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Population and Productivity of a Flock of Giant Canada Geese in Northeastern South Dakota

Ted A. Clausing

POPULATION AND PRODUCTIVITY OF A FLOCK OF GIANT CANADA GEESE IN NORTHEASTERN SOUTH DAKOTA

BY

TED A. CLAUSING

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

R. L. Linder
Thesis Advisor

Date

C. G. Scalet
Thesis Advisor

Date

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POPULATION AND PRODUCTIVITY OF A FLOCK OF GIANT CANADA GEESE IN NORTHEASTERN SOUTH DAKOTA

Abstract

Ted A. Clausing

Population and productivity studies of giant Canada geese (Branta canadensis maxima) were conducted in northeastern South Dakota in 1976 and 1977. One hundred ninety-three of 436 randomly selected sample quarter sections on the 5,459 km^2 study area contained potential goose nesting habitat in 1976. Forty-six pairs, 6 indicated pairs, and 6 single geese were found on these 193 quarter sections during the 1977 nesting season. The population was estimated to be 1,880 geese. Recommendations were to continue aerial surveys in the spring and late summer and to supplement them with annual searches of the sample quarter sections used in this study.

One hundred three nests were found on islands and artificial nesting structures. Mean clutch size was 5.44 with no significant difference ($P > 0.05$) between the size of clutches on islands and artificial nesting structures. Nest success was 95% with no significant difference ($P > 0.05$) between islands and artificial nesting structures. Success of eggs in artificial nesting structures (91%) was significantly ($P < 0.05$) higher than the success of eggs in island nests (86%). Abandonment was the only observed cause of unsuccessful nests and eggs.

Mean initial brood size from 97 successful nests was 4.9 young. Mean size of 23 broods observed in 1977 was 3.9 young. Gosling mortality was 17% during the first 4 weeks and 21% during the first 8 weeks. Brood mixing and losses of complete broods were observed during gosling mortality studies. The 1977 population estimates increased from 1,880 geese in the spring to 2,761 in August; a production of 881 geese to flight stage.

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INTRODUCTION

Giant Canada geese were reintroduced into Waubay National Wildlife Refuge (NWR) in northeastern South Dakota in 1937. The habitat of the refuge and of the surrounding prairie pothole region was suitable for geese and by 1962 the flock had grown to 380 birds (Hanson 1965). Restrictive hunting regulations since 1967 have allowed growth and expansion of the flock (Kuck 1973) and the population increased to 2,800 birds by fall, 1975 (unpublished data, South Dakota Department of Game, Fish and Parks, Webster). Tacha (1976) interviewed landowners of the area and found that some goose depredation had occurred but that most landowners would tolerate the 5,000 goose population proposed by the South Dakota Department of Game, Fish and Parks.

The South Dakota Department of Game, Fish and Parks in cooperation with the U.S. Fish and Wildlife Service initiated annual aerial counts of geese on concentration areas in the spring and late summer, 1964 (Drewien and Johnson 1968). Ground counts were made of the geese on concentration areas in the springs of 1966, 1967, 1974, and 1975 to determine the precision and accuracy of corresponding aerial counts. Tacha (1976) concluded that aerial counts made during the nesting season were imprecise and that improved census techniques were needed.

Drewien and Johnson (1968) estimated productivity of the flock during the 1964 to 1967 breeding seasons. Hilley (1976) reported the outcome of 283 nests located during 1974 and 1975 but he did not

estimate the resulting production to flight stage. Brood size and gosling mortality data were needed to understand the status of the flock.

The objectives of this study were (1) to estimate the spring population of the flock and (2) to determine the productivity of the flock.

STUDY AREA

The 5,459 km^2 study area included the portion of the Prairie Coteau north of U.S. Highway 212 and west of U.S. Highway 81 in Clark, Codington, Day, Grant, Marshall, and Roberts Counties in northeastern South Dakota. The Prairie Coteau is a glaciated highland with steep slopes on 3 sides. It separates the James River Lowland on the west from the Minnesota-Red River Lowland on the east (Westin et al. 1967).

The coteau is an ancient plateau which was made hilly by erosion and then covered with glacial drift from the third substage of the Wisconsin glacier (Klingelhoets et al. 1952). Topography is nearly level to rolling with many irregular drainage patterns and depressions to collect runoff waters. Elevations range from 532 m in the south to 610 m in the north. The soils of the area are medium textured, friable, calcareous, and rich in primary minerals. They are classified as Chernozem soils of the Poinsett-Kranzburg silty prairie group (Derscheid and Westin 1970).

Northeastern South Dakota has a subhumid continental climate with wide seasonal and daily temperature fluctuations (Spuhler et al. 1971). Webster, which is located in the study area, has an average annual temperature of 6 C with monthly averages ranging from -12 C in January to 21 C in July (U.S. Department of Commerce 1976). Average annual precipitation is 53 cm with nearly three-fourths falling between March and September (Derscheid and Westin 1970). Average annual surface

wind velocity is 16 to 19 km/h and average annual lake evaporation is 81 to 86 cm (Spuhler et al. 1971). Drought conditions existed during 1976 and wetland water levels were low during both field seasons. Lakes of the Waubay NWR are normally ice covered from early November to late April (unpublished data, Waubay NWR, U.S. Fish and Wildlife Service).

Native vegetation of the area is the tall grass prairie association, with big bluestem (Andropogon gerardii), little bluestem (Andropogon scoparius), switchgrass (Panicum virgatum), and indiangrass (Sorghastrum nutans) as major grasses (Johnson and Nichols 1970). Most native vegetation of the area has been replaced for the production of range forage, oats, corn, flax, and alfalfa hay (Derscheid and Westin 1970).

METHODS AND MATERIALS

Population estimates

An estimate of the number of nesting geese in 1977 was obtained by searching a randomly selected sample of 0.65 km^2 (legal quarter section) plots. Quarter sections were chosen as sample units because they were easily recognized by land use patterns, usually accessible by at least 1 road, and could be searched by 1 observer. The study area was stratified to increase efficiency and precision of the population estimates (Kozicky et al. 1956, Siniff and Skoog 1964, Caughley 1977).

Stratification of the study area was based on distribution of geese determined from previous studies (Drewien and Johnson 1968, Hilley 1976) and observations made in 1976. Three concentration areas (Table I) were located and designated as strata I, II, and III. Each strata was a square area of 64.8 km^2. Stratum IV contained the remaining 5,265 km^2 of the study area.

A random sample of quarter sections from each stratum was selected with a computerized table of random digits. Ten quarter sections (10%) were selected from each of strata I, II, and III and 406 (5%) were selected from stratum IV.

The 436 sample quarter sections were examined during May, June, and July 1976 to determine which contained Class III, IV, and V wetlands (Stewart and Kantrud 1971). These wetlands were considered to be potential

Table 1. Locations, sizes, and local names of strata used in sampling to estimate the population of giant Canada geese in northeastern South Dakota, 1977.

Stratum	Size (Km^2)	Local Name	Location		
			County	Township	Sections
I	64.8	Kettle Lakes	Marshall	Hamilton	13-16, 21-24, 25-28, 33-36
				Fort	1-4
				Lake	18, 19, 30, 31
				Eden	6
II	64.8	Waubay NWR	Day	Waubay	4-9, 16, 17 19-21, 28-33
				Grenville	24, 25, 36
				Racine	1, 12
III	64.8	Bitter Lake	Day	Central Point	3, 7-10, 14-23 26-35
IV	5265	Remainder of study area			

goose nesting habitat (Hilley 1976). Sample quarter sections with potential goose nesting habitat were searched during April and May 1977. Observations were made between 0900 and 1600 when geese were expected to be nesting or loafing on or near the wetlands (Weigand et al. 1968). A 20X spotting scope and 7X binoculars were used to locate and count geese.

Geese were recorded as pairs, indicated pairs (solitary gander or incubating goose), or singles (associated with a pair or group) according to their behavior. Counts from each stratum were expanded according to sampling intensity to obtain a population estimate for that stratum. Estimates from the 4 strata were summed to obtain a population estimate for the flock.

Productivity

Wetland areas were examined during the 1976 and 1977 nesting seasons to locate nests for the productivity study. Islands and artificial nesting structures (ANS) received particular attention because of their importance to nesting geese. Hilley (1976) found 96% of 283 nests in these locations during 1974 and 1975 in northeastern South Dakota. Islands were also important nesting areas for Canada geese in Montana (Geis 1956), Manitoba (Klopman 1958), Michigan (Sherwood 1968), Alberta (Vermeer 1970), and Washington (Hanson and Eberhardt 1971). The importance of ANS has been noted in Washington (Yocom 1952), Montana (Craighead and Stockstad 1961), Missouri (Brakhage 1965), and South Dakota (Drewien and Johnson 1968, Lengkeek 1973, Bultsma 1976).

Four types of ANS were present on the study areas: (1) hay or straw bales supported by a wooden frame mounted on fence posts; (2) large cylindrical flax-straw bales; (3) bowl-shaped fiberglass platforms mounted on a tripod of metal pipes; and (4) small man-made islands. Muskrat (Ondatra zibethica) houses were important nesting sites in 1974 (Hilley 1976) but due to the drought, they were not present during this study.

Systematic nest searches were conducted when adult geese were observed displaying incubation activities (Collias and Jahn 1959). Clutch size was recorded for all nests with complete clutches. Clutches judged to be incomplete due to a small number of eggs or a lack of down (MacInnes and Misra 1972) were revisited after several days, to record clutch size. Incubated nests were distinguished from deserted nests by the presence of the female, warm glossy eggs, and fresh down in the nest (Hanson and Eberhardt 1971). Successful nests were considered to be those from which at least 1 egg had hatched. Numbers of unhatched eggs and dead goslings were subtracted from clutch sizes to obtain initial brood sizes.

A least-squares analysis of variance was applied by Dr. W. Lee Tucker (Agricultural Experiment Station Statistician, South Dakota State University) to test for differences in clutch size between years and nest sites. Chi-square tests (Steel and Torrie 1960) were used to compare nest success and egg hatching success in ANS and natural nest site (NNS) nests.

Brood Size and Gosling Mortality

Wetlands were periodically searched for broods during May, June, and July 1977. Location, date, size of brood, and age of goslings were recorded for each brood observation.

Goslings were aged according to characteristics given by Hanson (1965) and Yocom and Harris (1965), when detailed observations were possible. However, most observations were made at considerable distance and goslings were classified as younger or older than 4 weeks, based on the first appearance of feathers.

Some individual broods could be identified because of location, size of brood, age of goslings, and markings of parents. Parental markings consisted of the presence or absence of green plastic neck collars or the symbols on the collars. Mortality was calculated from repeated observations of identifiable broods and by comparing observed brood size with calculated initial brood size.

RESULTS AND DISCUSSION

Population

Habitat.--Potential goose nesting habitat was found on 193 (44%) of 436 sample plots searched during 1976. The proportion of sample plots with potential goose nesting habitat was greater in strata I, II, and III than in stratum IV (Table 2). Twenty-five (83%) of 30 plots in concentration strata contained nesting habitat, while only 168 (41%) of 406 sample plots in stratum IV contained nesting habitat. This difference indicated that the strata which were established according to the apparent distribution of geese also reflected the distribution of goose nesting habitat.

Census.--A larger proportion of sample plots that contained potential goose nesting habitat was occupied by geese in the concentration strata than in stratum IV (Table 3). Eight (32%) of 25 sample plots were occupied in concentration strata, while 18 (11%) of 168 were occupied in stratum IV. This distribution was further evidence that there were differences in densities of geese between strata.

Forty-six pairs, 6 indicated pairs, and 6 single geese were found on sample plots searched during 1977 (Table 4). Expansion of these findings resulted in estimates of 800 pairs, 80 indicated pairs, and 120 single geese for a population of 1,880 geese (Table 4). The density of geese was higher in the combined concentration strata

Table 2. Number and percentage of sample quarter sections, within each stratum in northeastern South Dakota, which contained potential goose nesting habitat, 1976.

Stratum Number	Number of Quarter Sections in Sample	Number of Quarter Sections with Habitat	Percentage with Habitat
I	10	9	90
II	10	7	70
III	10	9	90
I+II+III	30	25	83
IV	406	168	41
All Strata	436	193	44

Table 3. Number and percentage of sample quarter sections, within each stratum in northeastern South Dakota, which were inhabited by geese during the 1977 nesting season.

Stratum Number	Number of Sample Quarter Sections With Potential Goose Habitat	Number of Sample Quarter Sections Inhabited by Geese	Percentage Inhabited by Geese
I	9	1	11
II	7	3	43
III	9	4	44
I+II+III	25	8	32
IV	168	18	11
All Strata	193	26	13

Table 4. Giant Canada geese counted on sample quarter sections in northeastern South Dakota and the estimated breeding population for 1977.

Stratum	Number Counted			Estimated Population				
	Pairs	Indicated Pairs	Single Geese	Pairs	Indicated Pairs	Single Geese	Total Geese	Percent of Total
I	2			20			40	2
II	3	1		30	10		80	4
III	7	3		70	30		200	11
I+II+III	12	4		120	40		320	17
IV	34	2	6	680	40	120	1560	83
All Strata	46	6	6	800	80	120	1880	100

(1.65 geese per km^2) than in stratum IV (0.30 geese per km^2). The estimated density of geese on the study area was 0.34 geese per km^2. Stratum IV contained 96% of the study area and 83% of the estimated goose population.

More than 93% of the geese located on sample plots were in pairs or indicated pairs. Most geese observed outside sample plots were also paired. Brakhage (1965) found that 40% of one-year-old- geese and over 90% of older giant Canada geese were paired in Missouri. The high percentage of paired geese that I found in 1977 indicated that few one-year-old geese were present in the population. Possible explanations of the low age ratio were (1) poor production in 1976, (2) poor gosling survival since 1976, or (3) migration of unpaired geese off the study area. Drought conditions in 1976 may have reduced production and survival of goslings. Differential migration has not been indicated by band returns. I believe that repetition of the census in future years could reveal trends in the age composition of the flock.

Population Trend.--Aerial surveys conducted by the South Dakota Department of Game, Fish and Parks showed population growth from 1970 to 1976 with declines in 1972 and 1977 (Table 5) (unpublished data, South Dakota Department of Game, Fish and Parks, Webster). Drought conditions in 1976 may have caused the decline in 1977 as well as the abnormal age composition discussed in the previous section. Population estimates from aerial surveys have been valuable in indicating population trends, however, management may be improved by refining these techniques.

Table 5. Population estimates (1970 to 1977) obtained by the South Dakota Department of Game, Fish, and Parks and by the present study (1977) for a flock of giant Canada geese in northeastern South Dakota.

Year	Spring Population		Fall Population	Indicated
	Pairs	Total Birds	Total Birds	Increment
1970	169	---[a]	1340	---[a]
1971	197	---[a]	1501	---[a]
1972	172	---[a]	798	---[a]
1973	210	414	1944	1530
1974	317	662	2423	1761
1975	390	803	2824	2021
1976	440	779	3354	2575
1977	377	859	2761	1902
1977	880[b]	1880[b]	2761	881[b]

[a]Data not available.

[b]Estimated from the present study.

Spring aerial surveys should be supplemented with an annual search of the 193 sample plots that I searched in 1977. Spring aerial surveys miss many geese because of their wide dispersal and secretive habits. Tacha (1976) and Hanson and Eberhardt (1971) concluded that aerial surveys of breeding geese did not provide reliable population estimates. Annual searches of sample plots should yield a more accurate index of the breeding population. Some geese were probably missed during the 1977 search but the indicated production of 881 goslings from 1,880 geese is more reasonable than 1,902 goslings from the 859 geese of the spring aerial survey.

Late summer aerial surveys should be continued and expanded to new concentration areas to determine the numbers of geese present during the gregarious period after the molt. These surveys should yield reliable estimates because the geese are conspicuously rafted on large lakes during late summer. Hanson and Eberhardt (1971) reported that accurate estimates could be made from aerial surveys of nonbreeding geese.

Productivity

Nest Sites.--Islands were the only NNS on which nests were found. Sixty-two (60%) of 103 nests were on NNS while 41 (40%) were on ANS. Giant Canada goose nests were found on 3 islands in 1976 and 2 in 1977. The distribution of nests was; 1 on island A, 13 on island B, and 19 on island C in 1976. The corresponding distribution was 0, 2, and 27 in 1977.

Island A was separated from the lake shore by a shallow marshy area in 1976 while the other islands were surrounded by open water. Hilley (1976) found 18 nests on island A in 1974 when water levels were near normal and none in 1975 when water levels were low. Water levels continued to decline through the 1976 and 1977 nesting seasons. Islands A and B had a total of 14 nests in 1976. These islands had only 2 nests in 1977 when they were accessible by land bridges. The number of nests on island B decreased by 11 between 1976 and 1977 while the number on island C increased by 8. Islands B and C were about 1 km apart in Cattail Lake, Marshall County. The major difference between them was that island C was still surrounded by open water in 1977. Nesting pairs were apparently attempting to locate their nests in secure areas as discussed by Hammond and Mann (1956).

Twenty nests were found on ANS in 1976 and 21 in 1977. Many ANS which had been in 20 to 60 cm of water in 1976 were on mudflats in 1977. Low water levels, which had reduced the security of the islands, had a similar affect on ANS. Geese were often observed on wetlands which contained ANS but they apparently did not nest because they remained in pairs throughout the normal incubation period when ganders should have been alone while their mates nested. Wetland habitat was reduced and aggressive displays increased during 1977. Poor habitat conditions and social strife had apparently reduced 1977 nesting efforts.

Clutch Size.--Clutch size was recorded for 52 completed nests in 1976. Fifty nests (96%) were successful and had a mean clutch size of 5.76±1.35 (Table 6). Twenty nests in ANS had a mean clutch size of 6.15±0.88 and 30 nests in NNS had a mean clutch size of 5.50±1.55 but the difference was not significant ($P > 0.05$). Brakhage (1965) and Hilley (1976) found larger clutches in ANS than in NNS in Missouri and South Dakota, respectively. The range of clutch sizes in 1976 was 5 to 8 eggs in ANS and 3 to 9 in NNS. The most common clutch size for both types of nests in 1976 was 6 eggs.

Fifty active nests were found in 1977. Forty-seven (94%) were successful and had a mean clutch size of 5.30±1.71 (Table 6). Twenty-one nests in ANS had a mean clutch size of 5.48±1.81 and 26 nests in NNS had a mean clutch size of 5.15±1.64 but the difference was not significant ($P > 0.05$). The range of clutch sizes was 1 to 9 and 6 was most common clutch size for both types of nests in 1977.

Differences in Clutch Size.--A least-squares analysis of variance was used to test for differences in clutch size between nest sites and years. Hilley (1976) studied 115 giant Canada goose nests on the same study area in 1974 and 133 in 1975. Clutch size data from those nests were combined with my data from 50 nests in 1976 and 47 in 1977. Analysis indicated no significant difference in clutch size between nests on ANS and those on NNS ($P > 0.05$). Differences in clutch sizes among years were significant ($P < 0.05$). Clutch sizes were smaller during

Table 6. Clutch size of successful giant Canada goose nests in northeastern South Dakota, 1976-1977.

	1976			1977		
	ANS	NNS	Combined	ANS	NNS	Combined
Number of nests	20	30	50	21	26	47
Number of eggs	123	165	288	115	134	249
Mean clutch size	6.15	5.50	5.76	5.48	5.15	5.30
Standard deviation	0.88	1.55	1.35	1.81	1.64	1.71
Standard error	±0.19	±0.28	±0.19	±0.39	±0.32	±0.25
Range	5-8	3-9	3-9	1-9	1-9	1-9

years when relatively fewer active nests were found. Hanson and Eberhardt (1971) found this same relationship in their 20-year study of western Canada geese (Branta canadensis moffitti) on the Columbia River in Washington. Habitat conditions and population densities seemed to affect both numbers of nests and mean clutch sizes.

Clutch Size Comparisons.--Overall mean clutch size from my study (5.44) was similar to clutch sizes reported in 9 studies of giant Canada geese in North America (Table 7). It is also similar to the mean clutch size (5.5) reported by Hanson and Eberhardt (1971) from 2,688 nests of western Canada geese. While clutch sizes varied from year to year, they appeared to be similar over long periods of time and large geographic areas.

Nest Success.--Ninety-seven of 102 completed nests hatched at least 1 egg for an overall success rate of 95% for the 1976 and 1977 nesting seasons. Nests on ANS were more successful than nests on NNS. The 41 nests on ANS were all successful. Nests on NNS were 94% successful in 1976 (30 of 32) and 90% successful in 1977 (26 of 29) for a combined NNS nest success rate of 92%.

Chi-square tests showed no significant difference ($P \geq 0.05$) between nest success on ANS and NNS when years were treated separately or together (Table 8). Hilley (1976) found a lower overall success of 87% and a significant difference between the success of ANS and NNS nests. Bellrose (1976) reported an average nest success rate of 69% from 8 studies of giant Canada geese and 70% from 11,865 nests of

Table 7. Comparison of mean clutch sizes from previous studies of giant Canada geese with the results from present study in northeastern South Dakota, 1976-1977.

Location	Number of Nests	Clutch Size	Authority
Manitoba	93	5.11	Klopman (1958)
Missouri	142	5.3	Brakhage (1965)
Michigan	416	5.2	Sherwood (1968)
Michigan	625	5.7	Weigand et al. (1968)
Alberta	135	5.53	Vermeer (1970)
Western South Dakota	64	5.48	Lengkeek (1973)
Western South Dakota	91	5.27	Bultsma (1976)
Northeastern South Dakota	248	5.20	Hilley (1976)
Northeastern South Dakota	97	5.44	Present Study

Table 8. Chi-square tests of success of giant Canada goose nests on ANS versus NNS in northeastern South Dakota, 1976-1977.

Year	Nest Site	Fate of Nest		Chi-square Value
		Success	Failure	
1976	ANS	20	0	1.30 N.S.
	NNS	30	2	
1977	ANS	21	0	2.31 N.S.
	NNS	26	3	
1976-1977	ANS	41	0	3.51 N.S.
	NNS	56	5	

N.S. = Not Significant

Canada geese in general. Some success rates more comparable to mine are; 93% (Dow 1943), 96% (Klopman 1958), and 98% (Rienecker 1971).

Desertion was the major cause of nest failure in this study. No evidence of predation or other destruction was observed. All unsuccessful nests were found intact and most remained undamaged for several weeks after desertion. The lack of predation may account for the high nest success and may be explained by the secure locations of the nests found during this study.

Success of Eggs.--Four hundred seventy-three of 537 (88%) eggs in successful nests hatched during the study. Hanson and Eberhardt (1971) found a hatchability of 89% for 14,796 eggs. Brakhage (1965) reported that hatching success ranged from 73 to 93% in 9 studies of giant Canada geese.

Hatching success was higher for eggs in successful ANS nests (91%) than it was for eggs in successful NNS nests (86%) during both years. Chi-square tests showed significant differences ($P<0.05$) between the success of eggs in nests on ANS and NNS in 1977 and when both years were combined (Table 9). The difference was not significant ($P>0.05$) in 1976. Hilley (1976) found that a higher percentage of eggs in ANS hatched than eggs in NNS in 1974 and 1975.

Abandonment was the major cause of unsuccessful eggs. Unhatched eggs were usually found covered with nest material after the nest had been deserted. Several eggs were found outside of nest bowls. Abandoned

Table 9. Chi-square tests of success of giant Canada goose eggs on ANS versus NNS in northeastern South Dakota, 1976-1977.

Year	Nest Site	Fate of Nest		Chi-square Value
		Success	Failure	
1976	ANS	109	14	1.45 N.S.
	NNS	143	28	
1977	ANS	107	8	7.36*
	NNS	114	26	
1976-1977	ANS	216	22	7.46*
	NNS	257	54	

N.S. = Not Significant

* = Significant ($P<0.05$)

eggs were not destroyed by predators or scavengers for several weeks and in a few cases they remained intact until the following nesting season. These cases of long egg persistence were all on ANS which were secure from mammalian predators.

Initial Brood Size.--Two hundred fifty-two goslings were produced from 50 successful nests in 1976 for a mean initial brood size of 5.04±1.51 (Table 10). Forty-seven successful nests produced 221 goslings in 1977 for a mean initial brood size of 4.70±1.52. Larger initial broods were produced on ANS (5.27±1.58) than on NNS (4.59±1.37) both years, because nests on ANS had a larger mean clutch size and higher egg hatchability. Mean initial brood sizes have been reported as 4.8 and 5.5 in Manitoba (Klopman 1958), 4.6 in western South Dakota (Lengkeek 1973), and 4.7 in eastern South Dakota (Hilley 1976).

The most common initial brood size from ANS nests was 6 young during both years. Most broods produced from NNS nests contained 4 young in 1976 and 5 in 1977. The range of initial brood sizes was 1 to 8 in 1976 and 1 to 9 in 1977.

Brood Observations.--Twenty-three broods with goslings less than 4 weeks old were observed during 1977. The mean brood size was 3.91±1.81 for a total of 90 goslings. Naylor and Hunt (1954) reported a mean brood size of 4.2 for young goslings in California. Repeated observations of several broods indicated limited mixing of broods even though they were in close proximity.

Table 10. Initial brood size information from successful giant Canada goose nests in northeastern South Dakota, 1976-1977.

	1976			1977		
	ANS	NNS	Combined	ANS	NNS	Combined
Number of nests	20	30	50	21	26	47
Number of goslings	109	143	252	107	114	221
Mean brood size	5.45	4.77	5.04	5.10	4.38	4.70
Standard deviation	1.39	1.48	1.47	1.76	1.24	1.52
Standard error	0.31	0.27	0.21	0.38	0.24	0.22
Range	1-8	2-8	1-8	1-9	1-6	1-9

Range of brood sizes observed in 1977 was 1 to 9 and was the same as the range of clutch sizes and initial brood sizes for 1977. The most common brood size was 5 young. This size was the same as the most common initial brood size and one less than the most common clutch size.

Gosling Mortality.--The mean observed brood size of 3.91 was 17% less than the mean initial brood size of 4.70 for 1977. This change represents a loss of 0.79 goslings per brood during the first 4 weeks of life. Hanson and Eberhardt (1971) reported a 14% gosling mortality during the first 3 weeks.

Eight broods which were isolated and could be identified were observed for 3 to 4 weeks after their initial discovery. The number of goslings in these broods decreased from 32 to 30 (6%) during the period. Mean brood size increased from 4.0 to 4.3 during the period because one of the goslings, which was lost, represented a complete brood. Loss of complete broods and the mixing of older broods are 2 major reasons for the lack of data concerning gosling mortality and total productivity.

Assuming that these 8 broods started with a mean initial brood size of 4.7, or about 38 goslings, and decreased to the 30 observed goslings, the mortality rate was 21% in less than 8 weeks. Observation of the 7 remaining broods with 30 goslings yielded an estimated mortality of 9%.

Previous studies have varied in the methods and results of their gosling mortality estimates. Williams and Marshall (1938) and Craighead and Craighead (1949) reported little gosling mortality. Geis (1956) reported a loss of 19% during the entire brood period and Brakhage (1965) estimated losses of 32%. It is apparent that mortality and productivity estimates should not be based entirely on random counts of broods.

Actual Productivity to Flight Stage.--Productivity of giant Canada geese to flight stage can be estimated from changes in population from spring to fall. Migratory movements are limited during the reproductive period and should not bias the estimate. Band returns indicated that few geese left the study area until after the late summer census (Kuck 1973). Some giant Canada geese from Missouri were known to molt on the study area in 1977 but their numbers were small. I used 2 population estimates from 1977 to estimate productivity.

The 1977 population increased from 1,880 geese in the spring to 2,761 in August. This population change indicated a production of 881 goslings to flight. Geis (1956) found that 44% of the spring population actually nested and that each nesting pair produced an average 2.7 goslings to flight stage. Using these figures the northeastern South Dakota flock would have produced 1,117 goslings in 1977. I believe that my estimate of 881 goslings is reasonable when the poor habitat conditions of 1977 are considered.

It was obvious from the estimated production that much unobserved nesting occurred during 1977. Two hundred to 300 successful nests must have been present while only 47 were found. Islands and ANS were carefully examined and they could not have accounted for so many additional nests without being detected. I believe that the importance of mainland NNS has been underestimated. Hilley (1976) found only 3 nests of this type and I found none. A large percentage of the nesting effort apparently has gone unnoticed. More intensive nest searches are needed but they were not possible during this or previous studies because of the large study area and low goose densities.

CONCLUSIONS

The population of giant Canada geese in northeastern South Dakota was estimated by searching a stratified random sample of quarter sections. Extrapolation of the findings produced an estimate of 1,880 geese in the spring of 1977. An aerial survey during the same period showed 859 geese and another survey in August showed 2,761. The random sample technique was believed to be better than the aerial circling technique for estimating numbers of nesting geese. I recommend that the spring and late summer aerial surveys be continued and that they be supplemented with a search of randomly selected quarter sections in the spring. This combination would yield information on population, distribution, and productivity of the flock. Increased expenses would be small because most of the searches could be done by personnel in conjunction with other duties.

Clutch size, nest success, and egg hatchability were similar to those reported in the literature. All nests found were on islands or artificial nesting structures. Desertion was the only cause of nest failure identified during the study. No evidence of predation was observed during either nesting season.

Brood observations indicated a gosling mortality of 17% during the first 4 weeks and 21% during the first 8 weeks. Gosling mortality has often been underestimated because of a failure to consider the loss of complete broods and the mixing of broods. Both problems were encountered during my productivity studies.

Productivity to flight stage was measured by the population change from spring to late summer. Population estimates in 1977 indicated a production of 881 goslings. This prcduction would have required far more nesting than I observed. A large number of mainland nests must have been undetected because islands and ANS were under close observation. Few mainland nests have been located in the past and little effort was directed toward them during this study. Intensive studies are needed to determine the importance of mainland nest sites to goose productivity.

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