Social Organization in a Flock of Resident Canada Geese

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Abstract: Visual observations of marked individuals in a resident flock of Canada geese (*Branta canadensis*) on the Eufaula National Wildlife Refuge, Alabama-Georgia, were conducted from July 1980 through May 1982. Associations among geese were examined during 2 periods (breeding, February–May; and nonbreeding, June–January). Social groupings were determined for 231 geese in 1980–81 and 240 in 1981–82 based on 4,577 observations during the breeding season and 666 observations during the nonbreeding season. Adult pairs that nested successfully remained with their young-of-the-year throughout the nonbreeding season and composed families; and pairs that did not nest successfully usually joined pseudofamilies, social groups of adult and yearling geese. Pseudofamilies were the predominant social units (80%) in the flock. All social units except yearling groups dissociated during the breeding season, and most pairs established nesting territories or dispersed from the area. The landing group count method is inappropriate to estimate productivity for goose flocks with a large percentage of pseudofamilies.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 43:362–371

Resident populations of Canada geese have been established throughout the United States and Canada (Dill and Lee 1970, Oberhou 1973, Chabreck et al. 1974) and provide hunting and viewing opportunities where migratory geese are uncommon, but they are considered nuisances in some locations because of a crop depredation and fecal accumulation (Conover and Chasko 1985). Management of resident goose flocks will be improved through a better knowledge of their ecology. Social biology of migratory geese has been studied extensively (Hanson 1953; Raveling 1969, 1970; Prevett and MacInnes 1980), but few comparable studies of resident flocks have been conducted (Hubbard 1976).

Understanding the social biology of geese has helped to manage migratory

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populations. For example, structure of social systems can affect distribution patterns, which in turn can influence harvest and survival rates (Raveling 1979, Zicus 1981). Average group counts also have been used to estimate annual productivity by assuming that small groups are family units (Raveling 1968). Comparable management techniques on resident flocks are inappropriate without knowledge of the flock's social structure. This study was designed to gather information on social structure and compare social biology of resident and migratory geese.

Special thanks are extended to J. E. Kennamer for guidance during the study and E. E. Crumpton and J. B. Ortego who helped in all phases of the project. I also appreciate the effort of all individuals who helped band geese. Personnel of ENWR provided equipment and assistance throughout the study. G. A. Baldassarre, P. W. Brown, R. D. Drobney, L. H. Fredrickson, D. A. Graber, N. R. Holler, D. D. Humburg, R. S. Lishak, R. E. Mirarchi, W. M. Shields, H. L. Stribling, and R. J. Warren provided valuable comments on drafts of the manuscript. This project was funded through the Alabama Agricultural Experiment Station of Auburn University, Project No. 13-0033, and is published as Alabama Agricultural Experiment Station Journal Series 15-881792p.

Study Area and Flock Description

The 4,500-ha Eufaula National Wildlife Refuge (ENWR) is located on the upper portion of the Walter F. George Reservoir on the Chattahoochee River, 10 km north of Eufaula, Alabama, and 70 km south of Columbus, Georgia. Impoundments total 200 ha and are managed for waterfowl by flooding wetland plants and agricultural crops. Water levels of other wetland habitats on ENWR are influenced by rainfall and drainage patterns and vary approximately 1 m during the year, exposing up to 3,200 ha of mudflats and habitats covered by shallow water during low river stages. Geese feed on sprouting vegetation in these habitats and loaf in these same areas throughout the day. Agricultural crops were grown on 400 ha of the upland portion of ENWR during the study, and winter wheat and other vegetation provided browse for geese following early morning feeding flights. Beaver ponds, pastures, and riparian woodlands comprise the remaining 700 ha on ENWR.

Canada geese, mostly the *B. c. maxima* subspecies, were introduced to ENWR between 1965 and 1971. Slightly more than 100 geese remained to breed, and nesting was first detected in 1968 (Johnson and Kennamer 1976). The flock consisted of approximately 500 geese in 1980–1982. Lack of large numbers of unmarked geese at ENWR during the study suggested that few migratory geese were present.

Methods

Molting and immature Canada geese were captured at ENWR during the summers of 1980 and 1981 by drive-trapping (Cooch 1953) and were sexed and aged by cloacal examination (Hanson 1967). Geese were marked with different combinations of 15 mm-wide, colored leg bands to enable individual recognition.

Systematic searches were conducted approximately once/week throughout the year, and individual geese were identified by using a 55-X spotting scope.

Attempts to identify and count every marked individual were made during each observation period, but some individuals were not identified in most groups >50 birds. The number of unmarked geese also was recorded and subtracted from total groups counts to estimate the number of geese that were marked but not identified. Social units within larger groups were identified by unity in preflight and flight behavior, consistent movements in swimming and walking, acceptance or tolerance of other geese in the group, joining a group in aggressive display, and spatial isolation from other units (see Raveling 1969).

Geese in their first year were called immatures, geese in their second year were referred to as yearlings, and geese ≥2 years old were called adults (Raveling 1969). Families were adult pairs with their young-of-the-year, whereas pseudofamilies were units of ≥3 adult or yearling geese that exhibited the same identifying characteristics as family units (Lebret 1956). Lone pairs were mated pairs that did not belong to a family or pseudofamily. Social unit was used as a collective term to include families, pseudofamilies, pairs, and solitary geese; whereas group referred to an aggregation of geese, not necessarily implying social bonds between members.

Social units were considered present during an observation period only if ≥50% of all constituent members were identified. If <50% of the social unit was identified, individual geese were recorded as separate from their social unit. Unidentified members referred to social unit members that were not identified during sightings of their social unit but may have been present because some geese in the group were not identified. Missing members were individuals that were not present during sightings when all geese in the group were identified. Breeding and nonbreeding seasons referred to February–May and June–January, respectively; but some observations of individual social units during February or May were considered nonbreeding observations because of differences in timing of individual social unit breakup or establishment.

Mann-Whitney U tests determined differences in mean size of Canada goose social units, as well as date of social unit breakup. Cohesion of social units during the nonbreeding period was tested by comparing the number of unidentified members to expected numbers (based on percent unidentified geese in total group counts) using Goodness-of-fit tests. Goodness-of-fit tests also were used to test occurrence of different social units in groups in which all geese were identified and differences in nesting rates and nest success rates between family and pseudofamily members. An alpha level of $P < 0.10$ was used in all statistical tests.

Results

Nonbreeding Season (June–January) Associations

Social class was determined for 233 of 257 marked geese in 1980–81 and 242 of 378 in 1982–82 (Table 1). Social class of other marked individuals could not be determined because of insufficient observations. Thirty-eight unmarked geese in

Table 1. Number of marked, resident Canada geese belonging to different social units and number of different social units identified a Eufaula National Wildlife Refuge during the nonbreeding season (June–January) 1980–81 and 1981–82.

	Individual geese		Social units	
Social unit	1980–81	1981–82	1980–81	1981–82
Families	40	31	9	9
Pseudofamilies	179	199	36	34
Pairs	8	6	4	3
Solitary geese	4	4	4	4
Undetermined	24	136		
Total	225	376	53	50

1980–81 and 22 in 1981–82 were considered members of social units because of frequent associations between marked and unmarked geese in small groups in which all individuals were identified or determined as unmarked. Marked geese were seldom observed away from their social units during the nonbreeding season (family members: 2.0% of 1,067 observations; pseudofamily members: 5.7% of 3,341 observations). Most of these observations were probably misidentifications of color combinations or observations in which a small percentage of total geese were identified; hence, most of the social unit may have been present, but not observed.

Social units disbanded during late winter when individual pairs separated from other geese and established and defended nesting territories. Pair bonds between previously unpaired geese also were formed during this period (Combs 1982). Old units reformed or new units were established following the breeding season.

Social Unit Descriptions

Average family and pseudofamily size did not differ between years, but families were usually smaller ($\bar{x} = 4.7$) than pseudofamilies ($\bar{x} = 6.1$) ($P = 0.01$). Age (i.e., adult or yearling) could not be determined for 51 marked geese of known social class during 1980–81 and 36 geese during 1981–82, but 25 of 30 pseudofamilies (83%) in which age was known for all members consisted entirely of adults. Only 17% of all pseudofamilies contained geese that were known to be yearlings, and only 1 pseudofamily consisted entirely of yearlings. Only 1 pseudofamily (a family of 4 plus 4 other adult or yearling geese) contained immatures. Pseudofamilies consisted primarily of paired geese. Pair status of 119 of 425 pseudofamily members was unknown, but 80% of the remaining 306 were paired.

Nonbreeding Social Unit Cohesion

Members of pseudofamilies were missing or unidentified more often than family members during the nonbreeding period ($P < 0.005$) (Table 2), suggesting that social bonds between family members were stronger than bonds within pseudofamilies. Number of missing pseudofamily members ranged from 1 to 5 ($\bar{x} = 1.8$), and 24

Table 2. Observations (%) of social units of resident Canada geese at Eufaula National Wildlife Refuge during the nonbreeding season (June –January), 1980–81 and 1981–82.

Observations	1980–81			1981–82		
	Families (N = 157)	Pseudo-families (N = 358)	Pairs (N = 38)	Families (N = 70)	Pseudo-families (N = 301)	Pairs (N = 20)
All members identified	83.4	56.1	65.8	80.0	52.2	95.0
Some missing members	1.3	8.4	0.0	0.0	9.3	0.0
Some unidentified members	14.6	34.4	34.2	20.0	36.9	5.0
Some missing and unidentified members	0.6	1.1	0.0	0.0	1.7	0.0

different geese were absent on more than 1 occasion. Twenty-one observations when pseudofamily members were missing occurred early or late in the season (i.e., first or last observations of that social unit) and probably represented geese that had not joined the social unit or had severed bonds with other members in preparation for breeding. Families occurred more often in groups in which all geese were identified (53.7%) than pseudofamilies (38.4%) ($P < 0.005$), indicating that ease in observation also influenced differences in number of unidentified or missing family and pseudofamily members. Number of unidentified members differed from expected frequencies derived from total group counts in only 2 of 70 pseudofamilies and no families or lone pairs, suggesting that many unidentified geese were present but not observed. Number of unidentified and missing family members did not differ from those of lone pairs (Table 2).

Families and pseudofamilies disbanded during late winter. Breakup of pseudofamilies occurred earlier ($\bar{x}$ date of last intact sighting = 8 January in 1980–81 and 22 December in 1981–82) than family breakup ($\bar{x}$ date of last intact sighting = 15 February in 1980–81 and 2 February in 1981–82) ($P < 0.005$). Pseudofamily breakup occurred earlier during 1981–82 than during 1980–81 ($P = 0.022$), but date of family breakup did not differ between years.

Breeding Season (February—May) Associations

Pairs of adult geese seldom associated with other members of their social units during the breeding season (Table 3), and groups consisting of members from the same social unit were usually small. Geese were observed in groups with 3 or more pairs from the same pseudofamily on only 6 occasions during the breeding season. Adult pairs from families were observed with their young-of-the-previous-year on only 3 occasions. Yearlings generally remained with their siblings following family breakup (Table 3) and often formed yearling groups that persisted throughout the breeding season. One male and 5 female yearlings (16% of 37 marked yearlings) paired during late winter and were observed 21 times with their new mates, separate from their siblings.

Table 3. Observations (%) of resident Canada geese away from their nesting territories at Eufaula National Wildlife Refuge during the breeding season (February–May), 1981 and 1982.

	1981			1982		
Observations	Pseudo-family members (N = 391)	Family adults (N = 19)	Family yearlings (N = 122)	Pseudo-family members (N = 115)	Family adults (N = 4)	Family yearlings (N = 15)
Alone	6.4	5.3	4.9	1.7	0.0	6.7
With mate	70.8	73.7	11.5	77.4	50.0	46.7
With other members of social unit	22.8	21.1	83.6	20.9	50.0	46.7

Family members nested more often ($P < 0.005$) and were more successful ($P < 0.005$) than pseudofamily members during 1981 (Table 4). Nest success rates did not differ between family and pseudofamily geese in 1982, but a smaller percentage of pseudofamily members nested than family members ($P < 0.005$) (Table 4). Other geese from families and pseudofamilies undoubtedly nested because nesting pairs were not identified for 21 of 74 nests found during 1981 and 2 of 56 during 1982, but 87% of these nests were unsuccessful.

Cohesion Between Years

Geese that did not nest successfully generally joined or rejoined pseudofamilies, whereas successful nesters remained apart with their families. Of 174 geese that were members of pseudofamilies during 1980–81 with sufficient observations to determine social class during 1981–82, 82.8% belonged to the same pseudofamily during both years. Nine geese identified as pseudofamily members during 1980–81 nested successfully during spring 1981, and only 1 of these pairs rejoined its former pseudofamily. Ten of 18 geese that changed pseudofamilies between years did so after pairing with a new mate during spring 1981. Six of these 10 joined their new mate's pseudofamily, and 4 joined pseudofamilies of which neither was a member.

Table 4. Number of nests and broods of resident Canada goose family and pseudofamily members nesting at Eufaula National Wildlife Refuge during 1981 and 1982.

	1981		1982	
Nest classification	Family members	Pseudofamily members	Family members	Pseudofamily members
Total nests found	5	33	5	32
Successful nests found	4	5	4	22
Broods found[a]	2	0	1	3

[a]Includes only broods from nests that were not found.

Four pairs nested successfully and were members of families during both 1980–81 and 1981–82. Adults from the remaining 1980–81 families did not nest successfully during spring 1981, but the 1981–82 social class was determined for only 4 of these geese. Three were members of pseudofamilies, and 1 was a member of a lone pair. Fourteen of 15 yearlings from 1980–81 families for which social class was determined belonged to pseudofamilies during 1981–82, and none associated with their parents during the nonbreeding season.

Discussion

Unlike the social structure in migratory geese (Raveling 1969, 1970), pseudofamilies were the predominant social units in the resident Canada goose flock at ENWR during the nonbreeding period. Although pseudofamilies have been determined in previous studies of several species of geese, most researchers have concluded that pseudofamilies consist of yearlings that have rejoined their parents or remained in sibling groups (Boyd 1959, Raveling 1969, Prevett and MacInnes 1980). Yearlings did not rejoin their parents in my study but usually remained with siblings or unrelated geese for a full year following family breakup. Most pseudofamilies consisted of pairs of adult geese. Few lone pairs were present during the nonbreeding season at ENWR, but pairs are considered the predominant social unit among unsuccessful nesting geese in migratory flocks (Raveling 1969).

Year-round association of individual geese; greater familiarity with feeding, roosting, and nesting locations; low productivity of the flock; genetic relationships among individuals; and lack of hunting pressure may have contributed to differences between the social structure of resident geese at ENWR and migratory flocks. Social contact among individual members is necessary in the establishment and maintenance of a dominance hierarchy as exhibited by migratory geese (Raveling 1969, 1979), and social contact is enhanced in resident geese because of year-round association and use of traditional feeding and roosting locations. Low productivity promotes the maintenance of a small, stable flock and facilitates contact among individuals by reducing the chance of separation of social unit members in large feeding or roosting aggregations, as well as decreasing the number of individuals in the flock that need to be recognized. Most resident goose flocks were established by releasing a few individuals, and genetic similarity and inbreeding may enhance establishment of social bonds between distantly related, non-paired individuals (D. G. Raveling, pers. commun.). Hunting is a recent selective pressure that disrupts social bonds among individuals (Hanson and Smith 1950, Raveling 1979, Prevett and MacInnes 1980); but Canada geese were protected in a 4-county area surrounding ENWR, eliminating this disruptive force and possibly enhancing the formation of social bonds.

Families are considered the dominant social units in migratory goose flocks; and dominance relationships between families are dependent on family size, with large families being dominant over smaller ones (Raveling 1970). Dominance relationships were not determined in my study, but unsuccessful nesting geese at ENWR

may form pseudofamilies to enhance their dominance rank in the flock. Families may be dominant over pseudofamilies, however, as indicated by the failure of geese to rejoin their pseudofamily after nesting successfully, greater cohesion among family members, and higher number of nesting attempts and increased success rates by family geese. Additional research is needed to test the role of pseudofamilies in dominance hierarchies.

The only social bonds apparent during the breeding season were yearling and pair bonds. Most adult pairs established and defended nesting territories. However, only a small percentage actually nested, probably because successful nest sites were limited at ENWR (Combs et al. 1984). Membership in a pseudofamily may confer advantages in obtaining preferred nesting territories. Pairs from the same pseudofamily, however, seldom associated during the breeding season and did not mutually defend nest sites; thus, if such an advantage occurs, it is conferred earlier in the year.

Most geese rejoined their pseudofamilies following the breeding season unless they nested successfully or remated with a member from a different social unit. Thus, pseudofamilies appear to be social units consisting of long-term associations between non-reproductive geese. Reformation of pseudofamilies occurred during June, and most pseudofamily members were together during trapping operations. Aggregations of molting geese probably facilitate social bonding by bringing together pairs of the same pseudofamilies that did not associate during the breeding season.

Management Implications

Differences in social structure between resident geese at ENWR and migratory geese demonstrate the plasticity of Canada goose social behavior. Several factors probably influence social bonding, and other resident flocks exposed to different factors (e.g., hunting or high productivity) may vary from the structure of the ENWR flock. For example, families were considered more stable than "unrelated subgroups" in a recently formed resident flock in Tennessee (Hubbard 1976). Goose social behavior and dominance relationships influence the fitness of individual geese (Raveling 1969, 1970); and the plasticity of social behavior should be considered in reviewing management options, setting hunting regulations, and establishing new flocks.

Disturbance, caused by hunting and dispersal techniques, disrupts social bonds and may increase mortality of migratory geese (Bartelt 1987). Closure of goose hunting at ENWR probably contributed to the social structure. Hunting the population in the future may modify the social system (e.g., disrupting pseudofamilies). The relationship between such modification and future productivity is not clear and warrants additional research. Non-nesting pseudofamily members may serve as a source of potential breeders if nesting geese are killed, but the role of pseudofamilies in maintaining limited nest sites and productivity is unknown. Resident goose flocks provide unique opportunities to design meaningful experiments investigating the relationships among harvest rates, social structure, and productivity because hunting

can be controlled; and changes in flock productivity following the loss of individually marked geese can be assessed.

Landing group counts have been proposed as a method to assess annual productivity of Canada geese (Raveling 1968, Raveling and Lumsden 1977) but is an unreliable technique during the hunting season because of disruption of social bonds (Raveling and Lumsden 1977, Bartelt 1987). The large number of pseudofamilies present in my study also negates the usefulness of the techniques at ENWR. Although pairs separate from other geese before landing in migratory flocks (Raveling 1968), pseudofamily members landed together in my study and were indistinguishable from families. Thereto, estimates of productivity of resident goose flocks at ENWR and other locations with similar social conditions should be conducted during summer while goslings are still distinguishable from adults.

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