294-296). Hence, geese in families have more ready access to food and other necessities of life and are freer from attack from

other geese than nonfamily birds. If necessary resources are in limited supply, families would be favored over other geese.

Since adopted Canada goslings become fully integrated into families (Sherwood 1966:132), and in view of increased dominance of large families, it is perhaps surprising that natural selection has not favored adoption of goslings by dominant adults in more Canada goose populations and in other Anserinae. This could be made even more advantageous through "kin selection" (cf. Mayr 1970:116-117) if brood mixing occurred between related birds; some young female Canada geese breeding for the first time nested near or used the same feeding areas as their parents (Martin 1964:35 and Sherwood 1966:70). In northern nesters, however, the need for frequent brooding would place a limit on the number of goslings that could be adopted, thus exerting strong counter-selection against "wholesale" brood adoption. Furthermore, in highly gregarious species, such large families would be frequently separated in large autumn concentrations, exposing separated members to increased risks (see below).

Heavy hunting mortality is a relatively recent though strong selective force on geese. The tendency for survivors to return to the spot where other family members have been

shot led Hanson and Smith (1950:127-128) to conclude that family cohesiveness was a liability under these circumstances. Cooch (1958:209) found that fewer nonbreeders and prebreeders than successful breeding adults were reported shot and attributed this to lessened vulnerability without families. However, in this study a greater proportion of marked adults and juveniles seen in families in the Northern States were sighted on the Gulf Coast and subsequently than lone adults and juveniles, suggesting that survival was greater in family birds (Table 27).

There are some indications in the literature (e.g., Bishop 1901) that juveniles are more prone to return if adults are killed than vice versa, behavior that hunters in some areas purportedly take advantage of by purposely shooting adults from flocks approaching decoys (C. D. Ankney, pers. comm.). This might explain not only why juveniles in families apparently have a lower survival than family adults, but why the latter seem to survive as well as lone adults (Table 27). It is possible that adults are more apt to circle back if contact with their mates is lost than if only juveniles are killed. If this is true, adults in families would be no more vulnerable than those of mated pairs without young. Geese separated from their family may be

TABLE 27

COMPARISON OF THE NUMBER OF GEESE SEEN IN THE NORTHERN STATES IN FAMILIES AND ALONE, THAT WERE SIGHTED LATER.

AGE	STATUS IN N. STATES	NOT SEEN AGAIN	SEEN AGAIN	% SEEN AGAIN
Juveniles	Alone	256	71	22
	In Family	304	141	32
Adults	Non-Family	391	197	33
	In Family	217	153	41

Juveniles: $X_1^2 = 9.411$, $P < 0.001$.

Adults: $X_1^2 = 6.032$, $P < 0.05$.

Adults vs. Juveniles - Alone: $X_1^2 = 14.106$, $P < 0.001$.

- Non-Family: $X_1^2 = 8.185$, $P < 0.01$.

more easily decoyed than those in families regardless of their age, which would further contribute to higher mortality of lone individuals. The foregoing suggests, then, that selection for family cohesiveness is apparently operating and will probably continue in blue geese despite this severe "artificial" form of mortality.

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APPENDIX A.1

SUMMER BANDING TOTALS FOR BLUE GEESE AND NUMBER OF NECK BANDS SIGHTED DURING FALL AND WINTER FOLLOWING BANDING. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	NUMBER BANDED			NUMBER SIGHTED		
	ADULTS	JUV.	TOTAL	ADULTS	JUV.	TOTAL
1967	1242	2568	3810	287(23)	266(10)	553(14)*
1968	1614	1446	3060	619(38)	430(30)	1048(34)
1969	1038	1525	2563	500(48)	453(30)	953(37)

* - Just 10 weeks were spent making Fall and Winter observations in 1967.

APPENDIX A.2

MUTILATION RATE OF NECK BAND CODES BY BLUE GEESE.

	YEARS AFTER BANDING											
	1			2			3			4		
	TOTAL	NOT MUT.	MUT.	TOTAL	NOT MUT.	MUT.	TOTAL	NOT MUT.	MUT.	TOTAL	NOT MUT.	MUT.
With Clear Layer	46	43	3*	9	4	5*	9	5	4	16	4	12
Without Clear Layer	37	17	20**	26	3	23**	28	0	28	--	--	--

* - Codes on bands were disfigured so as to alter the "identity" of the goose: Year 1 : 1, Year 2 : 1.

** - Codes on bands were altered as above: Year 1 : 4, Year 2 : 3.

With clear layer vs. without clear layer:
- Year 1: $X_1^2 = 23.13$, $P < 0.001$.
- Year 2: $P = 0.110$.
- Year 3: $P = 0.001$.

APPENDIX A.3

AVERAGE NUMBER OF BLUE GEESE HANDLED IN BANDING DRIVES IN WHICH NECK BANDS WERE APPLIED, 1967-1969

YEAR	GEESE HANDLED	NUMBER OF DRIVES	AVG. NO. PER DRIVE	RANGE
1967	5493	6	915	225-1207
1968	3528	7	504	271- 704
1969	2754	4	688	411-1527

APPENDIX A.4

RATE OF RECAPTURE AT BANDING OF GOSLINGS TAGGED IN THE NEST.

YEAR	GOSLINGS TAGGED	RECAPTURED	BROODS REPRESENTED
1966	151	11(7.3%)	4
1967	268	2(0.7%)	2
1968	923	22(2.4%)	13
1969	1202	11(0.9%)	7
TOTAL	2544	46(1.8%)	26

APPENDIX A.5

MIXING OF TAGGED GOSLINGS BETWEEN BROODS FROM THE TIME TAGS WERE PUT ON AT HATCH UNTIL BROODS WERE RECAPTURED FOUR TO FIVE WEEKS LATER IN BANDING DRIVES.

YEAR	BROODS WITH TWO OR MORE GOSLINGS, OR WITH MARKED ADULTS	NUMBER OF TAGGED GOSLINGS	BROOD MIXING OCCURRED
1966	4	11	0
1967	1	1	1*
1968	5	14	0
1969	3	7	0
1971**	18	53	3
TOTAL	31	84	4 (5% of goslings) (13% of broods)

* - One tagged gosling was caught but its neck-banded parent was not.

** - Data supplied by A. Aubin.

APPENDIX A.6

FLUCTUATION IN NUMBERS OF GOSLINGS FROM BROODS WITH MARKED ADULTS DURING THE BROOD REARING PERIOD. ONLY BROODS SEEN THREE OR MORE TIMES ARE INCLUDED.

	BROODS				GOSLINGS IN BROODS		
YEAR	TOTAL SEEN	MEAN No. DAYS SEEN	GOSLING DISAPPEARED TEMPORARILY	GOSLING DISAPPEARED PERMANENTLY	TOTAL	DISAPPEARED TEMPORARILY	DISAPPEARED PERMANENTLY
1968	8	9.1	2	2	17	2*	3
1969	34	6.5	5	4	99	5**	4
1970	26	6.0	0	3	78	0	3
TOTAL	68	6.6	7(10%)	9(13%)	194	7(4%)	10(5%)

* - The number of goslings in both broods was back to normal the same day.

** - The number of goslings in three broods was back to normal the same day.

APPENDIX A.7

RE-FORMATION OF GROUPS OF BLUE GEESE FOLLOWING MASS RELEASE FROM BANDING DRIVES IN 1968 AND 1969 AT McCONNELL RIVER, N.W.T. ONLY GROUPS IN WHICH MEMBERS WERE SEEN AT LEAST TWICE ARE INCLUDED. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	TYPE OF GROUP	TOTAL SEEN	INTACT EACH SIGHTING	REGROUPING OCCURRED	BREAKUP OCCURRED
1968	Family	42	23(55)	16(38)	5(12)
	Adult - Pair	3	--	2(67)	1(33)
1969	Family	38	20(53)	17(45)	4(11)
	Adult Pair	1	1	--	--
TOTAL	Family	80	43(54)	33(41)	9(11)
	Adult Pair	4	1(25)	2(50)	1(25)

APPENDIX A.8

RE-FORMATION OF MARKED ADULT AND JUVENILE BLUE GEESE INTO FAMILIES FOLLOWING MASS RELEASE FROM BANDING DRIVES IN 1968 AND 1969 AT McCONNELL RIVER, N.W.T. ONLY BIRDS SEEN AT LEAST TWICE ARE INCLUDED.

AGE	YEAR	TOTAL SEEN	REGROUPED					DID NOT REGROUP, OR SEPARATED					EST. NOT SEEN
			TOTAL	WITH FAM. EACH OBS.	JOINED FAMILY	JOINED ADULT	CHANGED FAMILY	TOTAL	LEFT FAM.	LEFT AD.	ALONE	WITH JUV.	
Ad.	1968	70	63	40	18	4	1	7	4	2	0	--	1
	1969	72	57	50	5	2	0	15	1	0	1	--	13
	TOTAL	142	120	90	23	6	1	22	5	2	1	--	14
Juv.	1968	79	75	55	16	--	4	4	2	--	2	0	0
	1969	99	88	73	13	--	2	11	4	--	5	2	0
	TOTAL	178	163	128	29	--	6	15	6	--	7	2	0

APPENDIX A.9

BROOD SIZES BEFORE* AND AFTER BANDING DRIVES IN 1968 AND 1969 AT THE McCONNELL RIVER, N.W.T.

YEAR	PERIOD	BROOD SIZE 1	2	3	4	5	6	7	N	X	$\bar{x}$
1968	Before Banding	22.3	21.2	12.2	2.7	1.7	0	0	120.6	60.1	2.01
	After Banding	32	21	12	2	4	0	0	138	71	1.94
1969	Before Banding	18.5	26.8	32.0	10.3	3.2	0.7	0.2	230.9	91.7	2.52
	After Banding	22	18	20	11	0	0	0	162	71	2.28

1968: $X^2_4 = 1.874$, $P > 0.10$

1969: $X^2_3 = 2.665$, $0.10 > P > 0.05$

* - Brood sizes for two weeks preceding banding were averaged.

APPENDIX A.10

GROUP STATUS OF JUVENILE BLUE GEESE TAGGED AT HATCHING, RECAPTURED AT BANDING, AND SUBSEQUENTLY SIGHTED AFTER BANDING DRIVES OR IN THE UNITED STATES DURING FALL AND WINTER.

YEAR	TAGGED GOSLINGS CAUGHT AT BANDING	NUMBER LATER SIGHTED	STATUS WHEN SIGHTED					
			JUST ONE OF BROOD CAUGHT			TWO OR MORE CAUGHT		
			ADOPTED INTO FAM.	WITH ADS. OF RIGHT COLOR	ALONE	WITH PARENTS	WITH SIBLING	ALONE
1966	11	0	--	--	--	--	--	--
1967	2	0	--	--	--	--	--	--
1968	22	7	0	2	1	2	0	2
1969	11	10	1	0	2	5	2	1
TOTAL	46	17	1(6)	2(12)	3(18)	7(41)	2(12)	3(18)

APPENDIX A.11

COMPOSITION OF BLUE GOOSE GROUPS IN THE UNITED STATES DURING FALL AND WINTER THAT HAD BEEN SEEN AFTER BANDING DRIVES AT THE McCONNELL RIVER IN 1968 AND 1969. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	TYPE OF GROUP	TOTAL SEEN	GROUP SAME	REGROUPING			BREAKUP				BREAKUP AND REGROUPING
				TOTAL	NEW BIRDS	ONE BIRD WAS ALONE, NOW IN GROUP	TOTAL	BIRDS MISSING	ONE BIRD OF GROUP SEEN	MEMBER CHANGED GROUP	
1968	Family	31	8(26)	4(13)	1(3)	3(10)	17(55)	8(26)	9(29)	0	2(6)
	Adult Pair	10	3(30)	2(20)	0	2(20)	5(50)	--	5(50)	0	0
	Juv. Group	0	--	--	--	--	--	--	--	--	--
1969	Family	52	7(13)	3(6)	1(2)	2(4)	36(69)	23(44)	12(23)	1(2)	6(12)
	Adult Pair	2	0	1(50)	0	1(50)	1(50)	--	1(50)	0	0
	Juv. Group	8	0	0	0	0	8(100)	1(13)	7(87)	0	0
TOTAL	Family	83	15(18)	7(8)	2(2)	5(6)	53(64)	31(37)	21(25)	1(1)	8(10)
	Adult Pair	12	3(25)	3(25)	0	3(25)	6(50)	--	6(50)	0	0
	Juv. Group	8	0	0	0	0	8(100)	1(13)	7(87)	0	0

APPENDIX A.12

GROUP STATUS IN THE UNITED STATES DURING FALL AND WINTER OF MARKED BLUE GEESE THAT HAD BEEN SEEN FOLLOWING BANDING DRIVES AT McCONNELL RIVER, N.W.T. IN 1968 AND 1969.

AGE	YEAR	TOTAL SEEN	IN SAME STATUS				REGROUPING		BREAKUP			CHANGED FAMILY
			IN FAM.	WITH MATE	WITH JUV.	ALONE	JOINED FAMILY	JOINED ADULT	LEFT FAM.	LEFT AD.	LEFT JUV.	
Adult	1968	51	23	6	--	2	5	2	6	7	--	0
	1969	75	48	0	--	1	7	1	16	1	--	1
	TOTAL	126	71	6	--	3	12	3	22*	8	--	1
Juv.	1968	42	30	--	0	1	2	--	9	--	0	0
	1969	88	48	--	2	2	4	--	24	--	8	0
	TOTAL	130	78	--	2	3	6	--	33**	--	8	0

* - 11 were with adults.

** - 7 were still with siblings.

APPENDIX A.13

GROUP STATUS OF NECK-COLLARED ADULT BLUE GEESE OBSERVED THREE OR MORE TIMES IN THE NORTHERN STATES (FALL) OR ON THE GULF COAST (WINTER). STATUSES ARE BASED ON ALL OBSERVATIONS. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	AREA	GROUP STATUS				
		TOTAL SEEN	IN FAMILY	IN ADULT PAIR	ALONE	STATUS UNDETER-MINED*
1967	N. States	62	32(52)	14(22)	16(25)	2
	G. Coast	5	3(60)	2(40)	0	0
1968	N. States	148	90(61)	38(26)	20(13)	9
	G. Coast	49	35(71)	8(16)	6(12)	0
1969	N. States	61	39(64)	10(16)	12(20)	0
	G. Coast	41	23(56)	10(24)	8(20)	2
TOTAL	N. States	271	161(59)	62(23)	48(18)	11
	G. Coast	95	61(64)	20(21)	14(15)	2

* - Not included in "Total Seen".

APPENDIX A.14

GROUP STATUS OF NECK-COLLARED JUVENILE BLUE GEESE OBSERVED THREE OR MORE TIMES IN THE NORTHERN STATES (FALL) OR ON THE GULF COAST (WINTER). STATUSES ARE BASED ON ALL OBSERVATIONS. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	AREA	TOTAL SEEN	GROUP STATUS			
			IN FAMILY	IN JUVENILE GROUP	ALONE	STATUS UNDETERMINED*
1967	N. States	69	42(61)	9(13)	18(26)	0
	G. Coast	4	4(100)	0	0	0
1968	N. States	145	126(87)	0	19(13)	3
	G. Coast	38	34(89)	0	4(11)	0
1969	N. States	69	52(75)	5(7)	12(18)	3
	G. Coast	29	19(66)	0	10(34)	0
TOTAL	N. States	283	220(78)	14(5)	49(17)	6
	G. Coast	71	57(80)	0	14(20)	0

* - Not included in "Total Seen".

APPENDIX A.15

PERCENTAGE OF NECK-BANDED BLUE GEESE REPORTED SHOT DURING THE FIRST YEAR FOLLOWING BANDING, 1967 1969.

YEAR	NUMBER BANDED		NUMBER RECOVERED		PERCENT RECOVERED		
	ADULT	JUV.	ADULT	JUV.	ADULT	JUV.	TOTAL
1967	1242	2568	95	269	8	10	9.6
1968	1614	1446	49	122	3	8	5.6
1969	1038	1525	60	202	6	13	10.2

Between Years (Totals):

1967 vs. 1968 : $X^2_1 = 31.93$, $P < 0.001$.

1967 vs. 1969 : $X^2_1 = 0.634$, $P > 0.10$.

1968 vs. 1969 : $X^2_1 = 35.99$, $P < 0.001$.

APPENDIX A.16

VARIABILITY IN GROUP COMPOSITION OF MARKED BLUE GOOSE FAMILIES OBSERVED ON THREE OR MORE OCCASIONS IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	AREA	FAM. SEEN	FAMILY ALWAYS INTACT	FAMILY NOT INTACT EACH SIGHTING					
				TOTAL	ADULTS MISSING	JUV. MISSING	AD. AND JUV. MISSING	JUV. WITH* DIFF. FAM.	EXTRA* BIRDS
1967	N. States	25	6(24)	19(76)	3(12)	8(32)	8(32)	0	0
	G. Coast	2	2(100)	0	--	--	--	--	--
1968	N. States	67	11(16)	56(84)	7(10)	15(22)	34(51)	3(4)	3(4)
	G. Coast	18	15(83)	3(17)	0	3(17)	0	0	0
1969	N. States	31	9(29)	22(71)	6(19)	5(16)	11(35)	1(3)	2(6)
	G. Coast	12	10(83)	2(17)	0	0	2(17)	0	0
TOTAL	N. States	123	26(21)	97(79)	16(13)	28(23)	53(43)	4(3)	5(4)
	G. Coast	32	27(84)	5(16)	0	3(10)	2(6)	0	0

* - These families were also seen with members missing and hence are recorded elsewhere in the table.

APPENDIX A.17

CONSTANCY OF FAMILY COMPOSITION IN THE NORTHERN STATES AND ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING. NUMBERS REFER TO TOTAL OBSERVATIONS OF MARKED FAMILIES SIGHTED ON THREE OR MORE OCCASIONS. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	AREA	TOTAL OBS.	FAMILY INTACT	FAMILY NOT INTACT					
				TOTAL	ADULTS MISSING	JUVENILES MISSING	AD. AND JUV. MISSING	EXTRA BIRDS	JUV. IN DIFF. FAM.
1967	N. States	117	72(62)	45(38)	15(13)	30(26)	0	0	0
	G. Coast	6	6(100)	0	--	--	--	--	--
1968	N. States	331	177(53)	154(47)	58(18)	76(23)	14(4)	3(1)	3(1)
	G. Coast	63	60(95)	3(5)	0	3(5)	0	0	0
1969	N. States	136	71(52)	66(46)	29(21)	29(21)	5(4)	2(1)	1(1)
	G. Coast	45	41(91)	4(9)	2(4)	0	2(4)	0	0
TOTAL									
	N. States	585	320(55)	265(45)	102(17)	135(23)	19(3)	5(1)	4(1)
	G. Coast	114	107(94)	7(6)	2(2)	3(3)	2(2)	0	0

APPENDIX A.18

VARIABILITY IN THE GROUP STATUS OF MARKED ADULT BLUE GEESE OBSERVED THREE OR MORE TIMES IN THE NORTHERN STATES AND ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING.

YEAR	AREA	ALL ADULTS			FAMILY ADULTS					PAIRED ADULTS				LONE ADULTS				STATUS
		TOTAL SEEN	SAME STATUS	CHANGED STATUS	TOTAL	IN FAM.	WITH ADULT	ALONE	ALL THREE STATES	TOTAL	IN PAIR	DIFF. ADULT	ALONE	TOTAL	ALONE	IN FAM.	WITH ADULT	UNKNOWN*
1967	N. States	62	40	22	32	20	2	10	0	14	4	0	10	16	16	0	0	2
	G. Coast	5	5	0	3	3	0	0	0	2	2	0	0	0	0	0	0	0
1968	N. States	148	67	81	90	41	4	38	7	38	10	1	27	20	16	0	4	6
	G. Coast	49	45	4	35	31	4	0	0	8	8	0	0	6	6	0	0	0
1969	N. States	61	30	31	39	19	3	14	3	10	0	0	0	12	11	0	1	0
	G. Coast	41	37	4	23	21	0	2	0	10	8	0	2	8	8	0	0	2
TOTAL																		
	N. States	271	137	134	161	80	9	62	10	62	14	1	47	48	43	0	5	8
	G. Coast	95	87	8	61	55	4	2	0	20	18	0	2	14	14	0	0	2

* - Not included under "All Adults".

APPENDIX A.19

VARIABILITY IN THE GROUP STATUS OF MARKED JUVENILE BLUE GEESE OBSERVED THREE OR MORE TIMES IN THE NORTHERN STATES AND ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING.

YEAR	AREA	ALL JUVENILES			FAMILY JUVENILES						JUVENILE GROUPS			LONE JUVENILES			
		TOTAL SEEN	SAME STATUS	CHANGED STATUS	TOTAL	IN FAM.	WITH JUV.	ALONE	ALL THREE STATES	CHANGED FAMILY	TOTAL	WITH JUV.	ALONE	TOTAL	ALONE	IN FAM.	WITH JUV.
1967	N. States	69	35	34	42	17	4	18	3	0	9	2	7	18	16	0	2
	G. Coast	4	4	0	4	4	0	0	0	0	0	0	0	0	0	0	0
1968	N. States	145	74	71	126	56	6	55	6	3	0	0	0	19	18	1	0
	G. Coast	38	34	4	34	30	0	4	0	0	0	0	0	4	4	0	0
1969	N. States	69	37	32	52	23	5	21	2	1	5	2	3	12	12	0	0
	G. Coast	29	28	1	19	18	0	1	0	0	0	0	0	10	10	0	0
TOTAL	N. States	283	146	137	220	96	15	94	11	4	14	4	10	49	46	1	2
	G. Coast	71	66	5	57	52	0	5	0	0	0	0	0	14	14	0	0

APPENDIX A.20

CONSTANCY IN THE GROUP STATUS OF MARKED ADULT BLUE GEESE IN THE NORTHERN STATES AND ON THE GULF COAST. NUMBERS ARE TOTAL SIGHTINGS OF INDIVIDUAL ADULTS SEEN AT LEAST THREE TIMES.

YEAR	AREA	ALL OBS. OF ADULTS			OBS. OF FAMILY ADULTS				OBS. OF PAIRED ADULTS				OBS. OF LONE ADULTS				
		TOTAL OBS.	CORRECT STATUS	INCORRECT STATUS	TOTAL OBS.	IN FAM.	WITH ADULT	ALONE	TOTAL OBS.	IN PAIR	ALONE	DIFF. ADULT	TOTAL OBS.	ALONE	IN FAM.	WITH ADULT	STATUS UNKNOWN*
1967	N. States	248	200	48	126	108	2	16	64	34	30	0	58	58	0	0	7
	G. Coast	15	15	0	9	9	0	0	6	6	0	0	0	0	0	0	0
1968	N. States	628	478	150	380	303	15	62	176	108	67	1	72	67	1	4	17
	G. Coast	165	161	4	123	119	4	0	24	24	0	0	18	18	0	0	0
1969	N. States	233	176	57	154	117	9	28	40	20	20	0	39	39	0	0	0
	G. Coast	146	142	4	79	77	0	2	32	30	2	0	35	35	0	0	7
TOTAL	N. States	1109	854	255	660	528	26	106	280	162	117	1	169	164	1	4	24
	G. Coast	326	318	8	211	205	4	2	62	60	2	0	53	53	0	0	7

* - Not included under "All Adults".

APPENDIX A.21

CONSTANCY IN THE GROUP STATUS OF JUVENILE BLUE GEESE IN THE NORTHERN STATES AND ON THE GULF COAST. NUMBERS ARE TOTAL SIGHTINGS OF INDIVIDUAL ADULTS SEEN AT LEAST THREE TIMES.

YEAR	AREA	ALL OBS. OF JUVENILES			OBS. OF FAMILY JUVENILES					JUVENILE GROUPS			LONE JUVENILES			
		TOTAL OBS.	CORRECT STATUS	INCORRECT STATUS	TOTAL OBS.	IN FAM.	WITH JUV.	ALONE	IN DIFF. FAMILY	TOTAL OBS.	WITH JUV.	ALONE	TOTAL OBS.	ALONE	IN FAM.	WITH JUV.
1967	N. States	274	226	48	174	136	6	32	0	34	25	9	66	65	0	1
	G. Coast	12	12	0	12	12	0	0	0	0	0	0	0	0	0	0
1968	N. States	560	448	112	488	380	15	90	3	0	0	0	72	68	4	0
	G. Coast	140	136	4	127	123	0	4	0	0	0	0	13	13	0	0
1969	N. States	238	189	49	184	138	10	35	1	12	9	3	42	42	0	0
	G. Coast	113	112	1	77	76	0	1	0	0	0	0	36	36	0	0
TOTAL	N. States	1072	863	209	846	654	31	157	4	46	34	12	180	175	4	1
	G. Coast	265	260	5	216	211	0	5	0	0	0	0	49	49	0	0

APPENDIX A.22

GROUP STATUS OF MARKED ADULT PAIRS OF BLUE GEESE NOT ACCOMPANIED BY JUVENILES, OBSERVED THREE OR MORE TIMES IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	AREA	TOTAL PAIRS	GROUP STATUS		
			PAIR INTACT	PAIR APART	1 AD. WITH DIFF. BIRD
1967	N. States	7	2(29)	5(71)	0
	G. Coast	1	1(100)	0	0
1968	N. States	19	5(26)	13(68)	1(5)
	G. Coast	4	4(100)	0	0
1969	N. States	5	0	5(100)	0
	G. Coast	5	4(80)	1(20)	0
TOTAL	N. States	31	7(23)	23(74)	1(3)
	G. Coast	10	9(90)	1(10)	0

APPENDIX A.23

GROUP STATUS OF MARKED ADULT PAIRS OF BLUE GEESE, ACCOMPANIED BY JUVENILES, OBSERVED THREE OR MORE TIMES IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	AREA	TOTAL PAIRS	GROUP STATUS	
			PAIR INTACT	PAIR APART
1967	N. States	11	6(55)	5(45)
	G. Coast	1	1(100)	0
1968	N. States	27	7(26)	20(74)
	G. Coast	16	16(100)	0
1969	N. States	15	7(47)	8(53)
	G. Coast	9	8(89)	1(11)
TOTAL	N. States	53	20(38)	33(62)
	G. Coast	26	25(96)	1(4)

APPENDIX A.24

CONSTANCY IN THE GROUP STATUS OF ADULT PAIRS OF BLUE GEESE NOT ACCOMPANIED BY JUVENILES IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING. NUMBERS REFER TO TOTAL OBSERVATIONS OF MARKED ADULT PAIRS SIGHTED ON THREE OR MORE OCCASIONS. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	AREA	TOTAL SIGHTINGS	GROUP STATUS		
			PAIR INTACT	PAIR APART	BIRD(S) WITH DIFFERENT AD.
1967	N. States	32	17(53)	15(47)	0
	G. Coast	3	3(100)	0	0
1968	N. States	88	54(61)	33(38)	1(1)
	G. Coast	12	12(100)	0	0
1969	N. States	20	10(50)	10(50)	0
	G. Coast	16	15(94)	1(6)	0
TOTAL	N. States	140	81(58)	58(41)	1(1)
	G. Coast	31	30(97	1(3)	0

APPENDIX A.25

CONSTANCY IN THE GROUP STATUS OF ADULT PAIRS OF BLUE GEESE ACCOMPANIED BY JUVENILES IN THE NORTHERN STATES OR ON THE GULF COAST DURING THE FALL AND WINTER FOLLOWING BANDING. NUMBERS REFER TO TOTAL OBSERVATIONS OF PAIRS SIGHTED ON THREE OR MORE OCCASIONS. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	AREA	TOTAL SIGHTINGS	GROUP STATUS	
			PAIR TOGETHER	PAIR NOT TOGETHER
1967	N. States	52	42(81)	10(19)
	G. Coast	3	3(100)	0
1968	N. States	135	92(68)	43(32)
	G. Coast	59	59(100)	0
1969	N. States	65	47(72)	18(28)
	G. Coast	35	33(94)	2(6)
TOTAL	N. States	252	181(72)	71(28)
	G. Coast	97	95(98)	2(2)

APPENDIX A. 26

CHANGES IN COMPOSITION OF BLUE GOOSE FAMILIES SEEN BOTH IN THE NORTHERN STATES AND ON THE GULF COAST IN THE SAME YEAR. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	GROUPING	TOTAL	FAMILY SAME	FAMILY DIFFERENT				
				TOTAL	BIRDS MISSING	NEW BIRDS	MISSING AND NEW	MEMBERS APART
1967	Family	2	1(50)	1(50)	1	0	0	0
	1 Member of Family	2	--	2(100)	2	0	0	0
1968	Family	18	12(66)	6(33)	4	1	1	0
	1 Member of Family	12	--	12(100)	10	1	0	1
1969	Family	20	12(60)	8(40)	4	3	1	0
	1 Member of Family	18	--	18(100)	17	1	0	0
TOTAL	Family	40	25(62)	16(38)	9(22)	4(10)	2(5)	0
	1 Member of Family	32	--	32(100)	29(91)	2(6)	0	1(3)

APPENDIX A.27

CHANGES IN THE GROUP STATUS OF ADULT BLUE GEESE ON THE GULF COAST FROM FAMILIES SEEN IN THE NORTHERN STATES AND ON THE GULF COAST IN THE SAME YEAR. NUMBERS IN PARENTHESES ARE PERCENTAGES.

		STATUS SAME	STATUS CHANGED						
				BREAKUP OCCURRED			REGROUPING OCCURRED		
YEAR	TOTAL	STILL IN FAMILY	TOTAL	TOTAL	NOW ALONE	NOW ABSENT	TOTAL	PREV. ALONE	PREV. NOT SEEN
1967	6	4(67)	2(33)	2(33)	0	2	0	0	0
1968	56	35(62)	21(38)	18(32)	7	11	3(5)	1	2
1969	62	35(56)	27(44)	23(37)	8	15	4(6)	1	3
TOTAL	124	74(60)	50(40)	43(35)	15(12)	28(23)	7(6)	2(2)	5(4)

APPENDIX A.28

CHANGES IN THE GROUP STATUS OF JUVENILE BLUE GEEST ON THE GULF COAST FROM FAMILIES SEEN IN THE NORTHERN STATES AND ON THE GULF COAST IN THE SAME YEAR. NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	TOTAL	STATUS SAME	STATUS CHANGED						
				BREAKUP OCCURRED			REGROUPING OCCURRED		
		STILL IN FAMILY	TOTAL	TOTAL	NOW ALONE	NOW ABSENT	TOTAL	PREV. ALONE	PREV. NOT SEEN
1967	10	4(40)	6(60)	6(60)	2	4	0	0	0
1968	53	26(49)	27(51)	24(45)	5	16	3(6)	1	2
1969	66	24(36)	42(64)	37(56)	8	29	5(8)	1	4
TOTAL	129	54(42)	75(58)	67(52)	15(12)	52(40)	8(6)	2(2)	6(4)

APPENDIX A.29

CHANGES IN COMPOSITION OF BLUE GOOSE FAMILIES SEEN DURING SPRING MIGRATION THAT WERE PREVIOUSLY SIGHTED IN FALL (NORTHERN STATES) OR WINTER (GULF COAST). NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	WHERE PREVIOUSLY SEEN	TOTAL FAMILIES	COMPOSITION OF FAMILY		
			FAMILY SAME	PART OF FAMILY TOGETHER	1 MEMBER OF FAMILY SEEN
1969	N. States	7	1	1	5
	G. Coast	4	4	0	0
1970	N. States	10	1	3	6
	G. Coast	10	6	2	2
TOTAL	N. States	17	2(12)	4(24)	11(65)
	G. Coast	14	10(71)	2(14)	2(14)

APPENDIX A. 30

GROUP STATUS OF ADULT BLUE GEESE IN SPRING THAT WERE SEEN PREVIOUSLY IN FALL (NORTHERN STATES) OR WINTER (GULF COAST). NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR	LAST SEEN	TOTAL SEEN	STATUS SAME				STATUS CHANGED					ABSENT FROM FAMILY	IS NEW BIRD IN FAM.
			TOTAL	IN FAM.	WITH ADULT	ALONE	TOTAL	WAS IN FAM. WITH ADULT	WAS IN FAM. ALONE	WAS ALONE IN FAM.	WAS ALONE WITH ADULT		
1969	Fall	6	4	2	2	0	2	2	0	0	0	8	0
	Winter	16	15	7	8	0	1	0	0	0	1	0	0
1970	Fall	17	10	4	2	4	7	2	3	2	0	9	0
	Winter	25	20	11	4	5	5	2	1	0	2	1	1
TOTAL													
	Fall	23	14(61)	6(26)	4(17)	4(17)	9(39)	4(17)	3(13)	2(9)	0	17	0
	Winter	41	35(85)	18(44)	12(29)	5(12)	6(15)	2(5)	1(2)	0	3(7)	1	1

APPENDIX A.31

GROUP STATUS OF JUVENILE BLUE GEESE IN SPRING THAT WERE SEEN PREVIOUSLY IN FALL (NORTHERN STATES) AND WINTER (GULF COAST). NUMBERS IN PARENTHESES ARE PERCENTAGES.

YEAR WHEN LAST SEEN	TOTAL SEEN	STATUS SAME				STATUS CHANGED				NOW MISSING FROM FAM.
		TOTAL	IN FAM.	WITH JUV.	ALONE	TOTAL	WAS IN FAMILY ALONE	WAS WITH JUVENILE ALONE	CHANGED FAMILY	
1969 Fall	7	2	2	0	0	5	5	0	0	8
Winter	10	10	7	0	3	0	0	0	0	0
1970 Fall	17	12	4	0	8	5	3	1	1	12
Winter	34	33	12	4	17	1	1	0	0	3
TOTAL										
Fall	24	14(58)	6(25)	0	8(33)	10(42)	8(33)	1(4)	1(4)	20
Winter	44	43(98)	19(43)	4(9)	20(45)	1(2)	1(2)	0	0	3

APPENDIX A. 32

GROUP STATUS OF ADULT AND JUVENILE BLUE GEESE IN THE NEST INITIATION PERIOD AT THE McCONNELL RIVER THAT WERE SEEN PREVIOUSLY IN WINTER OR SPRING. INDIVIDUALS FROM FAMILIES THAT HAD DISINTEGRATED BECAUSE ADULTS WERE ALREADY NESTING ARE EXCLUDED.

AGE	YEAR	TOTAL SEEN	GROUP STATUS				
			WITH FAMILY	ALONE	WITH SIBLING	ABSENT FROM FAMILY*	IS NEW BIRD IN FAMILY*
ADULT	1968	6	6	0	--	0	1
	1969	12	12	0	--	0	0
	1970	22	20	2	--	1	0
	TOTAL	40	38	2	--	1	1
JUV.	1968	8	8	0	0	1	0
	1969	18	12	0	6	2	0
	1970	31	17	7	7	7	0
	TOTAL	57	37	7	13	10	0

* - Not included in "Total Seen".

APPENDIX A.33

ADJUSTED TOTALS FOR MALE AND FEMALE BLUE GEESE IN BREEDING AND NONBREEDING CATEGORIES AT THE McCONNELL RIVER, N.W.T. FIGURES WERE OBTAINED BY APPLYING THE OBSERVED SEX RATIOS FOR THESE CATEGORIES TO THE TOTAL NUMBER OF GEESE OBSERVED (FROM TABLE 20).

AGE	OBSERVED									ADJUSTED			
	TOTAL SEEN			BREEDING			NONBREEDING			BREEDING		NONBREEDING	
	TOTAL	♀	♂	TOTAL	♀	♂	TOTAL	♀	♂	♀	♂	♀	♂
2	162	64	18	36	25	4	126	39	14	31	5	93	33
3	71	37	9	33	26	4	38	11	5	29	4	26	12
4	19	13	2	17	12	2	2	1	0	15	2	2	0

APPENDIX A.34

FREQUENCIES (PER THOUSAND UNMARKED GEESE) OF NECK BAND CLASSES REPRESENTING DIFFERENT AGES FROM COUNTS OF BLUE GEESE IN THE UNITED STATES AND AT THE McCONNELL RIVER, N.W.T.

YEAR	AREA	AGE 1	2	3	4	ADULT	UNMARKED GEESE COUNTED
1969	United States	1.1516	0.6497	0.3236	--	2.3806	134,161
	McConnell R.	1.0916	0.5084	0.4273	--	4.9904	32,062
1970	United States	0.5024	0.2620	0.2658	0.1799	1.7919	278,638
	McConnell R.	1.0065	0.8147	0.3055	0.3695	7.1896	34,369

APPENDIX A.35

ERRORS IN ESTIMATES OF PRODUCTIVITY PARAMETERS FROM AVERAGE GROUP COUNTS DUE TO DAY TO DAY BEHAVIORAL INCONSISTENCIES[a] AND TO MISCLASSIFICATIONS DURING COUNTS[b].

AREA	CATEGORY	DUE TO BEHAVIORAL INCONSISTENCIES			ERRORS DURING GROUP COUNTS					
					LANDING GEESE			AT TAKE-OFF		
		No.	% IN FAM.	% NOT IN FAM.	No.	% IN FAM.	% NOT IN FAM.	No.	% IN FAM.	% NOT IN FAM.
N. States	Family Juv.	890	74	26	36	100	0	63	98	2
	Non-Fam. Juv.	226	2	98	9	0	100	18	33	67
	Fam. Ad. Plum.	727	73	27	26	100	0	58	95	5
	N-Fam. Ad. Plum.	448	1	99	26	8	92	65	3	97
G. Coast	Family Juv.	218	97	3	19	100	0	35	94	6
	Non-Fam. Juv.	49	0	100	4	0	100	9	0	100
	Fam. Ad. Plum.	213	96	4	18	100	0	31	94	6
	N-Fam. Ad. Plum.	115	0	100	15	7	93	28	0	100

a - From data tabulated for Table 6.

b - From data tabulated for Table 24.

APPENDIX B

SAMPLE FAMILY HISTORIES

5.A. SAMPLE FAMILY HISTORY SHOWING TEMPORARY DISUNITY (BREAK-UP AND REGROUPING). THIS FAMILY ALSO SHOWS THE CONTRAST BETWEEN GULF COAST AND NORTHERN STATES IN CONSISTENCY OF ASSOCIATION.

		SAND LAKE				EAST TEXAS			
		OCT.				FEB.	MAR.		
		11	12	13	27	4	7	8	10
Adult	↑4	+	*	+ - -	+	+	+	+	+
Adult	⊓L	+	-	+ * +	+	+	+	+	+
Juv.	Iλ	+	-	+ - +	+	+	+	+	+
Juv.	λ⌊	*	-	+ - +	-	+	+	+	+

5.B. SAMPLE FAMILY HISTORY WHERE ONE MEMBER DISAPPEARED PERMANENTLY.

		McC. R.		SAND L.		SQUAW CR.		RICE PRAIRIES					SQ.CR.
		AUG.		OCT.		DEC.		FEB.					MAR.
		14	16	22	24	6	9	14	16	17	19	26	21
Adult	N⌋	+	+	+	-	+	+	+	+	+	+	+	+
Ad. (unmarked)		+	+	+	-	+	+	+	+	+	+	+	+
Juvenile	C△	+	+	+	*	+	+	+	+	+	+	+	+
Juvenile	Z⌊	+	+	+	-	+	+	+	+	+	+	+	+
Juvenile	△λ	+	+	+	-	-	-	-	-	-	-	-	-

5.C. SAMPLE HISTORY WHERE ALL BUT ONE MEMBER DISAPPEARED PERMANENTLY.

		SAND LAKE		SQUAW CREEK
		OCT. 11	NOV. 16	DEC. 7
Adult	⊤N	+	*	*
Adult	=K	+	-	-
Juv.	YC	+	-	-

LEGEND: + = with other geese; * = alone: - = not seen.