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Analysis of Aerial Surveys and Tolerance of Landowners for a Canada Goose Flock in Northeastern South Dakota

Thomas C. Tacha

ANALYSIS OF AERIAL SURVEYS AND TOLERANCE OF LANDOWNERS FOR A CANADA GOOSE FLOCK IN NORTHEASTERN SOUTH DAKOTA

BY

THOMAS C. TACHA

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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 as 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.

Thesis Adviser   Date

Head, Wildlife and Fisheries Sciences Department   Date

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Abstract

THOMAS C. TACHA

Four hundred rural landowners were interviewed in Day and Marshall counties in South Dakota in 1974 and 1975. These 400 interviews included 200 interviews with landowners living within 6.4 km of the three major summer-fall goose concentration areas and 200 interviews from a random sample of landowners living in the study area. Eighty-six percent of the interviewed landowners indicated that it was a good idea to expand the northeastern South Dakota Canada goose flock from 2,000 to 5,000 birds. Only 6 percent of the landowners had complaints about the geese, despite the fact that 23.5 percent of them had received goose-related crop damage. Percent occurrence of complaints and crop damage was influenced by distance of landowners' property from goose concentration areas. Most landowners who received damage had less than 200 dollars damage in any 1 year or on a 5-year average. Damage and complaints were from geese eating and trampling small grain swaths, geese grazing small grain shoots in the spring, and trespassing hunters. Landowners adjacent to goose concentration areas had a lower tolerance for geese than those farther away, but still retained relatively positive attitudes toward the geese and goose flock expansion.

Aerial circling surveys used to estimate numbers of breeding pairs of Canada geese were evaluated in 1974 and 1975. Analysis of variance factors of weeks, wetland units and week by unit interactions

were significant ($p<.05$) in tests on indicated pairs and nests for both years of the study. Counts using the aerial circling survey technique with fixed-wing aircraft were too variable to be reliable. Preliminary investigations indicate that a ground survey of stratified randomly selected plots may provide acceptably accurate and reliable population estimates.

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INTRODUCTION

A captive flock of breeding Canada geese *(Branta canadensis)* was donated to Waubay National Wildlife Refuge in 1937 (Schoonover 1970). The geese were later found to be of the giant (B. c. *maxima)* race (Hanson 1965). More breeders were added to that captive flock during following years and a program of annually releasing free-flying young was initiated. The population of the Canada goose flock in northeastern South Dakota grew to about 2,000 by the fall of 1973 (unpublished data, South Dakota Department of Game, Fish and Parks, Webster).

In 1972, the South Dakota Department of Game, Fish and Parks set a management goal of 5,000 geese for the northeastern South Dakota flock. The general public appeared to approve of this goose population increase; however some landowners indicated that they could not withstand increased waterfowl depredations on small grain crops. It appeared that landowner tolerance might be the major factor prohibiting management toward that goal. Waterfowl have become dependent on field crops for food as agriculture has expanded and wetlands and their associated food supplies have declined (Horn 1949). Bossenmaier and Marshall (1958) provide a discussion of the history and nature of waterfowl depredations. Landowner tolerance of waterfowl has diminished askflcad feeding by ducks and geese have increased (Paynter and Stephen 1964). The Committee on North American Wildlife Policy suggested that wildlife agencies should be concerned about wildlife damages to field crops (Allen 1973).

Aerial circling surveys have been used to census breeding pairs of the Canada goose flock in northeastern South Dakota since 1964. Aerial circling surveys consist of flights over selected areas which are circled at low altitude and minimum speed until observers are satisfied that all visible birds have been counted. Many of the variables associated with aerial surveys have been standardized (Crissey 1957). An example of standardized aerial surveys is the annual North American continental waterfowl breeding pair and production surveys (Standard Procedures for Waterfowl Population and Habitat Surveys--The Prairies, revised 1969, on file at Division of Management and Enforcement Office, U.S. Fish and Wildlife Service, Washington, D.C., 68 pp. mimeo). Diem and Lu (1960), Benson (1963), Chamberlain and Kaczynski (1965) and Henny et al. (1972) provide discussions of the format and problems associated with aerial surveys.

The objectives of this study were (1) to determine if landowners in northeastern South Dakota will tolerate a population of 5,000 geese and (2) to measure precision and accuracy of the aerial circling survey tec'-rque as used to census breeding pair populations of Canada geese.

STUDY AREA

The study area is located in northeastern South Dakota and encompasses 9,101 km^2 of Day and Marshall counties, Clark County north of U.S. Highway 212, Codington County north of U.S. Highway 212 and west of U.S. Highway 81, Grant County west of U.S. Highway 15, and Roberts County west of U.S. Highway 81 and South Dakota Highway 15. The study area is mostly located within the physiographic region known as the Prairie Coteau (Cauteau des Prairie). This glaciated upland region has an elevation of 485-605 meters and lies between the Minnesota and James River valleys (Westin et al. 1967).

Topography varies from nearly level to rolling hills. Soils developed from substrates deposited by the third (Cary) stage of the Wisconsin ice sheet and consist of clays, silts, sands, gravel and stone (Kingelroets et al. 1952). Topography and soils lend themselves to a surface pitted with thousands of glacially-formed depressions which constitute the lakes and marshes of the prairie pothole region. The predominate forms of land use are ranching and small grain farming (Evans and Black 1956).

The subhumid, temperate, continental climate is typical of the northern tall grass prairie association of the grasslands formation (Oosting 1956). Mean monthly temperatures range from -12 C in January to 22 C in July (Sphuler et al. 1971). Average annual precipitation is 52.3 cm with nearly two-thirds falling during the growing season (U.S. Department of Commerce 1965).

METHODS

Landowner Tolerance

Studies of landowner tolerance were conducted in Day and Marshall counties near three areas with major goose concentrations during summer and fall. These areas were Waubay and Bitter lakes, located in eastern Day County, and Kettle Lake, located in south-central Marshall County. Lists of farm operators currently living in the rural community (landowners) of Day and Marshall counties were supplied by the respective county agents.

Four hundred personal interviews with landowners were conducted during July and August in 1974 and 1975. Interviews took place during periods of highest goose depredations to obtain the most conservative estimate of landowner tolerance.

The base sample of 400 interviews included 70 percent or 200 of the landowners living within 6.5 km of the three areas with concentrations of geese. The other 200 interviews (a subsample in this study) comprised a 10 percent random sample of landowners living throughout Day and Marshall counties. The base sample of 400 interviews provided a measure of landowner attitudes (tolerance) toward the geese that was weighted toward landowners residing near goose concentration areas.

All 400 interviews included data on the landowner's county of residence, nearest goose concentration area, and distance from goose concentration area. All interviews contained the following dichotomous-answer (yes or no) questions:

(1) The South Dakota Department of Game, Fish and Parka intends to expand the northeastern South Dakota giant Canada goose flock from its present population of 2,000 birds to 5,000. Do you think this is a good idea?

(2) Do you have any complaints about the geese?

(3) Have you ever received crop damage due to the geese?

The subsample of 200 random interviews included an additional series of Likert-type statements and closed-response questions. The style and sequence of questions were carefully structured to not bias responses. Interviewed landowners were given a card with his answer options typed upon it and instructed to pick an answer corresponding to the question or statement provided verbally by the interviewer.

All statistical analyses in the landowner tolerance study were done using the "SPSS Tech 71" standardized computer package maintained at South Dakota State University. The base sample of 400 interviews was-analyzed using frequency distributions and chi-square programs drawn from "Tech 71". The subsample of 200 random interviews was further analyzed using frequency distributions, chi-square, and forward solution stepwise multiple regression programs drawn from the same standardized computer package.

Analyses were carried out to provide information to meet the landowner tolerance objective by answering several research questions. The following questions were answered using the base sample and responses to dichotomous-answer questions:

(a) How do landowners in general feel about goose flock expansion?

(b) Are landowners experiencing goose-related damage; and if so, is the damage worthy of complaint?

(c) Is low landowner tolerance a localized problem; and if so, where?

The research questions below were answered by using the subsample of 200 random interviews and responses to its ranked-answer questions and statements:

(a) How many geese do landowners want in the goose flock?

(b) Is the number of geese landowners want related to damage or complaints?

(c) Are landowners willing to cooperate with game agencies in combating goose problems in a mutually beneficial manner?

(d) How much damage do landowners feel the goose flock is presently inflicting on them?

(e) What kinds of damages are the geese causing?

(f) Have landowners tried to solve past goose problems by contacting game agencies?

(g) Are landowners that have contacted game agencies in the past satisfied with the aid they received?

Aer4ai,survey Techniques

Studies on precision of aerial circling surveys were conducted on six wetland units during the nesting season in 1974 and 1975 (Table 1). These wetland units were representative of those *annually* surveyed by the South Dakota Department of Game, Fish and Parks in land

Table 1. Locations of wetland units used in the study of aerial circling surveys.

	Location	
Wetland Unit	Township	Description[a]
Bitter Lake	Central Point	Bitter Lake GPA west of Day Co. Highway 3 and south of sections 17 and 18.
Spring Lake	North Waubay	Waubay NWR east of Day Co. road 3A and south of refuge headquarters road.
Dahling Slough	North Waubay	Section 6 in Waubay NWR west of Day Co. road 3A.
Hazelden Lake	Nutley	Hazelden Springs GPA.
Mydland South	Lynn	Nydland Pass CPA. in: the NE 1/4 of the SE 1/4 of section 15 and the NW 1/4 of the SW 1/4 of section 14.
Mydland North	Lynn	Mydland Pass GPA in: the SE 1/4 of the SW 1/4 and the SW 1/4 of the SE 1/4 of section 3, section 10 excluding the E 1/2 of the SE 1/4, and the NE 1/4 of the NW 1/4 and the NW 1/4 of the NE 1/4 in section 15.

a GPA=Game Production Area and NWR=National Wildlife Refuge.

area, water area, density and size of wetlands, and density of breeding pairs of Canada *geese.* Indicated pairs are defined as the number of nests plus the number of pairs of geese.

Twice each week for 4 weeks an aerial circling survey was made for nesting and indicated pairs on each of the selected wetland units. Each flight had two independent observers, one of which was the pilot. Data from each observer were recorded as "observed" indicated pairs and "observed" nests.

As many variables as possible were held constant between aerial survey flights. A Cessna 150 high wing monoplane and the same pilot were used throughout the study. Observers without experience in aerial surveys were used in 1974 and observers with experience were used in 1975. Surveys were conducted at minimum height (less than 50 m) and speed (less than 100 km per hour). Acceptable weather for flights was wind less than 60 km per hour, visibility of 20 km, no precipitation and less than 50 percent cloud cover. All flights were made within 2 hours of midday.

Nesting and indicated pairs were counted from the ground once each week on each wetland unit in the manner described by Stewart and Kantrud (1972:771-772). Data from ground surveys were recorded as "actual" indicated pairs and "actual" nests. Ground counts were conducted within 2 days of their comparison flights and were assumed 100 percent accurate, in keeping with methods described in most studies of air-ground comparisons such as the one by Martinson and Kaczynski (1967).

Several assumptions are implicit in this study. It was assumed that there was no ingress or egress of Canada goose pairs between ground counts and their associated flights. Week to week variations in natural phenomena such as fluctuation in water levels, vegetation height and vegetation density were accounted for by progressive ground surveys. No factors except those tested influenced ground or aerial surveys in a manner which affected reliability of results.

Precision of aerial surveys was tested using four factor combined nested and factorial analysis of variance. The four factors were wetland units, weeks, flights, and observers. Data were coded for computer analysis by using the formula "actual minus observed plus 10", for both indicated pairs and numbers of nests. Analysis of variance then tested the variation in the ratio of birds observed versus birds actually present. Analysis of the variation in this ratio between and within the four designated variables was used to provide an estimate of the precision of the aerial circling survey technique used in this study.

RESULTS AND DISCUSSION

Landowner Tolerance

Distribution of interviews corresponded to the total number of landowners in each county (Table 2). Day County had nearly twice as many landowners and interviews as Marshall County.

Distribution of interviewed landowners also corresponded to the size of the goose concentration area with which they were associated (Table 3). Waubay Lake was the largest goose concentration area and had the most interviews associated with it.

Distribution of interviewed landowners by distance from their nearest goose concentration area reflected the fact that over half of the interviewed landowners lived within 6.4 km of-major goose concentration areas (Table 4). The arbitrary distance groupings used were chosen to condense the "distance from concentration area" variable into approximately equivalent components for chi-square analyses.

Measurement of human attitudes (such as tolerance for a goose flock) is a complex problem (Summers 1970). Labovitz and Hagedorn (1971) found that personal interviews were the best method for gathering attitude information. Attitudes are a predisposition to respond to an object (Summers 1970). The Likert-type scale used for attitude measurement is the best predictor of behavior (Tittle and Hill 1967). Ranked-scale ansiteis provide a relatively accurate estimate of variations in attitudes (Rosonke 1974). A combination of measurement techniques increases validity and provides more accurate measures of

Table 2. Distribution of interviewed landowners by county of residence.

Sample	County	Distribution	
		Frequency	Percent
400 (Base)	Day	269	67.2
	Marshall	131	32.8
	Total	400	100.0
200 (Random)	Day	120	60.0
	Marshall	80	40.0
	Total	200	100.0

Table 3. Distribution of interviewed landowners by goose concentration area.

Sample	Concentration Area	Distribution	
		Frequency	Percent
400 (Base)	Bitter Lake	89	22.2
	Waubay Lake	180	45.0
	Kettle Lake	131	32.8
	Total	400	100.0
200 (Random)	Bitter Lake	32	16.0
	Waubay Lake	88	44.0
	Kettle Lake	80	40.0
	Total	200	100,0

Table 4. Distribution of interviewed landowners by distance from nearest goose concentration area (base sample of 400 interviews).

Distance (km)	Distribution: Frequency	Distribution: Percent
0 - 3.2	120	30.0
3.3 - 11.2	146	36.5
11.3 - 41.6	134	33.5
Total	400	100.0

Table 5. Landowner responses to dichotomous-answer questions (base sample of 400 interviews).

	Responses			
	Yes		No	
Question	Frequency	Percent	Frequency	Percent
Flock expansion	344	86.0	56	14.0
Complaints	24	6.0	376	94.0
Damage	94	23.5	306	76.5

attitudes. Structure and style of interview schedules used in this study were based on these factors.

Every interviewed landowner responded to dichotomous-answer questions on flock expansion, complaints and damage. Results from the 400 interviews indicated that 86 percent of the landowners felt it was a good idea to expand the local goose flock (Table 5).

Six percent of the landowners in the base sample of 400 interviews had complaints about the geese (Table 5), despite the fact that 23.5 percent said "yes" when asked if they had ever received damage from the geese. One in four landowners receiving goose-related crop damage felt it worthy of complaint.

Chi-square analyses indicated no significant ($p<.05$) difference between landowner responses to dichotomous-answer questions on flock expansion, complaints or damage, and location of interviewed landowners by county of residence (Table 6). Chi-square analysis also suggested no significant differences between landowner responses to these same three questions and location of interviewed landowners relative to different goose concentration areas. There was a significant difference between landowner responses to the damage and complaint questions and distance of interviewed landowners from their nearest goose concentration area. Examination of cells within chi-square tables reflected that a higher proportion of landowners adjacent to goose concentration areas had damage problems and complaints than those living farther away. Chi-square results indicated significant differences between landowner attitudes toward flock expansion and their experience with damage and complaints.

Table 6. Chi-square results from cross tabulations of distributions of interviewed landowners by responses to dichotomous-answer questions, and cross tabulation of responses to the dichotomous-answer flock expansion question by responses to the dichotomous-answer complaints and damage questions (base sample of 400 interviews).

Cross tabulations			Degrees of Freedom	Chi-square Value
County	X :	Flock expansion	1	0.32
		Complaints	1	2.27
		Damage	1	0.68
Concentration area		Flock expansion	2	0.52
		Complaints	2	3.57
	:	Damage	2	0.97
Distance	X	Flock expansion	2	3.97
		Complaints	2	29.88*
		Damage	2	63.00*
Flock expansion	X	Complaints	1	54.26*
		Damage	1	23.75*

* Significant difference (p<.05).,

The remainder of the data presented below is from the subsample of 200 random interviews. Data indicate landowner responses to questions with rank-scaled answers. Distribution of random interviews by county and goose concentration areas paralleled the base sample (Tables 2 and 3). Distribution of random interviews by distance from nearest goose concentration areas is equally spread from 0 to 46.4 km.

Landowner responses to ranked-answer statements indicate that 81 percent of the landowners in the study area agreed that goose flock expansion to 5,000 birds was a good idea (Table 7). Nearly 92 percent of the landowners agreed that geese do not cause them problems worthy of complaint. Interviews indicated that 78.5 percent of the landowners agreed that geese did not cause them any damage. Responses to ranked-answer statements on flock expansion, damage and complaints are consistent with those from dichotomous-answer questions.

In the subsample of 200 random interviews, landowners were asked how many geese they would like to see in the northeastern South Dakota Canada goose flock. A large proportion of landowners indicated that 5,000 or more birds would be an acceptable number (Table 7). This indicates that most landowners will tolerate goose flock expansion.

Over 94 percent of the interviewed landowners were willing to contact the U.S. Fish and Wildlife Service or the South Dakota Department of Game, Fish and Parks if they had problems with geese in the future (Table S). Less than 9 percent of the landowners were not willing to use scare devices, on a cost sharing basis with game agencies, to combat crop depredations by geese. Apparently most landowners will cooperate in controlling potential goose problems.

Table 7. Landowner responses to ranked-answer statements or questions on flock expansion, complaints, damage and goose flock size (subsample of 200 random interviews).

Statement or Question	Answer Scale	Percent of Landowner Responses						
		1	2	3	4	5	6	7
Flock expansion is a good idea	A[a]	1.0	4.0	3.0	11.0	13.0	63.5	4.5
Geese do not cause complaints	A	1.0	4.0	9.5	3.5	14.5	64.0	3.5
Geese do not cause damage	A	2.5	5.0	11.0	3.0	12.5	61.0	5.0
Best goose flock size	B[a]	0.0	13.5	24.0	51.5	4.5	0.5	6.0

a A scale: 1=totally disagree, 2=disagree, 3-somewhat disagree, 4=undecided, 5=somewhat agree, 6=agree and 7=totally agree. B scale: 1=0-1499, 2=1500-2999, 3=3000-4499, 4=4500-5999, 5=6000-7499, 6=7500-8999 and 7=9000 or more.

Table 8. Landowner responses to ranked-answer questions on willingness to contact game agencies about goose problems, willingness to use scare devices, and cost estimates for goose damages.

Question	Answer Scale	Percent of Landowner Responses[b] 1	2	3	4	5	6	7
Willing to contact	A[a]	1.0	1.5	0.5	2.5	2.0	85.5	7.0
Willing to use scare devices	A	1.5	6.5	0.5	1.5	3.0	84.5	2.5
Most damage in one year	B[a]	51.7	31.0	3.4	3.4	0.0	6.9	3.4
Average annual damage	B	89.7	3.4	6.9	0.0	0.0	0.0	0.0

a A scale: 1=totally unwilling, 2=unwilling, 3=somewhat unwilling, 4=undecided, 5=somewhat willing, 6-willing and 7=totally willing.
B scale: (dollars) 1=0-199, 2=200-399, 3=400-599, 4=600-799, 5=800-999, 6=1000-1199 and 7=1200 or more.

b Responses to "contact" and "scare devices" questions were based on subsample of 200 random interviews. Responses to "cost of goose damage" questions are based on 29 landowners in the subsample of 200 random into 'tews that had received damage from the geese in the past.

Twenty-nine of 200 landowners in the random sample had received damage from the geese in the past. When asked about the most monetary damage that geese had ever caused them in one year, 51.7 percent said less than 200 dollars and 82.7 percent said less than 400 dollars (Table 8). Nearly 90 percent of the interviewed landowners that had received damage in the past said that geese cost them less than 200 dollars per year on the average. Low tolerance of landowners for waterfowl is mainly a result of personal economic losses (Paynter and Stephen 1964). Hochbaum et al. (1954) stated that landowner estimates of damages received are invariably inflated but useful for general appraisals.

The 29 landowners in the random sample that had received goose related damages were asked what kind of problems geese had caused (Table 9). Nearly 80 percent of these landowners indicated that they had received damage from geese trampling and eating swathed grain. Hammond (1964) and MacLennan (1973) reported that depredations on swathed grain are the most common form of waterfowl damage to farmers.

The second most common form of goose depredation is grazing of young shoots of farm crops (McDowell and Pillsbury 1959). Results in this study agreed with those findings when 48.3 percent of the 29 landowners that had received damage complained about geese grazing young shoots of small grain (Table 9). Biehn (1951) and Griffith (1964) disputed the idea that grazing waterfowl caused damage to small grain crops except in isolated instances. Grazing of young small grain shoots

Table 9. Major sources of complaints from 29 landowners in the subsample of 200 random interviews that had received goose damage.

Complaint Source	Frequency	Percent
Swaths	23	79.3
Grazing	14	48.3
Trespassing (hunters)	15	51.7
Other	4	13.8

Table 10. Chi-square results from cross tabulations of cost estimates from goose damage by sources of complaints, from 29 landowners in the subsample of 200 random interviews that had received goose damage.

Cross tabulations		Degrees of Freedom	Chi-square Value
Worst damage in one year X	Swaths	2	3.27
	Grazing	2	2.84
	Trespass	2	6.75*
Average annual damage X	Swaths	2	0.87
	Grazing	2	3.12
	Trespass	2	3.12

* Significant difference (p<.05).

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can usually increase harvest yields later (Biehn 1951, Pirnie 1954). In *the* 17 grazing complaints I investigated during this study (three were not from interviews), none resulted in visible damage to crops. The presence of geese in valuable crop fields was the only necessary stimulus to complaint, regardless of the fact that they did not induce measurable crop damage.

Over 51 percent of the 29 landowners that had received goose damage complained about trespassing by goose hunters (Table 9). Paynter and Stephen (1964) wrote that field feeding waterfowl often create hunter trespass problems.

Damage estimates from landowners were cross tabulated with types of complaints (Table 10). Only trespassing complaints cross tabulated with worst damage in one year indicated a significant difference. This suggests that perception by landowners of problems with geese had more impact than the problem itself. Apparently, problems from the landowners' point of view were more emotionally than logically perceived, as trespassing did not yield economic damages, only complaints.

Twelve of the 29 landowners (41.4 percent) receiving damage from geese said that they had informed a game agency of their problems. Seven of these 12 landowners (58.3 percent) were satisfied with the action taken by the game agency.

Forward solution stepwise multiple regression was used to determine the extent to which respondents' attitudes to goose flock expansion, complaints or damage, and respondents' distance of residence from goose concentration areas helped explain the variation in the dependent variable of numbers of geese landowners would like to see in the goose flock (Table 11). Landowner responses to ranked-answer flock expansion and damage questions explained 32.1 percent of the variation in the dependent variable. Landowners wanting more geese in the flock were characterized by greater agreement that the flock should be expanded and greater agreement that geese did not cause them damage. Agreement that the landowner had no complaints and distance of landowners from goose concentration areas did not significantly contribute to variations in landowners ideas of how many geese should be in the flock.

If it is assumed that the dichotomous-answer questions are indicators of landowner tolerance, then landowner attitudes are favorable toward increasing the population of geese in northeastern South Dakota. Dichotomous-answer questions are supported by ranked-answer statements in the 200 random interviews.

Chi-square analyses indicated that distance of landowners from nearest goose concentration areas influence percentage occurrence of damage and complaints. Regression analysis showed that a significant amount of the variation in the numbers of geese landowners would like to see in the flock can be explained in part by the percentage of lattdr.Aers receiving damage. In chi-square tests, distance of landowners from concentration areas and complaints also did not explain a significant amount of the variation in the number of geese landowners would like to see in the flock. Chi-square analyses, however, suggested 'r

Table 11. Sums of squares a- proportion of variance accounted for by significant independent variables, for the dependent -iable of how many geese interviewed landowners would like in the goose flock (subsample of 20u .andom interviews).

Significant Independent Variables	Sums of Squares Accounted For	Percent of Variation Explained	Cumulative Percent of Variation	Regression Coefficient	Y-intercept
Ranked-answer flock expansion statement	77.44	29.57	29.57	0.496	0.388
Ranked-answer damage statement	6.53	2.50	32.07	0.127	

that attitudes toward flock expansion were influenced by percentage occurrence of damage and complaints.

There is a confusing conflict in these results. Chi-square tests reveal that percentage occurrence of damage and complaints significantly increases with proximity to concentration areas; but attitudes toward flock expansion do not significantly vary. Regression analysis shows that increased damage occurrence is equated with a reduction in numbers of geese landowners would like to see in the goose flock. Apparently, percentage occurrence of damage and of complaints are better indicators of landowner attitudes toward the relative size of the goose flock than the flock expansion questions.

Despite the problems in deriving statistical evidence, percentage occurrence and amount of damages determine if landowners will tolerate goose flock expansion. Goose crop depredations are common to only a minority of landowners near goose concentration areas in northeastern South Dakota, and are severe in only a few isolated instances. These findings agree with those of several studies which have shown that intensity or extent of waterfowl (especially goose) damage is related to distance of potential feeding fields from waterfowl concentration areas. Pirnie (1954), Hochbaum et al. (1954) and MacLennan (1973) found that fields closest to marshes or lakes with large concentrations of ducks or geese experienced the worst depredation problems. Bossenmaier and *Marshall* (1958) wrote that geese prefer fields near their roost but will range several miles to feed.

If the northeastern South Dakota goose flock is allowed to increase, both percentage occurrence and cost of crop depredations by geese may increase in years of high precipitation during the harvest season. Several studies including those by Bossenmaier and Marshall (1958) and MacLennan (1973) support this hypothesis.

Landowner tolerance problems in northeastern South Dakota are restricted to only a few individuals. These individuals influence others in a cumulative manner. Krech et al. (1962) reported that people act on what they believe to be true rather than on authenticated knowledge. Undoubtedly, crop damage from geese will increase as the flock grows. My experience with complaining landowners is that, if they are allowed to voice complaints, most forget the problem. This occurred in 31 of 34 goose-related complaints I investigated during this study. Some landowners will need assistance in moving birds from swathed grain to already harvested fields. Scouler (1952) and Wagar (1946) suggested federal and/or state cooperation in helping farmers prevent waterfowl damages. Landowners generally agree with this (Day 1944, Hochbaum et al. 1954).

Attitudes of landowners receiving damages from waterfowl should be important to wildlife agencies (Paynter and Stephen 1964). The number of landowners with negative attitudes can be reduced by offering both technical and psychological assistance to landowners in the study area. Attitudes (positive or negative) tend to persist over time (Summers 1970). Every effort should be made to improve relations with landowners receiving damages in the past and to prevent negative attitudes from developing.

Landowner attitudes should be constantly monitored, especially while the goose flock is increasing. Summers (1970) wrote that attitudes are learned phenomena and are subject to influences of surrounding people in their formation. Complaining landowners should be contacted immediately, before they negatively influence friends and neighbors. Periodic publicity on technical assistance should be made to insure continuing landowner-game agency understanding. Many landowners are not satisfied with past experiences with game agencies concerning the geese. Failure to improve communications with landowners will undoubtedly result in decreasing public sentiment toward both geese and game officials.

Aerial Survey Techniques

Data from the aerial circling survey study were recorded as "actual" and "observed" indicated pairs and nests for both 1974 (Table 12) and 1975 (Table 13). Week one data for 1974 were not used for statistical analysis because one of the observers was ill during his flight. This illness affected observations by both the pilot and the observer. The remainder of week one data from flight two was unusable for analysis of variance because of loss of flight one data. Data for wetland units five and six, week three, flight one, 1974 were lost due to the sudden appearance of poor weather conditions.

Analysis of variance tests on indicated pair observations for 1974 revealed significant variation between weeks, wetland units and the week by unit interaction (Table 14). The same statistical tests on nest data for 1974 revealed significant variation between weeks, wetland units and the week by unit interaction (Table 15).

Table 12. Actual and observed indicated pairs and nests from 1974, aerial circling survey study.

Week Wetland Unit	Actual		Flight 1 Observer 1		Flight 1 Observer 2		Flight 2 Observer 1		Flight 2 Observer 2	
	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests
Week one*										
Week two										
Bitter Lake	24	18	25	15	26	15	17	12	18	12
Spring Lake	9	6	6	2	6	2	7	4	9	6
Dahling Slough	1	1	1	1	1	1	1	1	1	1
Hazelden Lake	5	3	7	2	7	2	3	2	3	2
Mydland South	3	0	0	0	0	0	0	0	0	0
Mydland North	5	5	7	1	7	1	10	3	5	3
Week three										
Bitter Lake	32	12	22	11	23	11	23	13	25	13
Spring Lake	10	4	10	3	10	3	6	3	6	3
Dahling Slough	1	1	0	0	0	0	1	1	1	1
Hazelden Lake	6	3	3	3	6	3	2	2	2	2
Mydland South	3	0	ND	ND	ND	ND	0	0	0	0
Mydland North	7	5	ND	ND	ND	ND	7	3	8	3

Table 12. Continued.

Week Wetland Unit	Actual		Flight 1 Observer 1		Flight 1 Observer 2		Flight 2 Observer 1		Flight 2 Observer 2	
	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests
Week four										
Bitter Lake	8	0	**6**	0	6	0	13	3	11	3
Spring Lake	5	2	4	2	5	2	8	4	9	4
Dahling **Slough**	1	0	1	0	1	0	0	0	0	0
Hazelden Lake	5	2	3	2	3	2	4	2	4	2
Mydland South	2	0	0	0	0	0	3	0	3	0
Mydland North	5	3	5	2	6	2	3	2	3	**2**

* **Week one data were not used in analysis.**

Table 13. Actual and observed indicated pairs and nests from 1975, aerial circling survey study.

Week Wetland Unit	Actual		Flight 1 Observer 1		Flight 1 Observer 2		Flight 2 Observer 1		Flight 2 Observer 2	
	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests
Week one										
Bitter Lake	30	10	9	4	10	4	12	5	11	5
Spring Lake	5	3	7	3	8	4	3	1	4	2
Dahling Slough	0	0	0	0	0	0)	0	0	0	0
Hazelden Lake	7	3	6	3	5	3	3	3	2	2
Mydland South	1	0	1	0	1	0	0	0	f)	0
Mydland North	7	0		0	3	0	3	1	3	1
Week two										
Bitter Lake	34	8	19	6	19	6	14	4	19	6
Spring Lake	4	1	3	1	3	1	2	1	6	1
Dahling Slough	0	0	0	0	0	0	0	0	0	0
Hazelden Lake	5	2	3	2	3	2	5	3	4	2
Mydland South	1	0	0	0	0	0	1	0	1	0
Mydland North	3	0	6	0	3	0	2	0	2	0
Week three										
Bitter Lake	38	4	21	3	25	3	14	5	10	5
Spring Lake	5	1	3	1	3	1	3	2	4	2
Dahling Slough	0	0	0	0	0	0	0	0	0	0
Hazelden Lake	2	1	2	0	2	0	3	1	2	1
Mydland South	0	0	0	0	0	0	0	0	0	0
Mydland North	4	0	4	0	4	0	4	1	6	2

Table 13. Continued.

	Actual		Flight 1 Observer 1		Flight 1 Observer 2		Flight 2 Observer 1		Flight 2 Observer 2	
Week Wetland Unit	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests	Indicated Pairs	Number Nests
Week four										
Bitter Lake	28	0	13	0	11	0	11	0	3	0
Spring Lake	1	0	4	0	3	0	3	0	3	0
Dahling Slough	0	0	0	0	0	0	0	0	0	0
Hazelden Lake	8	0	S	0	3	0	0	0	0	0
Mydland South	0	0	O	0	0	0	0	0	0	0
Mydland North	2	0	2	0	2	0	2	0	2	0

la 14, Combined nested and factorial analysis of variance results 1974 indicated pair difference (actual minus observed plus 10), al circling survey study.

	Degrees of Freedom	Sums of Squares	Mean Squares
	2	58.90	29.45*
	5	28.59	5.72*
	10	61.60	6.16*
	3	4.23	1.41
	5	6.98	1.40
	6	0.31	0.05
	36	31.21	0.87

a W week, Uwetland unit, F-flight and 0-observer.

Table 15. Combined nested and factorial analysis of variance results for 1974 nest difference (actual minus observed plus 10), aerial circling survey study.

Source[a]	Degrees of Freedom	Sums of Squares	Mean Square
W	2	54.92	27.45*
U	5	116.25	23.25*
WxU	10	187.04	18.70*
F/W	3	36.90	12.30
UxF/W	5	16.58	3.32
0/F/W	6	6.12	1.02
Ux0/F/W	36	148.40	4.12

error mean square - 4.12

a Week, U'etland unit, Fflight and 0¨observer.

is sig nificant difference (p<.05).

Analysis of variance tests on data for indicated pairs in 1975 t shoved significant variation of factors of weeks, wetland units, week by unit interactions, flights within week interactions and unit by flight within week interactions (Table 16). Significant variation was found in the same factors and interactions for nest data in 1975 (Table 17).

Significant variation in the precision of aerial surveys between wetland units alone is reason to reject aerial circling surveys as a means of estimating Canada goose breeding populations. The fact that the observer factor was not significant in any of the analysis of variance tests is relatively unimportant. Accuracy estimates on the aerial survey technique tested in this study would be meaningless in view of the variations in precision. One of the most common sources of error in aerial surveys is that disproportionate numbers of animals are missed by observers (Sniff and Skoog 1964). Lack of precision found in this study indicates that disproportionate numbers of geese were missed by observers in the aerial circling survey as tested here.

Another technique for surveying breeding pairs of Canada geese in northeastern South Dakota was investigated on 6,011 km^2 (2321 square miles) of the study area. This technique is based on the one described by Stewart and Kantrud (1972) where random plots were searched for breeding birds.

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A random sample of 460 legal quarter sections (64.8 km) totalling 115 square miles (298 km^2) or 5 percent of the study area was selected. Two-hundred and eighty-five (62 percent) of the quarter ctions had no breeding pair habitat in April and May, 1975, when

Table 16. Combined nested and factorial analysis of variance results for 1975 indicated pair difference (actual minus observed plus 10), aerial circling survey study.

Source[s]	Degrees of Freedom	Sums of Squares	Mean Square
W	3	20.21	6.74*
U	5	4417.83	883.57*
WxU	15	180.42	12.03*
F/W	4	38.08	9.52*
UxF/W	20	172.42	8.62*
0/F/W	8	14.33	1.79
Uxo/F/W	40	74.67	1.87

error mean square = 1.87

a W-week, U'wetland unit, F=flight and 0-observer.

* Significant difference (p<.05).

Table 17. Combined nested and factorial analysis of variance results for 1975 nest difference (actual minus observed plus 10), aerial circling survey study.

Source[a]	Degrees of Freedom	Sums of Squares	Mean Square
	3	17.03	5.68*
U	5	57.05	11.41*
WxU	15	69.91	4.66*
F/W	4	5.13	1.28*
UxF/W	20	10.63	0.53*
0/F/W	8	0.25	0.31
UxO/F/W	40	4.25	0.11

error mean square - 0.11

a W'week, U-wetland unit, F-flight and O observer.

Significant difference (p<.05).

surveys were conducted. The remaining 175 sample units were intensely searched for breeding pairs and nests. Eleven nests and 34 indicated pairs were found on the 460 sample units. Modifications of this technique have been successfully used for surveys of breeding waterfowl populations in North Dakota (Stewart and Kantrud 1974) and South Dakota (Brewster et al. 1976).

The random plot survey needs more research. A stratification system would allow accuracy (confidence intervals) to be calculated (Stewart and Kantrud 1972). Stratification should be based on distribution of birds in terms of density of geese.

CONCLUSIONS

Landowner tolerance of the present population of Canada geese in northeastern South Dakota is high and goose damage problems are restricted to a small number of landowners near goose concentration was, Most complaints can be handled by allowing landowners to voice their problems to game agency officials. Technical assistance will be required in a few instances.

The majority of landowners in northeastern South Dakota will tolerate goose flock expansion and most landowners are willing to cooperate in controlling goose problems. These landowners are subject to influence by complaining neighbors and friends. Complaining landowners should be contacted immediately, before they can negatively influence others.

Many complaints can be diverted by contacting landowners with crop fields near goose concentration areas and informing them of game agency concern and available technical assistance. Landowner attitudes in potential problem areas should be continually monitored, especially during goose flock expansion and in years with high precipitation during the harvest season. Landowner attitudes should remain positive toward the geese if goose-related damages and complaints can be minimized.

Analysis of variance tests on aerial survey data for indicated Pairs and nests revealed significant variation in precision of aerial observations between weeks, wetland units and week by unit interactions for both years of this study. The aerial circling survey tested in this study is not precise. Estimates of Canada goose breeding pair populations based on this technique, using fixed-wing aircraft, are unreliable. Ground surveys of stratified randomly selected plots might be developed to provide acceptably accurate and reliable population estimates.

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