

REPRODUCTIVE SUCCESS OF THE RESIDENT CANADA GOOSE FLOCK AT THE EUFAULA NATIONAL WILDLIFE REFUGE

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ABSTRACT

During 1975 and 1976, a total of 75 Canada goose (Branta canadensis) nests were located in the Eufaula area. Of all nesting attempts found, 41 percent in 1975 and 51 percent in 1976 hatched at least one gosling. Nest mortality was due mainly to high water levels with predation, human interference, and competition for nesting territories also contributing. Minimum number of goslings raised per successful nest was 1.5 in 1975 and 2.9 in 1976. At least 81 goslings were raised to flight stage during these two nesting seasons. The flock at Eufaula has expanded by more than 200 percent since 1969.

Eufaula National Wildlife Refuge is one of five national wildlife refuges in the southeastern United States with established resident flocks of Canada geese (Oberheu 1973). Several southeastern states also have established flocks on state-owned or private land in addition to those of federal refuges (Chabreck et al. 1974, Gore and Barstow 1969).

Alabama wintered scattered small flocks of Canada geese during the years previous to the establishment of Wheeler National Wildlife Refuge in 1938 (Hankla and Rudolph 1967). Howell (1928) reported small flocks of 40 or more wintering in the Tennessee Valley region of north Alabama prior to 1928. He also reported them to be "numerous" every winter in the vicinity of Montgomery in central Alabama. Small flocks of geese were wintering on reservoirs of north and east-central Alabama during the period between 1929 and 1944 (Hankla and Rudolph 1967). With the construction of Wheeler Refuge, a major buildup of wintering geese occurred in north Alabama (Ibid. 1967). During this same period, numbers of Canada geese wintering in central and southern Alabama and along the Alabama and Florida coasts decreased, and recoveries of geese banded in Florida practically disappeared from the Mississippi flyway (Addy and Heyland 1968).

In response to the changes in migratory habits of Canada geese which occurred throughout the Southeast, a major Canada goose transplant program was initiated in 1953 and lasted through 1965. The objective was to re-establish Canada geese in the abandoned southeastern wintering areas. During this period, approximately 20,734 Canada geese were transplanted to nine national wildlife refuges in four southeastern states (Hankla 1968). In December 1965 and January and February 1966, 104 wing-clipped migratory sub-adult Canada geese were transferred from Wheeler Refuge to Eufaula Refuge as part of this program. In June 1966 a number of goslings were received at Eufaula from Brigantine National Wildlife Refuge, New Jersey. Transplants to Eufaula consisting of wing-clipped or pinioned non-migratory adult geese and goslings continued through March 1971. A total of 257 Canada geese survived transportation to be released on the refuge from December 1965 through March 1971 (Table 1).

In January 1975, a two-year study was initiated by personnel of the Agricultural Experiment Station at Auburn University to determine the reproductive success and population status of the Canada goose flock at Eufaula.

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Table 1. History of Canada goose transplants to Eufaula National Wildlife Refuge.

Origin	Age at Release	Month and Year of Release	Total Number Transplanted	Known Mortality	Est. Number Remaining to Breed	Probable Breeding Year
Wheeler NWR, Ala.	Sub-adults	Dec., 1965	28	—	0 ^a	1968
Wheeler NWR, Ala.	Sub-adults	Jan., 1966	46	—	0 ^a	1968
Wheeler NWR, Ala.	Sub-adults	Feb., 1966	30	—	0 ^a	1968
Brigantine NWR, N.J.	Goslings	Jun., 1966	78	37	41	1969
Harris Neck NWR, Ga.	Adults (4) and Goslings (8)	Jun., 1967	12 ^c	—	12	1968 (Ads.) 1970 (Gos.)
Private breeders in N. Central states	Adults (2) and Sub-adults (11)	Nov., 1967	14	1	13	1968 (Ad.) 1969 (Sub.)
Harris Neck NWR, Ga.	Adults	May, 1969	10 ^b	—	10	1970
Private breeders in Boligee, Ala.	Adults and Sub-adults	Jun., 1969	38	—	38	1970 (Ad.) 1971 (Sub.)
Private breeders in Minnesota	Adults	Mar., 1971	2	—	2	1972
TOTAL NUMBERS			258	38	116	

^aThree of these adults came from a private breeder in Swanquarter, N.C. originally.

^bBirds raised locally at Harris Neck from "Brigantine stock."

^cMortality which occurred prior to their first breeding season at Eufaula.

^dPossibly a small percentage remained as residents.

^eProbable breeding represents the first breeding season at Eufaula in which each group of geese were three years old or older.

as numerous persons in the Eufaula area and in Georgia who were interested enough in the goose flock to allow the researchers access to their land. We also wish to thank the personnel of the Alabama State Pathology Laboratory at Auburn University for making their facilities and expertise available.

MATERIALS AND METHODS

Study Area

The study area included Eufaula National Wildlife Refuge and the surrounding areas of Alabama and Georgia. Eufaula National Wildlife Refuge encompasses approximately 4518 hectares, of which 3210 hectares are in Alabama and 1308 hectares in Georgia. It is located about 80 kilometers south of Columbus, Georgia, and 12 kilometers north of Eufaula, Alabama, and lies along the Walter F. George Reservoir on the Chatahoochee River. The Walter F. George Reservoir or Lake Eufaula, as the residents in the area call it, has approximately 1033 kilometers of shoreline and covers about 18300 surface hectares. The Mobile District of the U. S. Army Corps of Engineers has statutory control of the water level of the lake. Annual lake levels vary approximately 1.5 meters with planned levels being 56.2 meters above mean sea level from November 15 through May 15 and 57.8 meters above mean sea level between May 15 and November 15. Due to this fluctuation in lake levels, large areas of mud flats and low islands are exposed during the winter and spring of each year. Many of the low islands are utilized as nesting sites by geese in the spring before they are flooded by high summer water levels. Thick stands of needle rush (*Juncus* sp.), alligator weed (*Alternanthera philoxeroides*), and other wetland plants are present in these shallow areas. This area of Alabama and Georgia is characterized by extensive agricultural areas which produce a number of crops. Canada geese and migrant blue and snow geese (*Chen c. caerulescens*) utilize crop residues left after harvest. Cattle are also raised in the area, and the large open pastures along the lake shore provide grazing areas for geese.

Study Procedures

Limited nesting and mortality data on the Eufaula flock have been recorded each year since 1965 by refuge personnel. During the nesting seasons of 1975 and 1976, attempts were made to locate all Canada goose nests within the study area. In many instances, reports of nests on private property were conveyed to refuge personnel by landowners. Most nests were located by first conducting thorough surveys of the area from a small boat or by automobile, during which locations of pairs of geese or sentinel ganders were pinpointed. Searches of these locations were made on foot until nests were found. After a nest was located, it was checked at intervals varying from one to seven days. Dates of

laying and hatching, number of eggs per clutch, and activity and location of the goose and gander at each observation were recorded. The fate of each nest was also recorded along with the number of eggs hatched, the number of goslings leaving the nest, reason for abandonment, if known, and embryonic development in unhatched eggs. Embryos found in eggs were aged according to criteria described by Cooper and Batt (1972), and projected hatch dates were determined using 28 days as the average incubation period required for hatch of giant Canada geese (Cooper and Batt 1972, Brakhage 1965). After completion of the clutch, each nest was checked for activity only from a distance until hatching occurred to minimize disturbance of the nesting pair.

After the lake reached high pool in June of each year, elevations of nests were measured in meters and centimeters above or below the water level. These measurements were subtracted from or added to the official lake elevation as received from the Corps of Engineers the same day the nest measurement was taken to give a nest elevation in relation to mean sea level which could be used to calculate an optimum lake level for nesting.

Brood survival data were collected during weekly brood censuses. Data including size and appearance of goslings, estimated age of goslings, and number of goslings in each brood were recorded. Ages of goslings were estimated using known age broods reared in small ponds in the area as guides. The criteria presented by Hanson (1965) and by Yocum and Harris (1965) were also reviewed and applied in age estimations. To facilitate following selected broods, radio transmitters weighing 140 to 168 grams were attached to cannon-netted adult geese just prior to the nesting season. Two harness types were used. One was the type described by Raveling (1969) where the antenna was incorporated inside the latex tubing of the harness. The other harness was a backpack type with a whip antenna. The backpack type was used exclusively after the first two geese were radioed since it was noted that those birds were bothered by the first type harness and one even succeeded in getting one leg through the large body loop. In addition, other broods were color-marked by injecting eggs with dye using procedures described by Evans (1951). In July 1975 and again in 1976, flightless Canada geese were captured by drive trapping to obtain sex and age ratios.

RESULTS AND DISCUSSION

Original Flock Size

To measure reproductive success of the Eufaula population, a base figure for the population size of the founding flock was derived by subtracting all known losses of transplanted geese from the total number released on the refuge (Table 1). Based on weekly refuge waterfowl census figures (Table 2) and data presented by Hankla (1968) which indicated that only one southeastern refuge (Holla Bend) had any degree of success in retaining transplanted migratory sub-adults held at the release site by wing-clipping, it appears that many of the Eufaula transplants left the refuge as soon as they regained flight during the period 1967 to 1969. At no time do the census figures during 1969 closely approach the expected number of transplanted Canada geese which should have been in the area had all transplanted geese remained as residents. The first year that no birds were wing-clipped was 1968. The August through October 1969 refuge census figures of about 120 geese are probably representative of the total resident flock size present at Eufaula during the winter of 1969-70 since a fairly accurate population size could be determined easily during that time of year. This figure agrees closely with the total number of surviving geese transplanted to Eufaula by June 1969 (217) plus the known number of goslings produced in 1968 and 1969 (nine goslings) minus the total number of sub-adult migratory geese transplanted to Eufaula from Wheeler (104). The resulting figure of 122 geese is very close to the 1969 September through October peak census figure.

Annual Reproduction at Eufaula

Although data were incomplete for the period 1965 through 1974, some records were kept on numbers of nests and broods located by refuge personnel. Some information was also available on the success of many of the nests located during that period. This data indicated that there was a general yearly increase in numbers of nests located from three

Table 2. Bi-monthly maximum numbers of Canada geese observed on the Eufaula National Wildlife Refuge (1965-1971) compared with the calculated numbers of transplanted geese expected to be present during the same periods if all transplants remained as residents.*

Bi-monthly Period	Year													
	1965		1966		1967		1968		1969		1970		1971	
	No. Obs.†	No. Exp.†	No. Obs.	No. Exp.	No. Obs.	No. Exp.	No. Obs.	No. Exp.	No. Obs.	No. Exp.	No. Obs.	No. Exp.	No. Obs.	No. Exp.
Jan.-Feb.	—	—	105	104	151	146	150	171	137	170	150	217	133	217
Mar.-Apr.	—	—	140	104	184	146	139	170	105	169	130	217	135	219
May-Jun.	—	—	181	181	119	158	142	170	82	217	130	217	138	219
Jul.-Aug.	—	—	146	146	116	158	147	170	108	217	110	217	164	219
Sep.-Oct.	2	0	143	146	126	158	147	170	119	217	130	217	154	219
Nov.-Dec.	40	28	143	143	150	172	166	170	138	217	130	217	155	219

*Data taken from Eufaula National Wildlife Refuge records (1965-1971).

†Maximum numbers observed during weekly censuses throughout each two-month period. Census figures include captive wing-clipped geese during 1965 through 1968. No geese were wing-clipped during or after 1968.

‡Number of transplanted geese expected to be present.

Table 3. Reproduction of the resident Canada goose flock at Eufaula National Wildlife Refuge, 1965-1976.

	Year											
	1965*	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
No. nests located	0	0	0	3	7	16	29	14	9	25	34	41
No. eggs produced	0	0	0	10+†	12+	78+	110+	58+	23+	109+	182	192
No. successful nests	0	0	0	Unk.	Unk.	5+	10+	7+	3+	14+	14	21
Average clutch size‡	—	—	—	—	—	—	—	—	—	5.43	6.04	5.65
No. goslings which left the nest	0	0	0	10+	11+	21+	34+	25+	10+	48+	51+	93+
Percent of nesting attempts producing one or more goslings	0	0	0	—	—	—	—	—	—	—	41.2	51.2
No. goslings surviving to July 1	0	0	0	4	5+	Unk.	Unk.	25+	Unk.	Unk.	21+	60+
Average brood size leaving the nest	—	—	—	—	—	—	—	—	—	—	3.64	4.42
No. goslings per successful nest surviving on July 1	0	0	0	—	—	—	—	—	—	—	1.50+	2.85+

*Data obtained from incomplete records, Eufaula National Wildlife Refuge, 1965-1974.

†Computed from clutches which were known to have been completed.

‡Numbers with "plus" signs are absolute minimums.

Table 4. Known Numbers of Canada goose nests and eggs lost during the 1975 and 1976 nesting seasons at Eufaula National Wildlife Refuge.

Reason for Loss	Number of Nests Lost			Number of Eggs Lost		
	1975	1976	Total	1975	1976	Total
Fluctuating water levels	12	7	19	73	32	105
Predators	1	4	5	6	16	22
Human interference	3	0	3	18	0	18
Competition with other geese	1	2	3	4	7	11
Unknown reasons	3*	7*	10	8	18	26.

*Includes some nests in which no eggs were laid.

nests in 1968 to 25 nesting attempts located in 1974 (Table 3). No nests were recorded in 1966 or 1967. During the two years of this study, 75 nesting attempts were recorded.

Thirty-four nesting attempts were located in 1975. At least 182 eggs were laid in 32 of those nests. Two of the nest sites were abandoned before laying began. Clutch size averaged 6.0 eggs per clutch for 26 nests in which clutches were known to have been completed. Numbers of eggs per clutch ranged from two to ten (Figure 1). Embryo development was recorded for 73 eggs from 13 successful nests which had hatched goslings in 1975. Fifteen of these eggs (21 percent) contained no evidence of developing embryos. This could have been due to infertility or to very early death of the embryo. The remaining eggs either hatched or contained well-developed embryos in eggs which did not hatch. Most of the latter eggs were incorporated into nest materials as the females built the nest up in response to rising water levels toward the end of the incubation period.

Of the 34 nesting attempts located in 1975, 14 (41 percent) produced at least one gosling per nest. Of the 81 eggs laid in these successful nests, 51 (63 percent) hatched successfully. The single greatest factor limiting nesting success was the fluctuating water level of the Walter F. George Reservoir, which flooded nine nests, causing abandonment, and affected hatching in several more (Table 4). Examination of the contents of eggs flooded by the lake

determined that 39 (80 percent) of the 49 flooded eggs in these nine nests contained well-developed embryos, most being within seven days of hatching. Three additional nests were flooded in small ponds as a result of the heavy rainfall which occurred in the Eufaula area in the spring of 1975. Nests containing clutches which were not disturbed by high water levels in Walter F. George Reservoir were determined to be 61 percent successful in hatching at least one gosling per nest. The effect of nest losses due to flooding by the reservoir on total reproduction in 1975 is apparent when total nest success (41 percent) and the latter figure are compared.

Twenty-one goslings are known to have been raised to flight stage out of at least 51 which left the nest in 1975. Forty percent of the goslings were hatched in the goose transplant holding pond, but only eight of these survived. Disease diagnosed as coccidiosis (*Eimeria* sp.) by the Alabama State Pathology Laboratory at Auburn University was determined to be the cause of one gosling mortality and suspected to be the cause of several more. Two different species of coccidia were found in the one examined gosling. The concentration of geese (up to 80 or more at times) in the small "goose pen" pond could have been a significant contributing factor to the outbreak of disease. Todd and Hammond (1971) state that little is known about most forms of coccidia occurring in wild geese, but many forms of coccidia are transmitted from one individual to another in food or water contaminated with feces. Conditions in the "goose pen" pond area during years previous to 1976 were conducive to the spread of this disease. An unknown species of predator also caused the death of one five-week old gosling in the "goose pen". Specific causes of mortality outside the "goose pen" were not determined.

In 1976, 41 nesting attempts were located. At least 192 eggs were laid in 38 of these nests. Three nests contained no eggs. At least 93 goslings hatched in 21 successful nests representing 51 percent of all known nesting attempts. Of the 114 eggs in these successful nests, 82 percent hatched. Average clutch size was determined to be 5.7 eggs per clutch in 1976 based upon 32 known completed clutches. Clutch size ranged from two to seven eggs per clutch (Figure 1). In 1976, 12 eggs out of 103 in 18 successful nests were found to contain no evidence of embryonic development. This represents only 12 percent compared with 21 percent in 1975. No reason can be given for this difference other than small sample size and possibly the 260 percent less rainfall recorded in the Eufaula area in April 1976 than in April 1975 which may have affected normal incubation.

Fluctuating water levels of Walter F. George Reservoir flooded seven nests in 1976 causing the loss of only 32 eggs to flooding versus 73 lost directly or indirectly to flooding in 1975. Nests containing clutches which were undisturbed by high water levels in Walter F. George Reservoir were determined to be 68 percent successful in hatching at least one gosling per nest in 1976.

The number of goslings surviving in mid-July improved considerably in 1976 compared with 1975. At least 60 survived in 1976 out of 93 hatched. Eight goslings were hatched in the transplant holding pond nest structures in 1976, but only two of these survived.

Nesting Period

The distribution of initiation of laying and hatching were plotted at weekly intervals throughout the nesting seasons of 1975 and 1976 (Figure 2). These data indicate that laying begins at Eufaula in late February and early March and continues through the end of April. The earliest date laying was initiated in 1975-76 was February 27, 1976, and the latest date was April 30, 1975. Figure 2 shows that nesting occurred slightly earlier in 1976 than in 1975. Based on 1975-76 data, the peak laying period occurs between March 1 and April 18. Incubation periods varied from 25 to 29 days, the average being approximately 28 days which is similar to the findings of Brakhage (1965) and Cooper and Batt (1972). Incubation was completed for most nests between April 10 and May 15. The earliest hatch date recorded occurred on April 7, 1976, and the latest would have occurred on or about June 3, 1976 had the nest not been flooded.

Nest Mortality

High water levels were determined to be the largest single cause of nest abandonment in both 1975 and 1976, with 40 percent of all eggs laid in 1975 and 17 percent of all eggs laid in

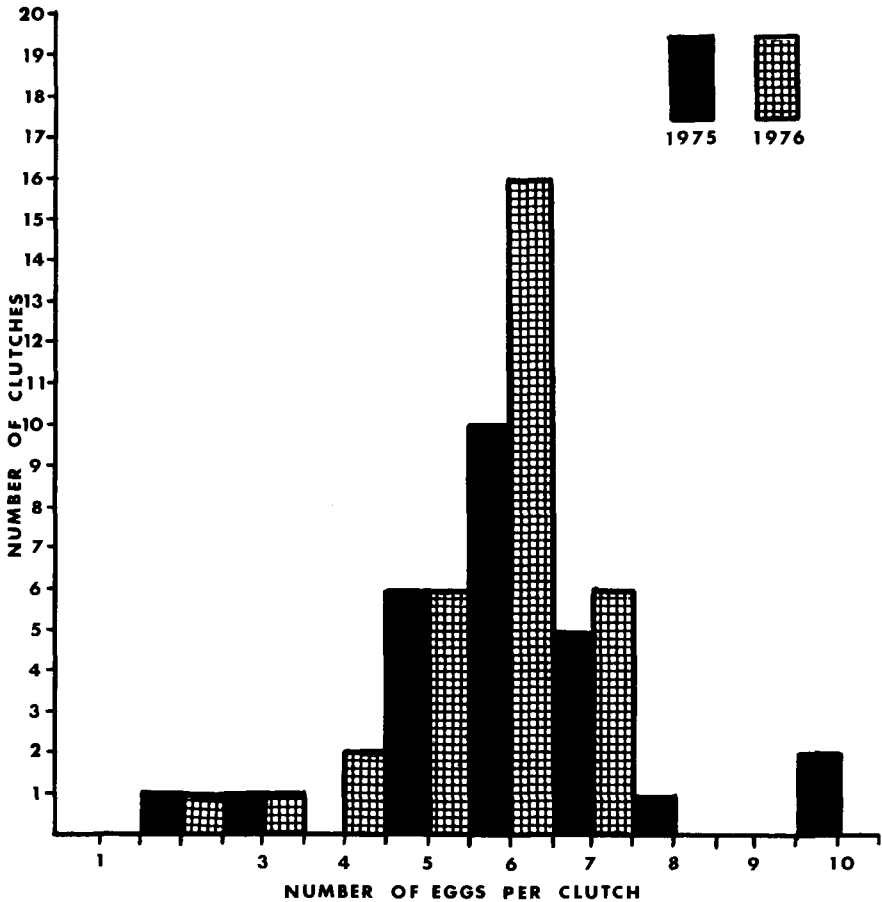


Figure 1. Distribution of completed clutch sizes of Canada geese during the 1975 and 1976 nesting seasons at Eufaula National Wildlife Refuge.

1976 abandoned due to this factor (Table 4). Measurements of nest elevations on Walter F. George Reservoir where most of the nest flooding occurred determined that locations of flooded nests ranged in elevation from 57.3 to 57.9 meters above mean sea level. A lake elevation maintained below 57.3 meters until after May 15 would have avoided flooding the majority of the nests abandoned due to high water on the reservoir.

Other causes of nest mortality during the two-year study period included predators which caused the abandonment of five nests containing 22 or more eggs. Known predators included bobcats which caused abandonment of two nests and a skunk which destroyed the eggs in one nest. All three of these nests were on small islands which were connected to the mainland by mud flats during periods of very low water levels early in the nesting season. The remaining nests were destroyed by unknown species of predators. Fire ants were thought to be a possible cause of gosling mortality prior to the study, but no evidence of this was seen even though four successful nests were located within two feet or less of fire ant mounds. One successful nest even had an active ant mound incorporated into the edge of the nest with no gosling mortality resulting.

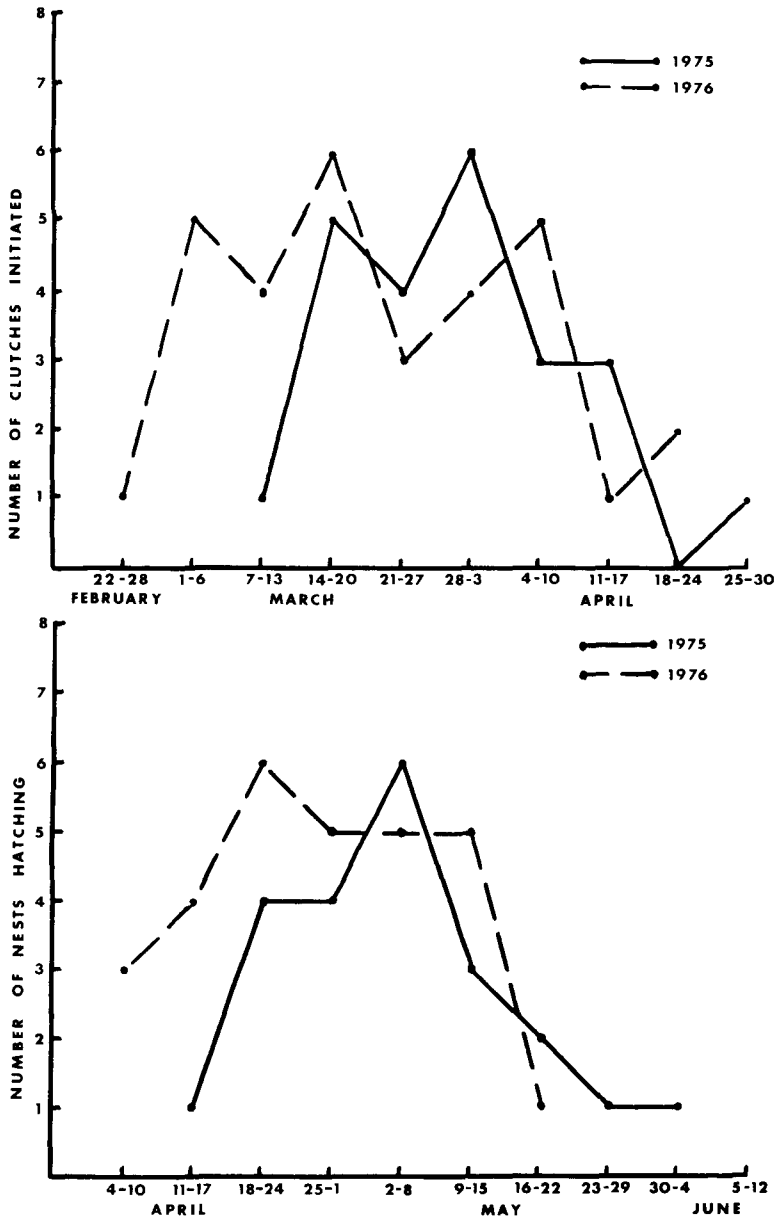


Figure 2. Distribution of Canada goose clutch initiation and hatching dates in the Eufaula National Wildlife Refuge area for 1975 and 1976. Hatching dates are either actual hatching dates or computed hatching dates of abandoned incubated nests based on 28 days as the normal incubation period.

Table 5. Comparison of the reproductive success of the Eufaula resident goose flock with that of other Canada goose nesting studies.

<i>Location</i>	<i>Number of Nests</i>	<i>Percent Successful</i>	<i>Number of Eggs</i>	<i>Percent Hatched</i>	<i>Average Clutch Size</i>	<i>Authority</i>
Eufaula (1976)	41	51	192	48.4 ^a	5.65	This study
Louisiana (1961-73)	737	60	4418	48.5 ^a	4.42	Chabreck et al. 1974
Missouri (ground Nests) (1962-64)	77	47	166	77 ^a	4.6	Brakhage 1965
Montana (1954)	254	51	1276	46.5 ^a	5.15	Geis 1956
Idaho (1949-51)	361	80	1492 ^b	86 ^c	5.2	Steel et al. 1957
California (1952)	201	79	810	87 ^c	5.1	Miller and Collins 1953
California (1939-40)	56	697		93 ^c	5.1	Dow 1943

^a Calculated from total number of eggs laid and number of eggs hatched.

^b Calculated from average clutch size and number of successful nests.

^c Calculated from number of eggs hatching from successful nests.

Human disturbance by persons using several of the islands where geese nested apparently caused the abandonment of three nests and 18 eggs. In two instances, the female was missing from the nest area, although the gander continued to protect the nest site for several days after the female disappeared. The only possible explanation was human interference since these nests were found on islands located one-quarter to one-half mile from the mainland and were visited regularly by people. No mammalian predators were present on these small islands. No nest abandonment was attributed to disturbance of nests by the researchers. Competition with other geese for nesting territories in the transplant holding pond caused the abandonment of one nest in 1975 and two nests in 1976.

Declines in numbers of nesting attempts in certain parts of the study area were noted in refuge records. This is thought to be due primarily to vegetative succession from open to brushy seral stages, the open areas being more suitable for nest sites. Further study is necessary to confirm this, however.

Gosling Survival

Average gosling losses during 1975 were determined to be approximately 2.1 goslings lost per successful nest between hatching and mid-June. Losses during 1976 were determined to be 1.6 goslings per successful nest for the same period. The 1975 figure is higher partly because of the large percentage (25.5 percent) of the total number of goslings which were lost in the transplant release pond in 1975. Losses were determined by subtracting the average number of goslings per successful nest surviving in mid-June from the average brood size of broods leaving the nests after hatching. Thus, for 1975 a known total of 51 goslings hatched from 14 nests giving an average brood size of 3.6 goslings per brood at the time of hatch. The total of 51 goslings includes only those which left the nest. Average number of goslings surviving in mid-June per successful nest was calculated by taking the total number of goslings censused in mid-June (21) and dividing that figure by the total number of successful nests. This admittedly could be biased toward a low average brood size in June because not all broods were seen again after hatching, but some mortality of entire broods was found to occur which would be hard to detect in observing unmarked pairs. Radio telemetry enabled the loss of a complete brood of four to be recorded within one week after hatching. Several entire color-marked broods were also lost, especially in the transplant pond area. This method of calculating gosling losses gives a maximum possible loss figure and a minimum number of goslings surviving. Survival figures would be higher if any goslings were missed during the censusing.

Gosling survival was determined using the same method in 1976 and showed a higher gosling survival rate than in 1975. Brood size at hatching was 4.4 goslings per brood in 1976, and by mid-June, brood size was 2.9 goslings per brood for all successful nests. Thirty-five percent of the total number of goslings hatched were lost in 1976 prior to mid-June. Fifty-nine percent were lost in 1975. Average brood size of surviving broods censused in mid-June was 3.5 goslings per brood in 1976, and 2.6 goslings per brood in 1975.

Sex Ratios

Drive trapping and cannon netting data obtained in 1975 and 1976 yielded a sex ratio of 45.7 percent males to 54.3 percent females from a combined sample of 81 geese. This is similar to sex ratios found by other researchers (Imber 1968, Brakhage 1965). Imber states that a lesser number of males than females has been found in several Canada goose flocks which may be caused by a higher mortality rate for males assuming equal percentages of males and females at hatching. This unequal sex distribution may be evidenced by polygamy and by unpaired females. Evidence of both polygamy and unpaired females were found in the Eufaula flock in 1976 when two polygamous groupings composed of one male and two females each were recorded. One of the polygamous groups failed to incubate any eggs, although seven were laid in two nests. One female from the other group incubated and hatched six eggs, but the entire brood disappeared within a week. In addition, one unpaired female which was radioed in 1975 did not pair in that year or in 1976, but nested and laid seven infertile eggs in 1976. This female was one of the original birds transplanted to Eufaula from Harris Neck Refuge in 1969.

Conclusions

It was determined that the Eufaula flock is well established and actively reproducing each year. Reproductive data compares favorably with that of flocks in other areas of the United States in spite of high losses of nests caused by fluctuating lake levels (Table 5). The flock has increased steadily from approximately 120 birds in the original flock in 1969 to an estimated 260 in the present flock. Average clutch size was determined to be slightly higher than that in most other studies of nesting Canada geese, but gosling losses were also higher at Eufaula than in several other studies (Geis 1956, Brakhage 1965), although this may be due to the differences in methods of computing gosling losses.

It was determined that flooding losses of nests could be greatly reduced by maintaining a reservoir level of 57.3 meters above mean sea level or lower from March 1 through May 15.

Further study should be given to the effects of plant succession on goose nesting habitat in the area, particularly on islands and peninsulas in the reservoir. Some evidence of loss of potential nest sites to succession since 1968 was noted in refuge records.

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