THESIS

PRODUCTIVITY OF CANADA GEESE IN LARIMER COUNTY, COLORADO 1967-1968

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY GARY C. WILL ENTITLED PRODUCTIVITY OF CANADA GEESE IN LARIMER COUNTY, COLORADO, 1967-1968 BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT OF THESIS

PRODUCTIVITY OF CANADA GEESE IN
LARIMER COUNTY, COLORADO, 1967-1968

Nesting Canada geese, Branta canadensis maxima, were studied during the breeding seasons of 1967 and 1968 to determine production in Larimer County. The resident flock was created by the Colorado Division of Game, Fish and Parks through introductions beginning in 1957. By 1962, the flock was considered well established and in need of no additional introductions.

A total of 396 geese (231 adults and 165 goslings) was neck banded to aid in the identification of individual birds and nesting pairs. Neck bands were devised from polyvinyl chloride tubing 0.04 inches thick with an inside diameter of 1.92 inches. Most pairs nested on man-made nesting sites, which included elevated structures, floating structures, and wooden boxes and wash tubs located on the ground. An average of 194 structures was available each year. In 1967 and 1968, 173 and 267 nests, respectively, were known to have been established and represented over 98 percent of all nesting attempts. The number of actual nest sites found was 168 in 1967 and 255 in 1968. Fifty-nine percent of all nests were on man-made structures and 34 percent were on islands. The mean clutch size was 4.74 ± 0.08

(mean ± standard error of the mean) for all nests. Successful nests averaged 5.15 ± 0.08 eggs, and unsuccessful nests, 3.75 ± 0.17. Clutch size ranged from 1 to 10 eggs; clutches of 5 eggs were most common. There was no significant difference in mean clutch size among nests located on all structures, elevated structures, natural sites, and ground sites, or between all nests in 1967 and 1968. Two dump nests and four undersized eggs were found. Nest success averaged 69 percent. Nests on structures were more successful (76 percent) than nests on natural sites (51 percent), and elevated nests were more successful (77 percent) than ground nests (55 percent). Nests containing six eggs were more successful (91 percent) than nests with fewer eggs (7-74 percent). Nest desertion, caused mostly by intraspecific conflict, was the greatest cause of nesting failure, but was no greater on man-made structures than on natural sites. Losses due to flooding and predation were minor. Structures greatly reduced predation. Two cases of renesting were known; one goose renested once, another twice. The overall hatching success of eggs was 80 percent. There was little difference in hatching success among nests on all structures (79 percent), elevated structures (80 percent), natural sites (84 percent), and ground sites (81 percent). The mean number of eggs hatched per successful nest was 4.11 ± 0.99. There was no significant difference in mean number of eggs hatched in nests on all structures, elevated structures, natural sites, and

ground sites. The proportion of eggs hatched was no greater in large clutches than in smaller clutches. Only 3.7 percent of eggs in successful nests were infertile. Embryonic deaths amounted to 15.2 percent, and occurred primarily during the very early or very late stages of development. "Gang broods" were common only on areas of high nesting density; they increased in size as the young-rearing period progressed. Goslings less than 3 weeks old were most vulnerable to adoption into other broods. Total gosling mortality was estimated at 26 percent. Mortality was greatest on areas of high nesting density, and ranged from 20 to 49 percent. Most mortality resulted from "gang broods" and the inability of the adults to care adequately for all young. The total number of goslings that survived to the flight stage was 374 in 1967 and 564 in 1968; an average of 3.0 goslings survived for every successful nesting attempt.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES--Continued

LIST OF TABLES--Continued

LIST OF TABLES--Continued

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The most magnificent of all North American waterfowl is the Canada goose (Branta canadensis). Because of its large size, extreme wariness, and keen sense of alertness, sportsmen have ranked it among the finest trophy animals of North America.

Canada geese were hunted so extensively by the early pioneers that most breeding populations were all but eliminated from the United States. Where local flocks managed to survive, they thrived as a result of man's progress in agriculture, as did the migrating flocks from the Canadian provinces. The millions of acres of grain cultivated annually, and the elaborate irrigation systems involving countless lakes and reservoirs, were as beneficial to geese as they were to man. With the help of waterfowl biologists and devoted conservationists, breeding populations of Canada geese began a period of steady increase.

Canada geese have adjusted well to man's modern environment and the population explosion. Because geese respond quickly to new management techniques and are easily reared in captivity, they have been the center of much attention in recent years and have offered a partial solution to the ever-growing need for outdoor recreation. Many state and federal conservation agencies have developed programs

designed to enhance the status of local breeding populations of Canada geese or to develop new populations through reintroductions. The primary objectives of most agencies are to: (1) develop a local population of adequate size which can be harvested, primarily by local sportsmen; and (2) contribute birds to their respective flyways to benefit all states involved. Many northern states now have resident or migrating populations, most of which were initiated from pinioned or captive birds.

Little is known of the early-day status of nesting Canada geese on the eastern plains of Colorado. If a nesting population did exist, it was eliminated at an early date (Bailey and Niedrach 1965). The Denver metropolitan goose flock originated from about a dozen captive birds that were at one time used as live decoys (Grieb 1963a). The small flock was purchased by Dan and Virgie Gallagher from a friend when the use of live decoys was outlawed in hunting waterfowl. The flock was released on Bowles Lake, Denver, where it later nested successfully. The progeny, upon reaching breeding age, began nesting throughout the Denver metropolitan area and the resident flock grew steadily. Grieb (1963a) suspected that some of the migrant geese which stopped in the Denver area became part of the resident flock.

The Colorado Division of Game, Fish and Parks became active in Canada goose propagation in 1957. By using birds obtained mostly from the Denver area, they were successful in establishing local breeding flocks on the eastern plains of Colorado, primarily in

Larimer and Boulder counties, and only recently in Weld County. The flocks grew rapidly under intensive management and acted as decoys, inducing a large number of northern geese to winter along the front range of the Rockies. In the fall of 1964, Canada geese were hunted in Larimer County for the first time since the establishment of local flocks. The primary objectives outlined by the Division had been met and local sportsmen enjoyed quality goose hunting where there was previously none.

Waterfowl biologists of today are confronted with the basic problem of maintaining waterfowl populations in the desired size, location, and variety. Intensive research on the biology of the Canada goose, combined with wise management, will assure the American sportsmen of quality waterfowl hunting for decades to come.

CHAPTER II

HISTORY OF CANADA GOOSE PROPAGATION IN EASTERN COLORADO

In 1954, the Colorado Division of Game, Fish and Parks initiated a program under their Federal Aid Waterfowl Project designed to establish resident Canada goose flocks throughout the state (Grieb 1957). The San Luis Valley, North Park, and the lake area adjacent to the foothills north of Denver were selected as potential introduction sites (Grieb 1956a). The program called for: (1) the experimental release of Canada goose goslings as nuclei for the establishment of resident breeding flocks, and the establishment of captive flocks as a source of gosling supply; and (2) artificial propagation and liberation experiments utilizing eggs collected from wild goose nests (Grieb 1956b). Canada geese obtained from the Bowdoin National Wildlife Refuge, Montana, and from C. Strutz, Jamestown, North Dakota, were used to build the captive flocks (Grieb 1956b). The Denver metropolitan flock was the source of eggs and most goslings.

Between 1958 and 1966, a total of 694 goslings and 159 adult Canada geese was released in north-central Colorado, primarily in Larimer County (College Lake and Terry Lake) and Boulder County (Valmont Reservoir) (Table 1). Several adults from Colorado City

Table 1. History of the release of Canada geese in north-central Colorado (1957-1966).

Year of Release	Adults: No. Released	Adults: Source	Goslings: No. Released	Goslings: Source	Release Site
1957 (Grieb 1958)	34	captives[a]	6	Denver[b]	College L.[c]
1958 (Banding Record 1958)[e]			23	Bonny Res.[d]	College L.
1959 (Grieb 1960)			49	Bonny Res. & Denver	College L.
1960 (Grieb & Sheldon 1961)			68	Bonny Res. & Denver	College L.
1961 (Grieb 1962)			96	Bonny Res. & Denver	Terry L.[c]
1962 (Grieb 1963b)			139	Denver	College L. (101) Terry L. (38)
1963 (Grieb 1964)	1	Denver	86	Denver	Valmont Res.[f]
1964 (Grieb 1965)			97	Denver	Valmont Res.
1965 (Grieb 1966)			130	Denver	Valmont Res.
1966 (Rutherford 1967)	124	Denver			Divide No. 8 Res.[c](43) New Windsor Res.[g](81)
Total	159		694		

[a]From captive flocks at Bonny Reservoir and Julesburg, Colorado; also includes several adults from Colorado City Park, Greeley, Colorado.

[b]Free-flying flock.

[c]Larimer County.

[d]Captive flock.

[e]Colorado Division of Game, Fish and Parks.

[f]Boulder County.

[g]Weld County.

Park, Greeley, Colorado; adults and goslings from the captive flocks at Bonny Reservoir and Julesburg, Colorado; and adults from the free-flying Denver metropolitan flock were the source of the release stock.

The early introduction attempts in Larimer County were unsuccessful, but a productive resident flock was eventually developed through continued effort. The first goslings were produced by the flock at College Lake in 1959 (Grieb 1960). By 1962, the Larimer County Canada goose flock was considered to be well established and in need of no additional introductions, the release of goslings was discontinued, and restoration efforts were concentrated in other counties (Grieb 1963). Productivity of the flock was adequate to maintain the population and provide a sizeable annual increase in breeding pairs (Table 2). In 1966, a total of 106 nests was established. Two hundred thirteen young were raised to the flight stage, boosting the resident population to over 750 birds (Rutherford 1967).

Growth of the Larimer County flock has been possible only through the establishment of a large number and variety of artificial nesting structures. Shortages of naturally occurring goose nesting sites led to the development of artificial sites. The net result of the nesting structures has been a significant increase in goose production (Rutherford 1962).

Table 2. Productivity of the Larimer County Canada goose flock (1957-1966), modified from Rutherford 1967.

Year	No. Birds of Breeding Age	No. Nests Established	No. Nests Successful	No. Birds Raised to Flight Stage	Approximate Size of Flock
1957	0	0	0	0	31
1958	0	0	0	0	54
1959	2	1	1	5	60
1960	8	4	4	14	120
1961	20	7	6	20	210
1962	53	23	21	79	400
1963	135	43	31	100	500
1964	250	68	59	154	600
1965	430	79	60	178	650
1966	500+[a]	106	75	213	750+[a]

[a]Difficult to make a good estimate.

The High Line Canada goose population, which migrates through central Colorado (Rutherford 1965), has been definitely affected by the success of the Larimer County resident flock. The majority of the High Line population now winters in Larimer, Boulder, and Weld counties. In January 1967, over 14,000 Canada geese were wintering in north-central Colorado (Rutherford 1967) (Table 3).

Table 3. January inventory of wintering Canada geese in north-central Colorado (1959-1967), modified from Rutherford 1967.

Year	Area			Total Census
	Boulder Co.	Metro-Denver	Larimer-Weld Co.	
1959	15	625	22	662
1960	65	1,039	660	1,764
1961	0	895	1,320	2,215
1962	0	670	1,945	2,916
1963	15	475	2,686	4,151
1964	80	1,260	3,836	5,791
1965	100	1,100	4,287	6,248
1966	580	1,514	5,966	9,948
1967	1,383	1,723	9,739	14,345

CHAPTER III

TAXONOMY OF BREEDING CANADA GEESE IN EASTERN COLORADO

Bailey and Niedrach (1965) stated that if the Continental Divide formed the barrier between early breeding races of Canada geese in Colorado, populations of the giant race could be expected in North Park and on the eastern plains. However, no specimens exist from these early populations because of extinction at the turn of the century.

The giant Canada goose (Branta canadensis maxima) was first described by Delacour (1951), who believed the race was extinct. In his description, Delacour delineated the breeding range of the non-migrating giant goose as the Great Plains of the central United States, which included North and South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, western Kentucky and Tennessee, and northern Arkansas.

H. C. Hanson, credited with the 1962 rediscovery of the giant Canada goose at Rochester, Minnesota (Hanson 1965), visited Colorado in October 1963 to make collections and observations of the resident Denver metropolitan flock, which was started from pinioned live decoys of eastern Colorado. Evidence obtained at that time identified the Denver flock as B. c. maxima, as well as the resident flock of

Larimer County, which was developed largely from progeny of Denver geese.

Hanson (1965) has expanded the area believed to be the original breeding range of the giant Canada goose to include states and provinces which are peripheral to the range given by Delacour. This description includes, among others, Colorado, Wyoming, and Montana east of the Rocky Mountains.

Canada geese (B. c. moffitti) from Montana and North Dakota supplemented goose introductions in Larimer County. B. c. moffitti and two smaller races, B. c. hutchinsii and B. c. parvipes, all migrate through Colorado (Grieb 1967), and it is suspected that a few have remained in Larimer County to breed. These three races may have interbred with the giant race to produce a diluted population of giant Canada geese.

Weights, measurements, and notes on white markings of molting adult and yearling Canada geese were taken during late June and early July of 1968 for the purpose of comparing the Larimer County flock to known populations of giant Canada geese, as well as to other races.

I sexed and aged all birds by cloacal examination and weighed them. Measurements taken included length of exposed culmen, culmen width, and length of middle toe including claw. I recorded the presence or absence of a small, often "hooklike" extension near the top of the posterior margin of the cheek patch, an excellent indicator of a B. c.

maxima population (Hanson 1965). The frequency of a white spot or bar across the forehead (limited to a spot above each eye in some individuals) and a pure white neck ring, which frequently occur in B. c. maxima (Hanson 1965), was determined.

Adult males averaged 3356 g, adult females 2914 g, yearling males 3269 g, and yearling females 2926 g (Table 4). These weights are considerably smaller than weights of B. c. maxima reported by Hanson (1965) (Table 5). By body weight alone, the Larimer County flock resembles B. c. interior more so than B. c. maxima.

The length of exposed culmen, in millimeters, of Larimer County geese was 57.5 $\pm$ 0.4 (mean $\pm$ standard error of the mean) for adult males, 56.3 $\pm$ 0.7 for yearling males, 57.2 $\pm$ 0.4 for adult and yearling males, 53.0 $\pm$ 0.4 for adult females, 54.5 $\pm$ 0.8 for yearling females, and 53.2 $\pm$ 0.4 for adult and yearling females. These measurements compared favorably with Hanson's (1965) for most B. c. maxima populations when a t test was applied (Table 6). The culmen width averaged 24.1 $\pm$ 0.1 for males and 22.9 $\pm$ 0.1 for females. The average length of middle toe and claw, in millimeters, was 103.1 $\pm$ 1.0 for adult males, 102.7 $\pm$ 0.9 for adult and yearling males, 97.2 $\pm$ 1.0 for adult females, and 96.9 $\pm$ 0.9 for adult and yearling females. Culmen width and middle toe length of Larimer County geese were very similar to those of B. c. maxima reported by Hanson (1965) (Tables 7 and 8).

Table 4. Body weights of molting Larimer County Canada geese (June 29-July 9, 1968).

Age and Sex Class	Sample Size	Mean Weight (g)	Range	Standard Deviation
Yearling males	26	3269	2494-3730	301
Adult males	74	3356	2704-4429	228
All males	100	3333	2494-4429	304
Yearling females	14	2926	2564-3357	245
Adult females	82	2914	2378-4243	329
All females	96	2915	2564-4243	318
All males and females	196	3129	2378-4243	375

Table 5. Body weights of Branta canadensis maxima and B. c. interior during the incubation and flightless period of the molt, modified from Hanson 1965.

Subspecies by Age and Sex Class	Locality	Date (mo/day/yr)	Period of Activity	Sample Size	Mean Weight (g)	Range
YEARLING MALES						
B. c. maxima	Missouri	6/17/63	molting	13	4593	
B. c. maxima	Thelon R., N.W.T.	7/2/64	molting	1	4540	
B. c. maxima	Missouri	7/2/63	molting	18	4308	
B. c. interior	Akimiski I., N.W.T.	7/16-21 1958 & 1959	molting	18	3853	3425-4065
ADULT MALES						
B. c. maxima	Missouri	6/17/63	molting	47	4886	
B. c. maxima	Saskatchewan	5/29/62	a	1	4780	
B. c. maxima	Missouri	7/2/63	molting	55	4626	
B. c. maxima	Alberta	5/5/62	incubating	1	4610	
B. c. maxima	Manitoba	7/19/62	molting	3	4477	4200-4800
B. c. maxima	South Dakota	7/10/63	molting	7	4192	3686-5018
B. c. maxima	South Dakota	7/9/63	molting	13	4104	3685-4905
B. c. interior	Akimiski I., N.W.T.	7/10-8/7 1958 & 1959	molting	45	3946	3140-5135
YEARLING FEMALES						
B. c. maxima	Missouri	6/17/63	molting	18	4026	
B. c. maxima	Thelon R., N.W.T.	7/4/64	molting	1	3859	
B. c. maxima	Missouri	7/2/63	molting	21	3742	
B. c. interior	Akimiski I., N.W.T.	7/10-27 1958 & 1959	molting	20	3235	
ADULT FEMALES						
B. c. maxima	Missouri	6/17/63	molting	61	4193	
B. c. maxima	Missouri	7/2/63	molting	74	3830	
B. c. maxima	Alberta	5/5/62	incubating	1	3790	
B. c. maxima	South Dakota	7/10/63	molting	8	3721	3402-4082
B. c. maxima	South Dakota	7/9/63	molting	9	3453	3289-3799
B. c. interior	Akimiski I., N.W.T.	7/12-8/8 1958 & 1959	molting	30	3349	2815-3870
B. c. interior	Ontario	5/28-6/6/59	incubating	8	3287	2925-3840

[a]With 1-week-old brood.

Table 6. Length of exposed culmen of Larimer County Canada geese compared with those of Branta canadensis maxima, B. c. moffitti, B. c. interior, and B. c. canadensis.[a]

Subspecies by Age and Sex Class	Sample Size	Mean Length (mm)	Range	Standard Deviation	Source of Geese	t Values
YEARLING MALES						
B. c. maxima	8	57.5 ± 0.7[b]	54-59	2.1	Minnesota	1.1431[c]
B. c. maxima (?)	10	56.3 ± 0.7	52.7-60.6	2.3	Larimer Co.	
B. c. interior	5	54.2 ± 0.04	53-55	0.1	Illinois	-2.0408[c]
ADULT MALES						
B. c. maxima	8	65.3 ± 1.4	61-72	4.0	Minnesota	7.2108
B. c. maxima	9	59.4 ± 1.0	54-62	3.1	Minnesota	1.9727[c]
B. c. maxima	10	58.3 ± 1.1	51-62	3.5	Manitoba	0.8328[c]
B. c. maxima (?)	41	57.5 ± 0.4	53.2-59.2	2.5	Larimer Co.	
B. c. interior	18	55.5 ± 0.6	51-60	2.6	Illinois	-2.7983
ADULT AND YEARLINGS MALES[d]						
B. c. maxima	16	60.0 ± 0.7	53-68	1.4	museum skins	4.2754
B. c. maxima	13	58.6 ± 0.8	55-63	2.9	South Dakota	1.7430[c]
B. c. maxima (?)	51	57.2 ± 0.4	52.7-60.6	2.5	Larimer Co.	
B. c. canadensis	15	56.1 ± 0.8	52-62	3.1	museum skins	-1.4153[c]
B. c. moffitti	14	54.6 ± 0.6	50-58	2.1	museum skins	-3.5635
B. c. interior	110	53.7 ± 0.3	49-61	2.8	Illinois	-7.6419
YEARLING FEMALES						
B. c. maxima (?)	6	54.5 ± 0.8	52.6-58.5	2.0	Larimer Co.	
B. c. maxima	6	52.7 ± 0.7	51-55	1.6	Minnesota	-1.7219[c]
B. c. interior	11	51.3 ± 0.6	46-53	1.9	Illinois	-3.2579
ADULT FEMALES						
B. c. maxima	14	59.8 ± 0.9	55-63	3.4	Minnesota	7.6870
B. c. maxima	6	54.8 ± 0.5	53-56	1.2	Manitoba	1.6121[c]
B. c. maxima	6	54.0 ± 2.0	51-56	5.0	Minnesota	0.7492[c]
B. c. maxima (?)	44	53.0 ± 0.4	47.3-57.9	2.7	Larimer Co.	
B. c. interior	19	49.9 ± 0.5	45-55	2.2	Illinois	-4.4140
ADULT AND YEARLING FEMALES[d]						
B. c. maxima	5	56.8 ± 1.1	55-61	2.5	museum skins	2.9627
B. c. maxima	8	53.5 ± 0.6	51-56	1.7	South Dakota	0.3158[c]
B. c. maxima (?)	50	53.2 ± 0.4	47.3-58.5	2.6	Larimer Co.	
B. c. moffitti	10	51.6 ± 0.8	47-56	2.5	museum skins	-1.7879[c]
B. c. canadensis	11	51.0 ± 0.8	45-55	2.8	museum skins	-2.5054
B. c. interior	92	49.8 ± 0.3	43-56	2.4	Illinois	-7.8413

[a] All data from Hanson (1965) except for Larimer County.
[b] Mean ± standard error of the mean.
[c] Significant at the 5-percent level.
[d] Does not include immatures (5-8 months old).

Table 7. Width of culmen at midpoint of nares of Larimer County Canada geese compared with those of Branta canadensis maxima, B. c. moffitti, B. c. interior, and B. c. canadensis, yearlings and males combined.[a]

Sex and Subspecies	Sample Size	Mean Width (mm)	Range	Standard Deviation	Source of Geese	t Values
MALES						
B. c. maxima	19	24.6 ± 0.2[b]	23.0-25.7	0.8	Minnesota	2.3266
B. c. maxima (?)	51	24.1 ± 0.1	21.4-26.5	0.8	Larimer Co.	
B. c. maxima	14	24.0 ± 0.6	22.9-26.8	2.3	museum skins[c]	-0.2587[d]
B. c. interior	22	22.8 ± 0.2	21.0-24.1	0.8	Illinois	-6.3756
B. c. moffitti	10	22.2 ± 0.1	21.7-22.9	0.4	museum skins	-7.3359
B. c. canadensis	14	22.1 ± 0.2	21.1-23.3	0.7	museum skins	-8.5106
FEMALES						
B. c. maxima	10	23.8 ± 0.3	22.3-25.4	1.0	Minnesota	2.5981
B. c. maxima	3	23.5 ± 0.2	22.6-24.5	0.3	museum skins	1.0368[d]
B. c. maxima (?)	50	22.9 ± 0.1	20.9-24.9	1.0	Larimer Co.	
B. c. interior	20	21.4 ± 0.1	20.7-22.7	0.6	Illinois	-6.2761
B. c. moffitti	6	21.0 ± 0.3	20.0-21.8	0.7	museum skins	-4.5259
B. c. canadensis	11	21.1 ± 0.3	20.2-22.4	0.3	museum skins	-5.9132

[a]All data from Hanson (1965) except for Larimer County.
[b]Mean ± standard error of the mean.
[c]Culmens from museum skins would have undergone a slight amount of shrinkage.
[d]Significant at the 5-percent level.

Table 8. Length of middle toe and claw of Larimer County Canada geese compared with those of Branta canadensis maxima, B. c. moffitti, B. c. interior, and B. c. canadensis.[a]

Subspecies by Ages and Sex Class	Sample Size	Mean Width (mm)	Range	Standard Deviation	Source of Geese	t Values
ADULT MALES						
B. c. maxima	8	106.5 ± 0.9[b]	104-112	2.6	Minnesota	1.4362[c]
B. c. maxima (?)	42	103.1 ± 1.0	91.2-113.5	6.6	Larimer Co.	
B. c. maxima	15	101.6 ± 1.1	92-108	4.4	Minnesota	-0.8182[c]
B. c. maxima	10	100.3 ± 1.7	88-108	5.5	Manitoba	-1.2430[c]
B. c. interior	25	95.0 ± 0.6	91-100	2.8	Illinois	-5.8344
YEARLING AND ADULT MALES[d]						
B. c. maxima (?)	51	102.7 ± 0.9	89.9-113.5	6.7	Larimer Co.	
B. c. maxima	12	98.3 ± 1.4	92-107	5.0	museum skins	-2.1400
B. c. moffitti	8	94.6 ± 1.4	86-100	3.9	museum skins	-3.3327
B. c. canadensis	7	90.1 ± 1.1	86-94	3.0	museum skins	-4.9061
ADULT FEMALES						
B. c. maxima	13	98.9 ± 1.6	90-110	5.9	Minnesota	0.8157[c]
B. c. maxima (?)	44	97.2 ± 1.0	84.3-112.4	6.8	Larimer Co.	
B. c. maxima	11	94.1 ± 1.4	88-105	4.8	Minnesota	-1.4262
B. c. maxima	6	90.0 ± 1.1	87-95	2.8	Manitoba	-2.5652
B. c. interior	20	89.0 ± 0.5	84-92	2.3	Manitoba	-5.2597
YEARLING AND ADULT FEMALES[d]						
B. c. maxima (?)	49	96.9 ± 0.9	84.0-112.4	6.6	Larimer Co.	
B. c. maxima	5	92.4 ± 3.0	87-100	6.8	museum skins	-1.4484[c]
B. c. canadensis	3	87.3 ± 0.1	87-88	0.2	museum skins	-2.5196

[a]All data from Hanson (1965) except for Larimer County
[b]Mean ± standard error of the mean.
[c]Significant at the 5-percent level.
[d]Does not include immatures (5-8 months old).

A white forehead spot or bar was present in 18 percent of all geese examined, in 25 percent of the males, and in 11 percent of the females (Table 9). Signs of a white neck ring were evident in 43 percent of all geese examined, in 52 percent of all males, and in 34 percent of all females. The posterior margin of the cheek patch was extended in 35 percent of all geese examined, in 43 percent of the males, and in 28 percent of the females.

Canada geese of Larimer County strongly resemble giant Canada geese of some Eastern populations. If interbreeding has occurred between the four races of geese present in the county, the dilution of the dominant B. c. maxima has been slight, except for a possible decrease in body weight. Because of the similarities between the Larimer County flock and known populations of giant geese, I have assumed that the Canada geese of Larimer County are Branta canadensis maxima.

Table 9. The occurrence of white forehead markings, white neck rings, and cheek-patch extensions (all which frequently occur in Branta canadensis maxima) in Larimer County Canada geese (June 27-July 29, 1968).

Type of Marking	Age and Sex Class	Sample Size	No. With	% With
White forehead spot	Adult males	44	11	25.0
	Yearling males	12	3	25.0
	All males	56	14	25.0
	Adult females	46	6	13.0
	Yearling females	7	0	0.0
	All females	53	6	11.3
	All males and females	109	20	18.3
White neck ring	Adult males	44	23	52.2
	Yearling males	12	6	50.0
	All males	56	29	51.7
	Adult females	46	16	34.7
	Yearling females	7	2	28.5
	All females	53	18	33.9
	All males and females	109	47	43.1
Extended cheek patch	Adult males	34	15	44.1
	Yearling males	8	3	37.5
	All males	42	18	42.8
	Adult females	38	10	26.3
	Yearling females	2	1	50.0
	All females	40	11	27.5
	All males and females	82	29	35.3

CHAPTER IV

DESCRIPTION OF STUDY AREAS

Larimer County is located in extreme north-central Colorado. The eastern one-fourth of the county extends into the short grass region of the Great Plains, and the western three-fourths is in the Rocky Mountains.

The area east of the foothills is characterized by flat to gently rolling topography, agriculture, industry, and a rapidly growing metropolitan and suburban population. The Cache La Poudre River flows from the mountains through Fort Collins, and southeast out of the county. A great network of irrigation canals and reservoirs, combined with naturally occurring lakes, ponds and marshes, have resulted in ideal waterfowl habitat. The resident Canada goose flock is concentrated in this area, which extends from the town of Waverly in the north to Loveland in the south (Fig. 1). The Big Thompson River, south of Loveland, also flows southeast through the county, and has made possible an irrigation system comparable to that of the Fort Collins area, with equally high waterfowl potential. Small flocks of geese breed in this area, which extends from Loveland in the north to the Larimer County boundary in the south (Fig. 1).

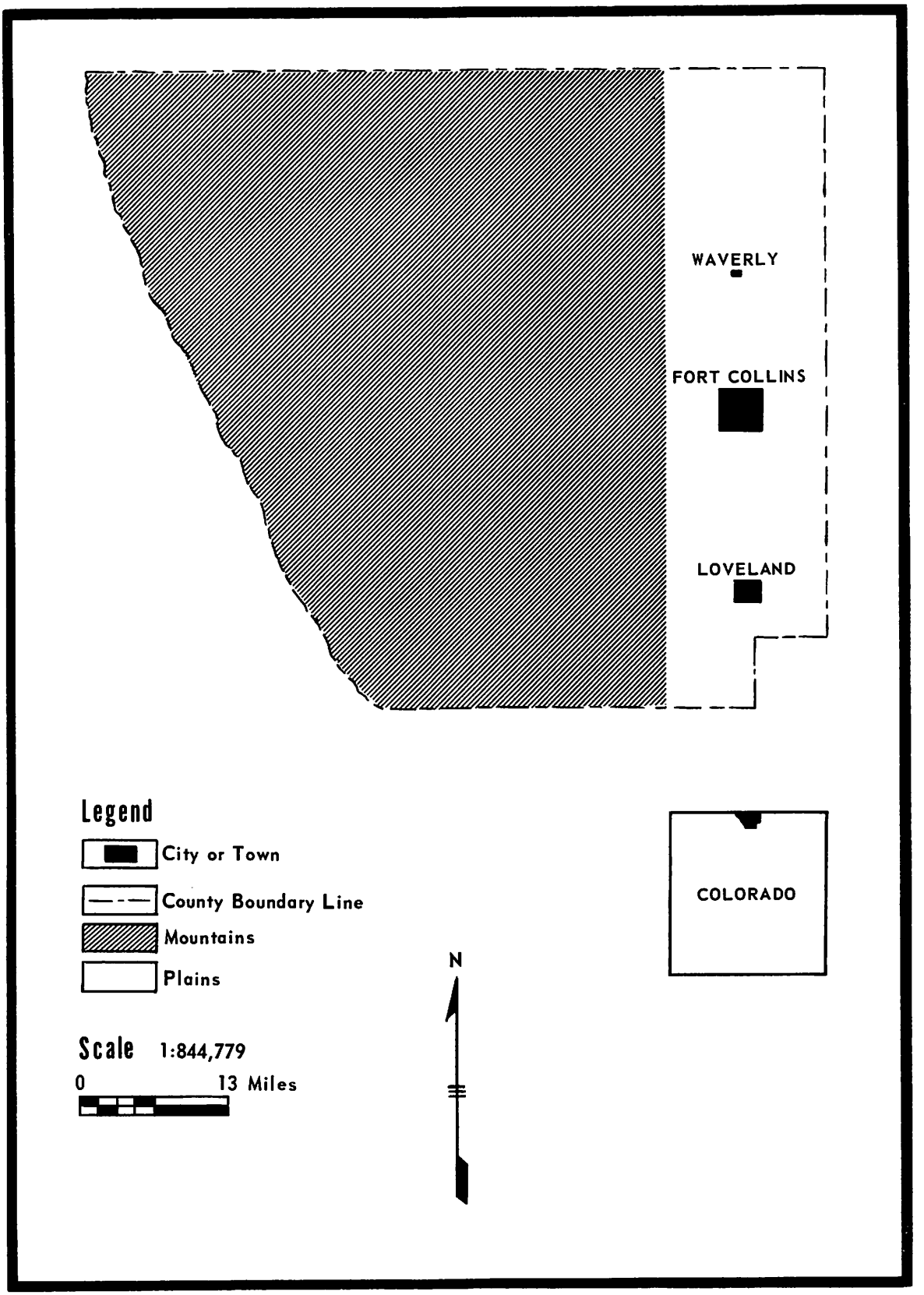

Fig. 1. Larimer County, Colorado.

I established two study areas which included all Canada goose production in Larimer County as well as all bodies of water used by geese for resting and loafing. The Fort Collins Study Area encompassed approximately 425 square miles. It extended from the foothills in the west to the county boundary in the east, and from Township 10 North, south to Loveland and Colorado Highway 34. I studied all major bodies of water within this area, and smaller lakes, ponds, and marshes with nesting potential (Fig. 2). This study area included 100 bodies of water, which covered approximately 11,150 surface acres (excluding the Cache La Poudre River). The legal description of each water area is presented in Table 10. A general description of physical characteristics of water areas used by Canada geese during the 1967 and 1968 breeding seasons appears in Table 11.

The Loveland Study Area covered approximately 125 square miles and included all major bodies of water and smaller bodies with nesting potential. This study area extended from the foothills to the eastern and southern county boundaries, north to Loveland and Colorado Highway 34 (Fig. 3). I studied 23 water areas, which covered approximately 2,000 surface acres (excluding the Big Thompson River). The legal description of each water area, and a general description of physical characteristics of water areas used by geese during the 1967 and 1968 breeding seasons appear in Tables 12 and 13, respectively.

Names of water areas appearing on the Larimer County Highway Map, published by Executive Presentations, Loveland, Colorado, or recently applied names used by irrigation companies or landowners were also used in this study. In several cases I named small ponds and marshes which were previously unnamed.

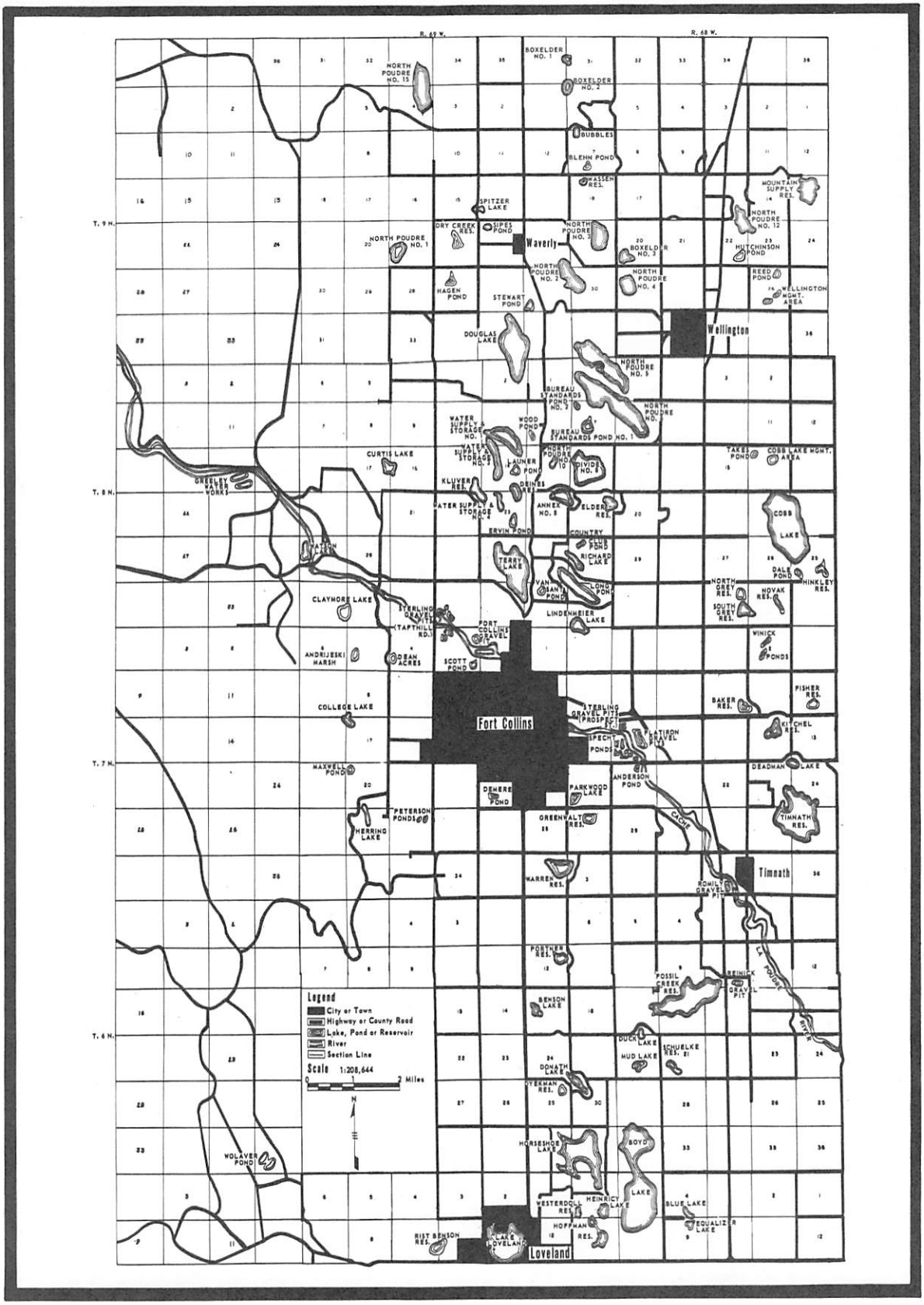

Fig. 2. The Fort Collins Study Area and the 100 bodies of water which were under observation during the 1967 and 1968 breeding seasons.

Table 10. Legal description of bodies of water under observation in the Fort Collins Study Area.

Water Area	Township	Range	Section
Anderson Pond[a]	T. 7 N.	R. 68 W.	20
Andrijeski Marsh[a]	T. 7 N.	R. 69 W.	5
Annex No. 8	T. 8 N.	R. 68 W.	18, 19
	T. 8 N.	R. 69 W.	13, 14
Baker Reservoir	T. 7 N.	R. 68 W.	10, 11
Benson Lake	T. 6 N.	R. 68 W.	13
Blehm Pond[a]	T. 9 N.	R. 68 W	7
Blue Lake	T. 5 N.	R. 68 W.	4
Boxelder No. 1	T.10 N.	R. 68 W.	31
	T.10 N.	R. 69 W.	36
Boxelder No. 2	T. 9 N.	R. 68 W.	6
	T. 9 N.	R. 69 W.	1
	T.10 N.	R. 68 W.	31
	T.10 N.	R. 69 W.	36
Boxelder No. 3	T. 9 N.	R. 68 W.	20
Boyd Lake	T. 5 N.	R. 68 W.	5, 6, 7, 8
	T. 6 N	R. 68 W.	29, 30, 31, 32
Bubbles	T. 9 N.	R. 68 W.	6, 7
Bureau Standards Pond 1	T. 8 N.	R. 68 W.	7
Bureau Standards Pond 2	T. 8 N.	R. 68 W.	7
Cache La Poudre River			
Claymore Lake	T. 8 N.	R. 69 W.	31, 32
Cobb Lake	T. 8 N.	R. 68 W.	13, 14, 23, 24, 25, 26
Cobb Lake Mgmt. Area	T. 8 N.	R. 68 W.	14
College Lake	T. 7 N.	R. 69 W.	7, 8, 17, 18
Country Club Pond[a]	T. 8 N.	R. 68 W.	21, 22, 27, 28
Curtis Lake	T. 8 N.	R. 69 W.	16, 17
Dale Pond[a]	T. 8 N.	R. 68 W.	25
Deadman Lake	T. 7 N.	R. 68 W.	13, 14, 23, 24
Dean Acres[a]	T. 7 N.	R. 69 W.	4, 5
Deines Reservoir[a]	T. 8 N.	R. 69 W.	14, 23
Demere Pond[a]	T. 7 N.	R. 69 W.	23
Divide No. 8	T. 8 N.	R. 68 W.	18
Donath Lake	T. 6 N.	R. 68 W.	13, 19
	T. 6 N.	R. 69 W.	24, 25

Table 10. Legal description of bodies of water under observation in the Fort Collins Study Area--continued.

Water Area	Township	Range	Section
Douglas Lake	T. 8 N.	R. 69 W.	1, 2
	T. 9 N.	R. 69 W.	25, 26, 35, 36
Dry Creek Reservoir	T. 9 N.	R. 69 W.	22
Duck Lake	T. 6 N.	R. 68 W.	17, 20
Dyekman Reservoir[a]	T. 6 N.	R. 69 W.	25
Elder Reservoir	T. 8 N.	R. 68 W.	17, 18, 19, 20
Equalizer Lake	T. 5 N.	R. 68 W.	9
Ervin Pond[a]	T. 8 N.	R. 69 W.	23
Fisher Reservoir[a]	T. 7 N.	R. 68 W.	12
Flatiron Gravel Pits[a]	T. 7 N.	R. 68 W.	17
Fort Collins Gravel Pit[a]	T. 7 N.	R. 69 W.	3
Fossil Creek Reservoir	T. 6 N.	R. 68 W.	9, 10, 15, 16, 17
Greeley Water Works	T. 8 N.	R. 68 W.	14, 23
Greenwalt Reservoir[a]	T. 7 N.	R. 68 W.	30
Hagen Pond[a]	T. 9 N.	R. 69 W.	27
Heinricy Lake	T. 5 N.	R. 68 W.	6, 7
Herring Lake[a]	T. 7 N.	R. 69 W.	20, 29
Hinkley Reservoir[a]	T. 8 N.	R. 68 W.	25
Hoffman Reservoir	T. 5 N.	R. 68 W.	6, 7
Horseshoe Lake	T. 5 N.	R. 68 W.	6
	T. 5 N.	R. 69 W.	1
	T. 6 N.	R. 68 W.	30, 31
	T. 6 N.	R. 69 W.	36
Hutchinson Pond[a]	T. 9 N.	R. 68 W.	22
Kitchel Reservoir	T. 7 N.	R. 68 W.	14
Kluver Reservoir	T. 8 N.	R. 69 W.	14, 15, 22
Lake Loveland	T. 5 N.	R. 69 W.	11, 14
Launer Pond[a]	T. 8 N.	R. 69 W.	14
Lindenmeier Lake	T. 7 N.	R. 68 W.	6
	T. 8 N.	R. 68 W.	31
Long Pond	T. 8 N.	R. 68 W.	30, 31
	T. 8 N.	R. 69 W.	25, 26
Maxwell Pond[a]	T. 7 N.	R. 69 W.	20
Mountain Supply Reservoir	T. 9 N.	R. 68 W.	13
Mud Lake[a]	T. 6 N.	R. 68 W.	17, 20
North Grey Reservoir	T. 8 N.	R. 68 W.	34, 35
North Poudre No. 1	T. 9 N.	R. 69 W.	21

Table 10. Legal description of bodies of water under observation in the Fort Collins Study Area--continued.

Water Area	Township	Range	Section
North Poudre No. 2	T. 9 N.	R. 68 W.	30
	T. 9 N.	R. 69 W.	24, 25
North Poudre No. 3	T. 9 N.	R. 68 W.	18, 19
North Poudre No. 4	T. 9 N.	R. 68 W.	29
North Poudre No. 5	T. 8 N.	R. 68 W.	5, 6
	T. 9 N.	R. 68 W.	31
North Poudre No. 6	T. 8 N.	R. 68 W.	5, 6, 7, 8
	T. 9 N.	R. 68 W.	31
North Poudre No. 10	T. 8 N.	R. 69 W.	13
North Poudre No. 12	T. 9 N.	R. 68 W.	14, 15, 22, 23
North Poudre No. 15	T. 9 N.	R. 69 W.	4
	T.10 N.	R. 69 W.	33
Novak Reservoir[a]	T. 8 N.	R. 68 W.	35
Parkwood Lake	T. 7 N.	R. 68 W.	19
Peterson Ponds[a]	T. 7 N.	R. 69 W.	28
Portner Reservoir	T. 6 N.	R. 69 W.	12
Reed Pond[a]	T. 9 N.	R. 68 W.	26
Richard Lake	T. 8 N.	R. 68 W.	30
	T. 8 N.	R. 69 W.	25
Reinick Gravel Pit[a]	T. 6 N.	R. 68 W.	10
Rist Benson Reservoir	T. 5 N.	R. 69 W.	9, 10
Romily Gravel Pit[a]	T. 7 N.	R. 68 W.	34
Schuelke Reservoir[a]	T. 6 N.	R. 68 W.	21
Scott Pond[a]	T. 7 N.	R. 69 W.	3
Sipes Pond[a]	T. 9 N.	R. 69 W.	23
South Grey Reservoir	T. 8 N.	R. 69 W.	34, 35
Specht Ponds[a]	T. 7 N.	R. 68 W.	17
Spitzer Lake	T. 9 N.	R. 69 W.	14, 15
Sterling Gravel Pits (Prospect Street).[a]	T. 7 N.	R. 68 W.	17
Sterling Gravel Pits (Taft Hill Road).[a]	T. 7 N.	R. 69 W.	3
	T. 8 N.	R. 69 W.	33, 34

Table 10. Legal description of bodies of water under observation in the Fort Collins Study Area--concluded.

Water Area	Township	Range	Section
Stewart Pond[a]	T. 9 N.	R. 69 W.	25
Takes Pond[a]	T. 8 N.	R. 68 W.	14
Terry Lake	T. 8 N.	R. 69 W.	25, 26, 35, 36
Timnath Reservoir	T. 7 N.	R. 68 W.	23, 24, 25, 26
VanSant Pond[a]	T. 8 N.	R. 69 W.	36
Warren Reservoir	T. 7 N.	R. 68 W.	31
	T. 7 N.	R. 69 W.	36
Wassen Reservoir	T. 9 N.	R. 68 W.	18
Water Supply & Storage No. 1	T. 8 N.	R. 68 W.	10, 11, 14
Water Supply & Storage No. 3	T. 8 N.	R. 68 W.	10, 11, 14, 15
Water Supply & Storage No. 4	T. 8 N.	R. 69 W.	14, 23
Watson Lake	T. 8 N.	R. 69 W.	30
	T. 8 N.	R. 70 W.	25
Wellington Mgmt. Area	T. 9 N.	R. 68 W.	26
Westerdoll Reservoir	T. 5 N.	R. 68 W.	6, 7
Winick Ponds[a]	T. 7 N.	R. 68 W.	2
Wolaver Pond[a]	T. 6 N.	R. 70 W.	36
Wood Pond[a]	T. 8 N.	R. 69 W.	12

[a]Names which I designated for this study.

Table 11. General characteristics of water areas in the Fort Collins Study Area which were used by Canada geese during the 1967 and 1968 breeding seasons.

Water Area	Owner	Approx. Surface Acres at High Water Level	Primary Use	Recreation	Public Access	Special Features	Adjacent Land Use
Anderson Pond	J. A. Anderson	6	livestock	none	restricted	abandoned gravel pit; no emergent vegetation	agricultural
Andrijeski Marsh	J. J. W. Andrijeski	1	none	hunting	partially restricted	shallow; with dense cattails	agricultural
Annex No. 8	Windsor Reservoir and Canal Company	139	irrigation	none	restricted	shore line barren[a]	agricultural
Blehm Pond	L. C. Blehm	10	irrigation	none	partially restricted	shallow; with emergent vegetation	agricultural
Boxelder No. 3	North Poudre Irrigation Company	46	irrigation	fishing	unrestricted	leased to Colorado Division of Game, Fish and Parks	agricultural
Boyd Lake	Greeley-Loveland Ditch Company	1626	irrigation	boating fishing	unrestricted	leased to Colorado Division of Game, Fish and Parks	agricultural residential
Bureau of Standards Pond 1	U. S. Bureau Standards	39	none	none	restricted	peninsula; cattails on north side; natural lake	agricultural
Bureau of Standards Pond 2	U. S. Bureau Standards	3	none	none	restricted	shallow; with emergent vegetation	agricultural
Cache La Poudre River			irrigation	fishing hunting	partially restricted	many islands	agricultural industrial residential
Claymore Lake	Pleasant Valley Lake and Canal Company	72	irrigation	fishing	partially restricted	dike on south and east sides; no emergent vegetation	agricultural
Cobb Lake	Windsor Reservoir and Canal Company	659	irrigation	none	restricted	shore line barren[a]	agricultural
College Lake	Colorado State University	57	irrigation	none	restricted	geese fed by Colorado Division of Game, Fish and Parks; no emergent vegetation[a]	agricultural industrial
Country Club Pond	Fort Collins Country Club	14	irrigation	hunting	partially restricted	dense cattails around shore line	agricultural
Curtis Lake	Water Supply and Storage Company	158	irrigation	none	partially restricted	dense cattails on northwest side	agricultural industrial
Dale Pond	D. F. Peterson	8	irrigation	none	restricted	shallow; little emergent vegetation	agricultural
Deadman Lake	B. G. Weitzel	23	irrigation	none	restricted	natural lake; little emergent vegetation	agricultural
Dean Acres	P. Ramos	12	recreation	fishing	restricted to surrounding residenses	one island; shallow; dense aquatic vegetation	agricultural residential

Table 11. General characteristics of water areas in the Fort Collins Study Area which were used by Canada geese during the 1967 and 1968 breeding seasons--continued.

Water Areas	Owner	Approx. Surface Acres at High Water Level	Primary Use	Recreation	Public Access	Special Features	Adjacent Land Use
Deines Reservoir	M. L. Deines	36	irrigation	hunting	partially restricted	dike on south side; cattails and rushes on north and east sides	agricultural
Demere Pond	R. M. Demere	1	recreation	aesthetic	restricted	dike on east side	agricultural residential
Divide No. 8	Windsor Reservoir and Canal Company	371	irrigation	none	restricted	dike on south side; shore line barren[a]	agricultural
Douglas Lake	Windsor Reservoir and Canal Company	507	irrigation	none	restricted	dike on south and west sides; shore line barren[a]	agricultural
Dry Creek Reservoir	J. M. McClure	51	irrigation	limited hunting	partially restricted	dike on south side; shallow; dense cattails on north side	agricultural
Dykeman Reservoir	T. J. Dyckman	14	irrigation	none	partially restricted	dike on north side; shore line barren[a]	agricultural
Elder Reservoir	Windsor Reservoir and Canal Company	78	irrigation	none	restricted	dike on south side, little emergent vegetation	agricultural
Equalizer Lake	Greeley-Loveland Ditch Company	83	irrigation	fishing	unrestricted	leased to Colorado Division of Game, Fish and Parks; dense cattails on west side	agricultural
Ervin Pond	E. W. Stewart	12	irrigation	none	restricted	dike on south side; cattails and rushes on north side	agricultural
Flatiron Gravel Pits	Prospect Land Company	11	gravel removal	none	restricted	many islands; shallow; dense emergent vegetation	agricultural industrial residential
Fort Collins Gravel Pit	City of Fort Collins	5	recreation	fishing	unrestricted	one island; little emergent vegetation	agricultural industrial
Fossil Creek Reservoir	North Poudre Irrigation Company	692	irrigation	boating hunting	partially restricted	peninsula; dense cattails on north and west sides	agricultural
Greenwalt Reservoir	E. Greenwalt	35	irrigation	none	restricted	dike on east side; shore line barren[a]	agricultural
Hagen Pond	H. Hagen	9	irrigation	hunting	restricted to club members	dike on south side; cattails on north side	agricultural
Herring Lake	L. Burnes C. Herring	42	irrigation	fishing	partially restricted	dike on north side; little emergent vegetation[a]	agricultural
Hinkley Reservoir	North Poudre Irrigation Company	104	irrigation	fishing	restricted to club members	dike on southeast side; little emergent vegetation[a]	agricultural

Table 11. General characteristics of water areas in the Fort Collins Study Area which were used by Canada geese during the 1967 and 1968 breeding seasons--continued.

Water Areas	Owner	Approx. Surface Acres at High Water Level	Primary Use	Recreation	Public Access	Special Features	Adjacent Land Use
Hoffman Reservoir	Seven Lakes Irrigation Company	37	irrigation	none	restricted	little emergent vegetation	agricultural
Horseshoe Lake	Seven Lakes Irrigation Company	590	irrigation	fishing	unrestricted	leased to Colorado Division of Game, Fish and Parks; dense cattails on southwest side	agricultural residential
Hutchinson Pond	D. D. Hutchinson	9	irrigation	none	restricted	dike on south side; cattails on northwest side	agricultural
Kitchel Reservoir	Kitchel Reservoir Company	46	irrigation	fishing hunting	restricted to club members	dike on south side; cattails on north and east sides	agricultural
Launer Pond	R. Launer	3	irrigation	fishing	restricted	dike on south side; shallow; little emergent vegetation	agricultural
Lindenmeier Lake	Water Supply and Storage Company	96	irrigation	boating	restricted to club members	dense emergent vegetation on east and west sides	agricultural residential
Long Pond	Water Supply and Storage Company	184	irrigation	boating	restricted to club members	dike on south side; little emergent vegetation[a]	residential
Maxwell Pond	P. M. Maxwell	1	irrigation	none	restricted	shallow; shore line barren[a]	agricultural
North Grey Reservoir	Lake-Canal Irrigation Company	26	irrigation	hunting	restricted to club members	dike on south and west sides; cattails on north side	agricultural
North Poudre No. 1	North Poudre Irrigation Company	62	irrigation	none	restricted	dike on south side; shore line barren[a]	agricultural
North Poudre No. 2	North Poudre Irrigation Company	236	irrigation	boating hunting	restricted to club members	dike on south side; emergent vegetation on north side	agricultural
North Poudre No. 3	North Poudre Irrigation Company	149	irrigation	hunting	partially restricted	dike on southeast side; little emergent vegetation[a]	agricultural
North Poudre No. 5	North Poudre Irrigation Company	371	irrigation	boating hunting	restricted to club members	dike on south side; dense cattails on east side	agricultural
North Poudre No. 6	North Poudre Irrigation Company	456	irrigation	boating	restricted to club members	dike on south side; shore line barren[a]	agricultural
North Poudre No. 10	North Poudre Irrigation Company	36	irrigation	fishing	unrestricted	dike on east side; shore line barren[a]	agricultural
Novak Reservoir	H. F. Lind C. Novak	23	irrigation	none	restricted	dike on south side; dense cattails on north side	agricultural

Table 11. General characteristics of water areas in the Fort Collins Study Area which were used by Canada geese during the 1967 and 1968 breeding seasons--continued.

Water Areas	Owner	Approx. Surface Acres at High Water Level	Primary Use	Recreation	Public Access	Special Features	Adjacent Land Use
Parkwood Lake	Parkwood Homes Association	20	recreation	aesthetic fishing	restricted to surrounding residences	dense aquatic vegetation	industrial residential
Peterson Ponds	F. G. Peterson	5	trout production	fishing	restricted	two ponds; dikes on east sides; dense cattails	agricultural residential
Reed Pond	R. E. Reed	1	irrigation	none	restricted	one small island; shallow	agricultural
Richard Lake	Water Supply and Storage Company	65	irrigation	fishing	unrestricted	dike on south side; shore line barren[a]	agricultural
Reinick Gravel Pit	R. Reinick	3	livestock	none	restricted	shallow; shore line barren due to livestock	agricultural
Rist Benson Reservoir	Louden Ditch Company	47	irrigation	none	restricted	dike on south side; little emergent vegetation[a]	agricultural residential
Romily Gravel Pit	Romily Angus Inc.	30	gravel removal	none	restricted	two islands; steep banks; no emergent vegetation	agricultural
Schuelke Reservoir	G. A. Schuelke	41	irrigation	hunting	restricted to club members	dike on southeast side; little emergent vegetation[a]	agricultural
Scott Pond	G. W. Scott	2	none	fishing	restricted	abandoned gravel pit; shallow	agricultural
Sipes Pond	R. Sipes	9	irrigation	none	restricted	dike on south side; no emergent vegetation[a]	agricultural
South Grey Reservoir	Lake-Canal Irrigation Company	59	irrigation	hunting	restricted to club members	dike on west side; little emergent vegetation[a]	agricultural
Specht Ponds	Great Western Sugar Company	10	livestock	fishing hunting	partially restricted	abandoned gravel pits; 11 shallow ponds, many islands; some emergent vegetation	agricultural
Spitzer Lake	North Poudre Irrigation Company	14	irrigation	fishing	unrestricted	dike on south side; shore line barren[a]	agricultural
Sterling Gravel Pits (Prospect Street)	River Bend Farms Inc.	20	gravel removal	none	restricted	two ponds; steep banks; no emergent vegetation	industrial
Sterling Gravel Pits (Taft Hill Road)	Sterling Sand and Gravel Company	35	gravel removal	none	restricted	six shallow ponds; many islands; some emergent vegetation	agricultural
Stewart Pond	W. Stewart	20	irrigation	none	restricted	dike on west side	agricultural

Table 11. General characteristics of water areas in the Fort Collins Study Area which were used by Canada geese during the 1967 and 1968 breeding seasons--concluded.

Water Areas	Owner	Approx. Surface Acres at High Water Level	Primary Use	Recreation	Public Access	Special Features	Adjacent Land Use
Takes Pond	R. T. Takes	2	recreation	fishing hunting	restricted	dike on west side; cattails on north side	agricultural
Terry Lake	Larimer and Weld Reservoir Company	427	irrigation	none	restricted	one large island; geese fed by Colorado Division of Game, Fish and Parks	agricultural residential
Timnath Reservoir	New Cache La Poudre Irrigation Company	576	irrigation	none	restricted	one island; peninsula; little emergent vegetation[a]	agricultural
VanSant Pond	B. F. VanSant	7	irrigation	none	restricted	shallow; some emergent vegetation	agricultural residential
Warren Reservoir	The Warren Lake Reservoir Company	136	irrigation	boating fishing	restricted to club members	dike on east side; shore line barren[a]	agricultural residential
Wassen Reservoir	North Poudre Irrigation Company	26	irrigation	none	restricted	dike on south side; little emergent vegetation	agricultural
Water Supply and Storage No. 1	Water Supply and Storage Company	208	irrigation	none	restricted	dike on south side; shore line barren[a]	agricultural
Water Supply and Storage No. 3	Water Supply and Storage Company	197	irrigation	none	partially restricted	dike on south side; shore line barren[a]	agricultural
Water Supply and Storage No. 4	Water Supply and Storage Company	115	irrigation	none	partially restricted	dike on south and east sides; dense cattails on north side	agricultural
Watson Lake	Colorado Division of Game, Fish and Parks	40	recreation	fishing	unrestricted	two islands; steep banks; no emergent vegetation	agricultural
Westerdoll Reservoir	Seven Lakes Irrigation Company	50	irrigation	none	partially restricted	shore line barren[a]	agricultural
Winick Ponds	A. Winick	7	none	none	restricted	alkali ponds; some emergent vegetation	agricultural
Wolaver Ponds	W. Wolaver	6	irrigation	none	restricted	two ponds; no emergent vegetation	agricultural
Wood Pond	R. L. Wood	1	none	none	restricted	shallow; steep banks; no emergent vegetation	agricultural

[a]Shore line mostly without vegetation due to fluctuating water level.

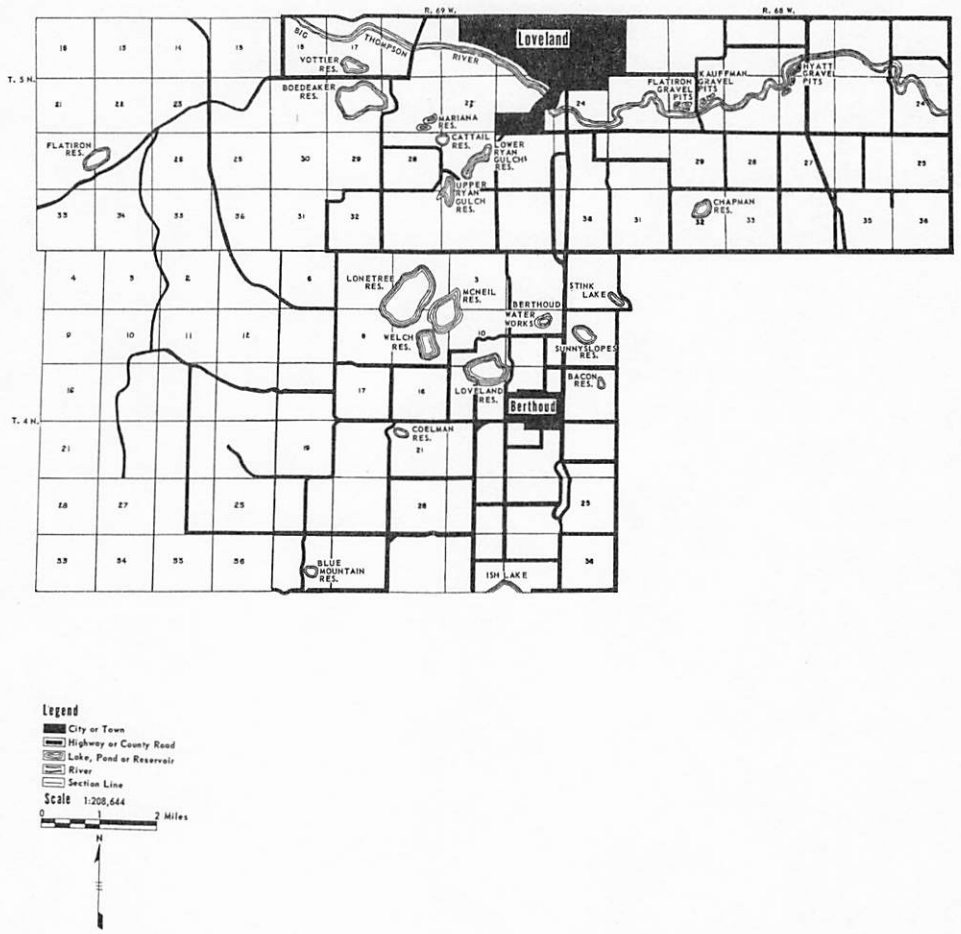

Fig. 3. The Loveland Study Area and the 23 bodies of water which were under observation during the 1967 and 1968 breeding seasons.

Table 12. Legal description of bodies of water under observation in the Loveland Study Area.

Water Area	Township	Range	Section
Bacon Reservoir	T. 4 N.	R. 69 W.	13
Berthoud Water Works	T. 4 N.	R. 69 W.	11
Big Thompson River			
Blue Mountain Reservoir	T. 4 N.	R. 69 W.	31
Boedeaker Reservoir	T. 5 N.	R. 69 W.	20, 21
Cattail Reservoir	T. 5 N.	R. 69 W.	27, 28
Chapman Reservoir	T. 5 N.	R. 68 W.	32
Coleman Reservoir	T. 4 N.	R. 69 W.	21
Flatiron Gravel Pits[a]	T. 5 N.	R. 68 W.	20
Flatiron Reservoir	T. 5 N.	R. 70 W.	27, 28
Hyatt Gravel Pits[a]	T. 5 N.	R. 68 W.	15, 21, 22
Ish Lake[b]	T. 4 N.	R. 69 W.	34, 35
Kauffman Gravel Pits[a]	T. 5 N.	R. 68 W.	20
Lonetree Reservoir	T. 4 N.	R. 69 W.	4, 5, 8, 9
Loveland Reservoir	T. 4 N.	R. 69 W.	10, 15
Lower Ryan Gulch Reservoir	T. 5 N.	R. 69 W.	27
Mariana Reservoir[a]	T. 5 N.	R. 69 W.	21
McNeil Reservoir	T. 4 N.	R. 69 W.	3, 4, 9, 10
Stink Lake[a, b]	T. 4 N.	R. 68 W.	6
	T. 4 N.	R. 69 W.	1
Sunnyslopes Reservoir	T. 4 N.	R. 69 W.	12
Upper Ryan Gulch Reservoir	T. 5 N.	R. 69 W.	27, 34
Vottier Reservoir	T. 5 N.	R. 69 W.	17
Welch Reservoir	T. 4 N.	R. 69 W.	9

[a]Names which I designated for this study.
[b]Only a portion of the lake is in Larimer County.

Table 13. General characteristics of water areas in the Loveland Study Area which were used by Canada geese during the 1967 and 1968 breeding seasons.

Water Areas	Owner	Approx. Surface Acres at High Water Level	Primary Use	Recreation	Public Access	Special Features	Adjacent Land Use
Big Thompson River			irrigation	fishing hunting	partially restricted	many islands	agricultural industrial residential
Boedeaker Reservoir	Home Supply Ditch Company	362	irrigation	boating	restricted to surrounding residences	dike on southeast side; two islands; little emergent vegetation[a]	agricultural residential
Chapman Reservoir	Gard Lateral Ditch Company	49	irrigation	fishing hunting	restricted to members	dense cattails on south and west sides	agricultural
Flatiron Gravel Pits	Flatiron Materials Company	8	gravel removal	none	partially restricted	many islands; steep banks; no emergent vegetation	agricultural
Flatiron Reservoir	U. S. Bureau of Reclamation	35	irrigation power	fishing	unrestricted	dike on northeast side; emergent vegetation on south side	agricultural
Hyatt Gravel Pits	Colorado Division of Game, Fish and Parks	20	recreation	fishing	unrestricted	abandoned gravel pits; many islands; little emergent vegetation	agricultural
Kauffman Gravel Pits	Kauffman Excavating Company	10	gravel removal	none	partially restricted	many islands; dense cattails	agricultural
Lonetree Reservoir	Home Supply Ditch Company	454	irrigation	fishing boating	unrestricted	leased to Colorado Division of Game, Fish and Parks	agricultural
McNeil Reservoir	Handy Ditch Company	157	irrigation	hunting	restricted to club members	dike on south side; one island; little emergent vegetation[a]	agricultural
Welch Reservoir	Handy Ditch Company	286	irrigation	fishing hunting	restricted to club members	dike on south side; dense cattails on southwest side	agricultural

[a]Shore line mostly without vegetation due to fluctuating water level.

CHAPTER V

METHODS OF STUDY

Field investigations in 1967 were begun on March 20 and were terminated on July 10. I made a reconnaissance of all bodies of water in the Fort Collins Study Area during the last 12 days of March and the first week of April. I located all artifical goose nesting structures which were erected by the Colorado Division of Game, Fish and Parks, and plotted their locations on aerial photographs. Total counts of Canada geese were made at each water area to determine the spring distribution of the breeding population. Notes on breeding behavior were recorded to aid in the establishment of the breeding chronology.

During each visit to a water area, I made a special effort to search all potential nesting habitat for newly established nests and to count all geese present. Most sites with artificial nesting structures were easily searched from a vehicle at one or more vantage points because of easy access, barren shore lines, or high visibility. The shore lines of remote lakes and reservoirs were searched on foot. Areas of high goose concentration (College and Watson lakes) were visited daily, when possible, and the more remote areas were visited once or twice per week. The search for nests continued throughout the period of egg laying and incubation.

When I discovered a nest, I plotted its location on an aerial photograph and recorded all data relating to the nest and nest site on a 5- by 8-inch Unisort Analysis Card. Following the discovery of a nest, I visited it once each week until its fate was apparent. Information concerning the status of the nest and the adults was added to the data card. College and Watson lakes were visited daily because of the large number of nests. All observations were made at a considerable distance from the nest without flushing the goose. I visited the actual nest site only twice throughout the period of occupation in an attempt to minimize disturbance and nest desertion. Nests were checked once to confirm the presence of eggs and again to count the eggs in completed clutches.

All eggs were collected following termination of each nest, whether nests were successful, deserted, or destroyed. Unhatched eggs remaining in nests which successfully hatched at least one gosling were opened and analyzed for embryonic development and fertility.

I was not permitted to trespass on reservoirs owned by Windsor Reservoir and Canal Company, or on Terry Lake, which is owned by the Larimer and Weld Reservoir Company. I was able to obtain some data on these areas by making observations from county roads and private land adjacent to them. Much of the nest data from these areas were supplied by G. I. Crawford, who also assisted in gathering data from nests on islands and on floating nest structures.

To determine the percent of 1-, 2-, and 3-year-old geese breeding in the population, I made an attempt to identify the numbers on U. S. Fish and Wildlife Service leg bands worn by nesting geese. A 20X to 60X Bushnell spotting scope and 7 X 35 Scope binoculars were used for this particular study, as well as in all other field observations.

The distance from each nest to the nearest permanent water was measured when the nest was first discovered. The distance from each nest to the nearest occupied nest was measured after the termination of both nests. To qualify for such a measurement, both nests had to be occupied simultaneously during either the period of egg laying or incubation. I used a Lufkin Hi-Line, 150-foot, woven, nonmetallic tape for all measurements.

Once hatching began, I maintained brood counts on all brood-rearing areas to determine gosling movement and mortality. These counts were conducted until the goslings reached flight stage or could not be distinguished from the adults.

I made a complete inventory of the population during the first week of July on all areas where brooding and molting occurred. The total number of adults (including yearlings) and goslings was recorded for each area. I believe this was a reliable census technique because of limited movement of geese between water areas during the molt period.

On July 5 and 6, 1967, I assisted personnel of the Colorado Division of Game, Fish and Parks in trapping and banding at Terry Lake, Watson Lake, and College Lake. All trapped geese were sexed and aged, then banded with U. S. Fish and Wildlife Service leg bands. At this time, I neck banded 396 geese, 231 of which were adults (not previously leg banded) and 165 were goslings with heads large enough to prevent band loss. Badly worn neck bands were replaced on eight recaptured adults. The bands made possible the identification of individual geese during the 1968 breeding season.

G. I. Crawford designed the neck bands, which were made from green polyvinyl chloride tubing 0.04 inches thick with an inside diameter of 1.92 inches. The material was purchased from the Industrial Division of the B. F. Goodrich Company, Denver, Colorado. Sections of tubing 1.50 inches long were cut to produce each neck band. A three-digit number consisting of inch-high figures was painted twice on the outside of each band with a 1/8-inch camel hair brush and a mixture of clear, liquid vinyl tinted with white titanium pigment. The pigmented vinyl fuzed with the neck band to produce permanent, brillant white numbers on a green background. To mark a goose for later identification, the neck band was simply slipped over the goose's head and allowed to ride at the base of the neck. One staple was used to reduce the inside diameter of neck bands applied to some small goslings once the band was slipped over the head.

A nesting study was not carried out in the Loveland Study Area during the 1967 breeding season because of the small goose population, the large land area involved, and the shortage of time. Instead, I made a complete reconnaissance of the study area on July 10. At this time I searched all bodies of water for broods and molting adults. This was considered to be a relatively accurate method of determining the number of goslings which reached the flight stage, as well as the total population in the study area.

Between July 31 and August 24, 1967, I assisted the Colorado Division of Game, Fish and Parks in erecting 31 man-made goose nesting structures throughout Larimer County. Twenty-one of the structures were erected in the Fort Collins Study Area and 10 were erected in the Loveland Study Area. The structures were placed only on water areas which had been used frequently by Canada geese during the previous breeding season. The new structures were under intensive observation during the 1968 breeding season to determine the degree of acceptance by nesting geese.

I resumed the study on March 15, 1968, and terminated it on July 9. Methods of investigation were identical to those used in 1967, with some minor modifications. The Windsor Reservoir and Canal Company granted me permission to trespass on their reservoirs, and I thoroughly searched all areas with potential nesting habitat. The Larimer and Weld Reservoir Company did not allow either the

Colorado Division of Game, Fish and Parks or me to trespass on their property to collect nesting data or to conduct trapping and banding operations. As a result, the actual number of nests, eggs, and goslings produced could not be determined. With little success, I took aerial photographs of nesting areas to locate nests. The 1968 production at Terry Lake was finally estimated by projecting 1967 production data. The final inventory of all geese was conducted from private land adjacent to the reservoir.

A Cessna 150 fixed-wing aircraft, piloted by F. A. Harrington, was used on April 4, April 24, and July 1, 1968, a total of 5.9 hours to take aerial photographs, search for geese and potential nesting sites, and to aid in the census of the entire population. A Cessna 185, owned by the Colorado Division of Game, Fish and Parks, and piloted by W. L. Russell, was used 1.7 hours on July 8 to aid in the census of the Loveland Study Area.

A 12-foot aluminum John boat, equipped with a Johnson 1-1/2-horsepower outboard motor, was used to search islands and the shore lines of large reservoirs for nests, and to collect data on those nests which had been established on floating nest structures.

I assisted the Colorado Division of Game, Fish and Parks in trapping operations at Dean Acres, Terry Lake, Watson Lake, and College Lake on June 27, July 3, July 5, and July 9, 1968, respectively. At this time I weighed and measured adult and yearling geese in order

to compare the Larimer County flock with known flocks of giant Canada geese. Measurements included culmen length, culmen width, and length of middle toe. Geese were weighed on a Chatillon spring platform scale. Weights were recorded to the nearest ounce and later converted to grams. Mauser vernier calipers were used for culmen and toe measurements.

Unlike 1967, a complete nesting study was carried out in the Loveland Study Area during the 1968 breeding season. The methods of study were identical to those used in the Fort Collins Study Area except that each nest was visited every 10 to 14 days instead of once each week.

Surface acreages of water areas were computed using a Keuffel and Esser planimeter on topographic maps published by the U. S. Geological Survey, and from 1963 aerial photographs provided by the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service.

CHAPTER VI

TYPES AND LOCATIONS OF MAN-MADE NESTING STRUCTURES

The acceptance of man-made nesting sites, or structures, by Canada geese has been widely documented (Yocum 1952; Ballou 1954; Harris and Harris 1959; Vaught 1960; Craighead and Stockstad 1961; Brakhage 1962, 1965). Marshes and islands, preferred nesting sites of the Canada goose throughout much of its range, are not abundant on the plains of eastern Larimer County. To compensate for this shortage, the Colorado Division of Game, Fish and Parks began erecting artificial nesting sites in 1957 on suitable areas to supplement the existing habitat.

Between 1967 and 1968, a great variety of man-made nesting structures were available to breeding geese. Included were galvanized wash tubs, ground boxes, elevated platforms, and floating rafts. Elevated platforms and floating structures were by far the most abundant. Elevated structures were of the following three types: (1) a four-legged structure which supported a wooden platform and several bales of hay or wood shavings, (2) a single-pole structure which supported a wash tub built in a wooden frame and filled with shavings, and (3) the most recent model, also of the single-pole type, but which supported a wooden nest box constructed of snow fence material. Four-pole

structures ranged in height from 4 to 5 feet, while single-pole structures were 7 to 8 feet high. The floating structures resembled a small canoe, were approximately 8 feet long and 2 feet wide, supported a low nest box and splash shield, and were anchored in strategic locations. Construction materials, dimensions, and suggestions for building and erecting the four major types of structures are described by Grieb and Crawford (1967).

In 1967, a total of 186 man-made nesting structures were available, all of which were in the Fort Collins Study Area (Table 14). Of these, 139 or 74.7 percent were of the elevated type; single-pole structures made up 37.1 percent and four-pole structures 37.6 percent. Thirty-one floating nests were available and amounted to 16.7 percent of the total. Ground boxes, tubs, and barrels formed 8.6 percent of the total number of available nesting structures.

During July and August of 1967, 33 new single-pole structures were erected on 13 different bodies of water, 31 by the Colorado Division of Game, Fish and Parks and 2 by the U. S. Bureau of Reclamation. Twenty-one of the structures were located in the Fort Collins Study Area and the remaining 12 in the Loveland Study Area (Table 15). Nine of the locations were previously without artificial structures. In several cases, the new structures were placed directly over of near old nest sites in hopes that they would be accepted the following spring, and that this would reduce losses to flooding and predation. Two tubs were added on College Lake and two elevated

Table 14. Location of 186 nesting structures available to Larimer County Canada geese during the 1967 breeding season[a].

Water Area	Types of Structure					
	Single-Pole	Four-Pole	Floating	Box or Tub	Other	Total
Anderson Pond	5					5
Annex No. 8	12					12
Bureau Standards Pond 1			2			2
Claymore Lake			4			4
College Lake	2	34	3			50
Dean Acres	1		3	10	1[b]	5
Divide No. 8	9		6	1		15
Dry Creek Reservoir			1			1
Elder Reservoir	12					12
Flatiron Gravel Pits	7					7
Herring Lake	5					5
Lindenmeier Lake	1	3				4
North Poudre No. 1			1			1
Peterson Pond	1					1
Schuelke Reservoir	1		1			2
Sterling Gravel Pits[c]			1			1
Sterling Gravel Pits[d]			2			2
Terry Lake		27				27
Timnath Reservoir	3		1			4
VanSant Pond	1					1
Watson Lake	9	6	6	3	1[e]	25
Total	69(37.1)[f]	70(37.6)	31(16.7)	14(7.5)	2(1.1)	186

[a]All structures were in the Fort Collins Study Area.

[b]Tire.

[c]Prospect Street.

[d]Taft Hill Road.

[e]Barrel.

[f]Percent.

Table 15. Location of 33 single-pole nesting structures erected throughout the Fort Collins and Loveland study areas during July and August 1967.

Water Area	Study Area	No. Erected
Bureau Standards Pond 2[a]	Fort Collins	1
Divide No. 8	Fort Collins	1
Dry Creek Reservoir	Fort Collins	2
Elder Reservoir	Fort Collins	1
Fossil Creek Reservoir[a]	Fort Collins	5
Kitchel Reservoir[a]	Fort Collins	4
North Grey Reservoir[a]	Fort Collins	2
North Poudre No. 1	Fort Collins	2
South Grey Reservoir[a]	Fort Collins	2
Takes Pond[a]	Fort Collins	1
Boedeaker Reservoir[a]	Loveland	6
Flatiron Reservoir[a]	Loveland	2
Welch Reservoir[a]	Loveland	4
TOTAL		33

[a]Areas previously without nesting structures.

platforms supporting baled hay were built on Dale Pond by landowners. Two floating structures were added just before the 1968 nesting season and several others were relocated on more favorable sites.

A number of structures which were available in 1967 were not available in 1968, either because of their removal or because of damage by shifting ice during late winter. Twenty-one four-pole structures were removed from Terry Lake by the Larimer and Weld Reservoir Company, two single-pole structures were rendered useless by ice, and one other was removed from College Lake by the Division.

In the 1968 breeding season, 201 man-made nesting structures were available to Larimer County geese, an increase of 15 over 1967. Ninety-five percent were in the Fort Collins Study Area with only 5 percent in the Loveland Study Area. Elevated structures amounted to 73.7 percent. Ninety-nine (49.3 percent) were single-pole, 49 (24.4 percent) were four-pole, 33 (16.4 percent) were floating and 20 (10 percent) were of miscellaneous types (Table 16).

The distance between nesting structures varied considerably from one area to the next. Generally, structures located along shore lines were spaced at about 150-foot intervals, although some were less than 50 feet apart and others more than 1000 feet. Structures on islands (i.e., Terry and Watson lakes) were closer than 150 feet. The distance between floating structures were generally more than 150 feet.

There was also great variation in the distance from nesting structures to the nearest water. Usually, structures were located as close to water as conditions would allow. In most cases they were well behind the winter high-water levels because of the constant

Table 16. Location of 201 nesting structures available to Larimer County Canada geese during the 1968 breeding season.

Water Area	Single-Pole	Four-Pole	Box or Floating	Box or Tub	Other	Total
FORT COLLINS STUDY AREA						
Anderson Pond	5					5
Annex No. 8	12					12
Bureau Standards Pond 1			1			1
Bureau Standards Pond 2	1					1
Claymore Lake			6			6
College Lake	1	34	3	12	1[a]	51
Dale Pond					2[b]	2
Dean Acres	1		5	1		7
Demere Pond			1			1
Divide No. 8	10		1			11
Dry Creek Reservoir	2					2
Dyekman Reservoir			1			1
Elder Reservoir	13					13
Flatiron Gravel Pits	7					7
Fossil Creek Reservoir	5		1			6
Herring Lake	5					5
Kitchel Reservoir	4					4
Lindenmeier Lake	1	3				4
North Grey Reservoir	2					2
North Poudre No. 1	2					2
Parkwood Lake			2			2
Peterson Ponds	1					1
Schuelke Reservoir	1					1
South Grey Reservoir	2					2
Sterling Gravel Pits[c]			1			1
Sterling Gravel Pits[d]			3			3
Takes Pond	1					1
Terry Lake		6				6
Timnath Reservoir	3					3
VanSant Pond	1					1
Watson Lake	9	6	7	3	1[e]	26
Wolaver Pond			1			1
Subtotal	89	49	33	16	4	191
LOVELAND STUDY AREA						
Boedeaker Reservoir	4					4
Flatiron Reservoir	2					2
Welch Reservoir	4					4
Subtotal	10	0	0	0	0	10
Total	99(49.3)[f]	49(24.4)	33(16.4)	16(8.0)	4(2.0)	201

[a]Tire.
[b]Erected by the landowner; similar to four-pole structure.
[c]Prospect Street.
[d]Taft Hill Road.
[e]Barrel.
[f]Percent.

threat of shifting ice. However, structures were frequently surrounded by water during the nesting period because of rising water levels brought on by the spring thaw. In all cases, structures were located in relatively open areas and offered a high degree of visibility.

CHAPTER VII

RESULTS AND DISCUSSION

PRENESTING PERIOD

During January and February of 1968, I visited a number of water areas in the Fort Collins Study Area, which were used heavily by Canada geese, to determine the prenesting activities and distribution of resident geese.

Weather was the primary factor influencing the distribution of geese during the prenesting period. Nearly all ponds, lakes, and reservoirs in the county were frozen throughout January and much of February. Geese used only those areas which were kept free from ice either by high concentrations of waterfowl or by electrically powered circulators (aerators). Those areas used most heavily were College Lake, Divide No. 8, Greenwalt Reservoir, Lindenmeier Lake, Terry Lake, and Watson Lake. Geese remained concentrated on these six areas until the spring thaw, which began during the last week of February. By the end of the first week in March, most of the water areas were free from ice, and the resident geese were widely distributed.

The first signs of breeding activity in Larimer County were noticed at College Lake during the week of January 15, when the average daily maximum and minimum temperatures for that week reached 48.7 F and 20.4 F, respectively (Fig. 4). Daily high temperatures for the week ranged from 35 to 54 F. Daily high temperatures for all of January ranged from 16 to 61 F, of which 23 days were at least 35 F or warmer. January 17 was the first day on which the mean daily temperature reached 35 F or over, and January 20 marked the first day of temperatures over 40 F (Fig. 5). This general warming trend, combined with increased day length, may have been partially responsible for triggering the start of the breeding period. I observed a number of pairs in the vicinity of nesting structures. These pairs, which I assumed to be the older birds in the population, were courting, selecting nest sites, and occasionally defending a nesting structure.

My findings are similar to those of other investigators. Brakhage (1965) discovered that giant Canada geese of Missouri began courtship in late January or early February, when daily high temperatures ranged from 35 F to 65 F. Kossack (1950) reported that the mean daily temperature was 45 F when courtship started in Illinois. Steel, Dalke, and Bizeau (1957) found that geese began breeding activities in Idaho before the marshes were free from ice and snow.

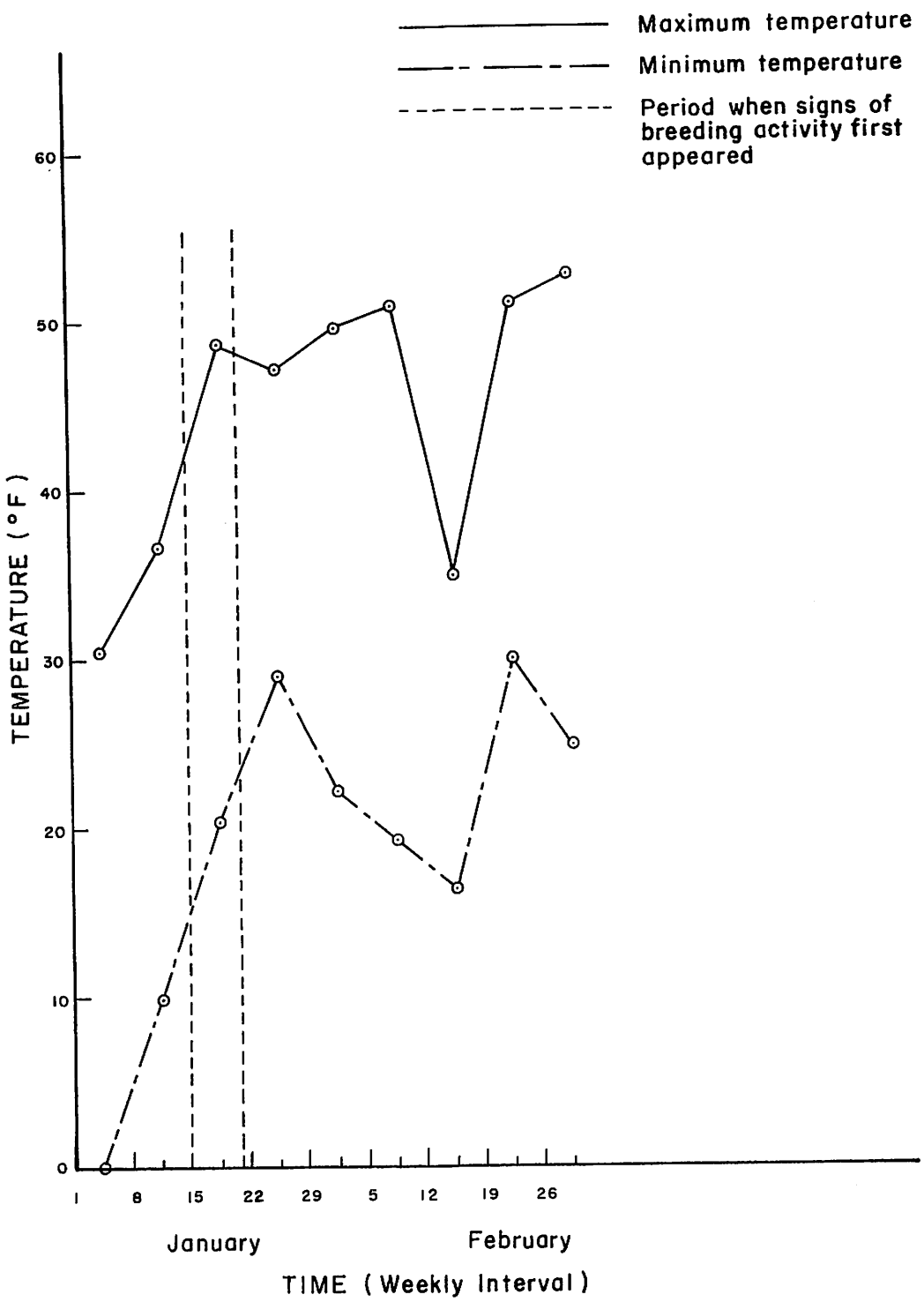

Fig. 4. Weekly means of daily maximum and minimum temperatures recorded at Fort Collins, Colorado, during the pre-nesting period of 1968.

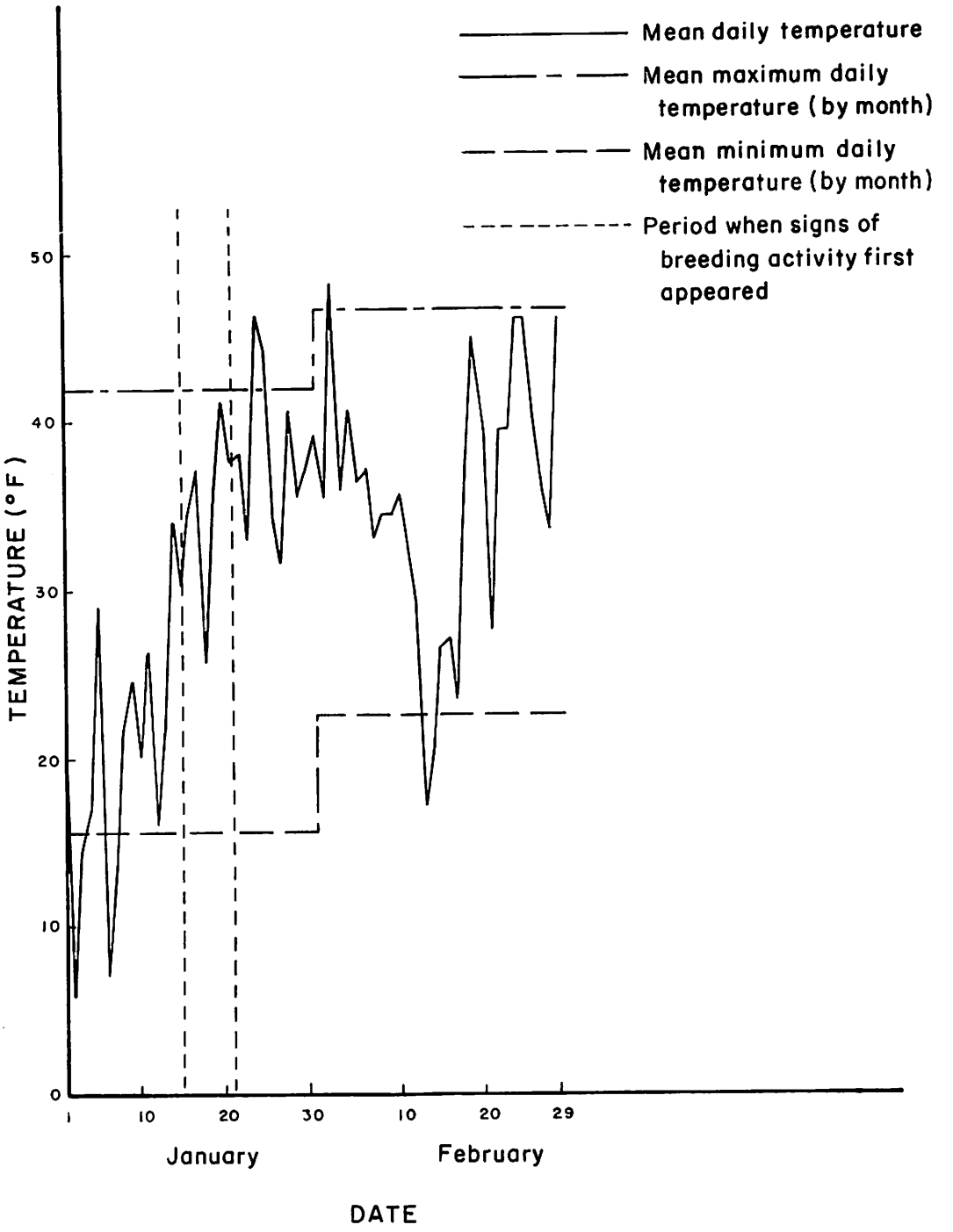

Fig. 5. Mean daily temperatures recorded at Fort Collins, Colorado, during the prenesting period of 1968.

NESTING PERIOD

Nesting Chronology

Brakhage (1965) defined the length of the nesting period as the interval between the laying of the first egg and the hatching of the last successful nest. It has been reported that weather influences the start of the nesting period and renesting controls its length (Balham 1954, Naylor and Hunt 1954, Klopman 1958, Collias and Jahn 1959, Hanson and Browning 1959, Brakhage 1965).

The time of nesting is extremely variable between populations. Not only local weather conditions, but also latitude and altitude have an effect on the time of breeding (Weller 1964). The rate of egg laying and the length of time required for incubation is also variable. Kossack (1950) and Brakhage (1965) both reported that 1.5 days were required by B. c. maxima for the laying of each egg. Brakhage (1962) reported a period of 1.6 days. The length of incubation for B. c. maxima was found to be 26 days by Kossack (1950), 28 days by Brakhage (1965), and 28.6 days by Collias and Jahn (1959).

By "back-dating" from the date of hatch 1.5 days for the laying of each egg and 28 days for incubation, I determined that the first egg was laid in Larimer County on approximately March 12 in 1967 and on March 7 in 1968. Similar findings have been reported by other investigators in Colorado. Grieb and Sheldon (1961) found that B. c. moffitti began laying in late March in northwestern Colorado, and Szymczak

(1967) reported that the first egg laid by the Denver metropolitan flock appeared on March 21.

As expected, geese of Colorado begin nesting at approximately the same time as flocks of other states in similar latitudes. Brakhage (1962, 1965) found that B. c. maxima began nesting in Missouri between March 15 and 20. Kossack (1950) stated that B. c. maxima in Illinois began laying on March 23. Geis (1956) reported that the first eggs appeared in Montana about March 15. Martin (1964) learned that geese in Utah began laying around mid-March, and Rienecker and Anderson (1960), working in California, found that nesting began about March 10.

The last nest in Larimer County was initiated on May 3, 1967 and on May 10 in 1968. The peak period of nest initiation was nearly identical in both years and lasted for almost 3 weeks. This period extended from March 20 to April 9 in 1967, and from March 18 to April 7 in 1968 (Fig. 6). The length of the nest-initiation period was 53 days in 1967, but in 1968 it was 65 days and was influenced by late renesting. Szymczak (1967) reported a 55-day period of nest initiation for the Denver flock in 1966, with a 5-day peak between April 5 and 9.

The 7-day-peak period of egg-laying activity, determined by the number of nests in the laying stage, was March 27 to April 2 in 1967 and March 25 to 31 in 1968 (Fig. 7). The peak of laying was

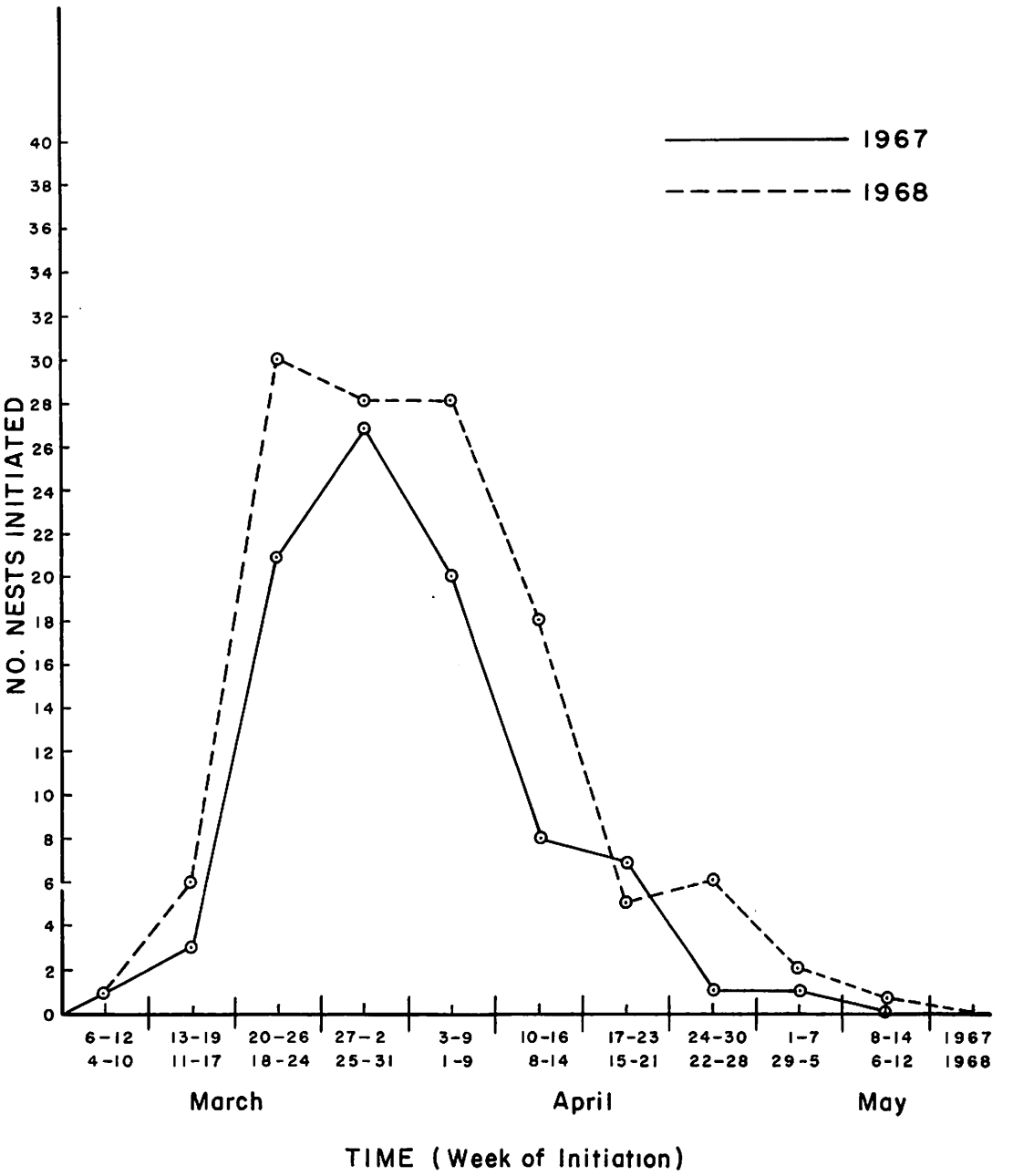

Fig. 6. Distribution of nest initiation by weekly intervals (based on 89 successful nests in 1967 and 125 in 1968).

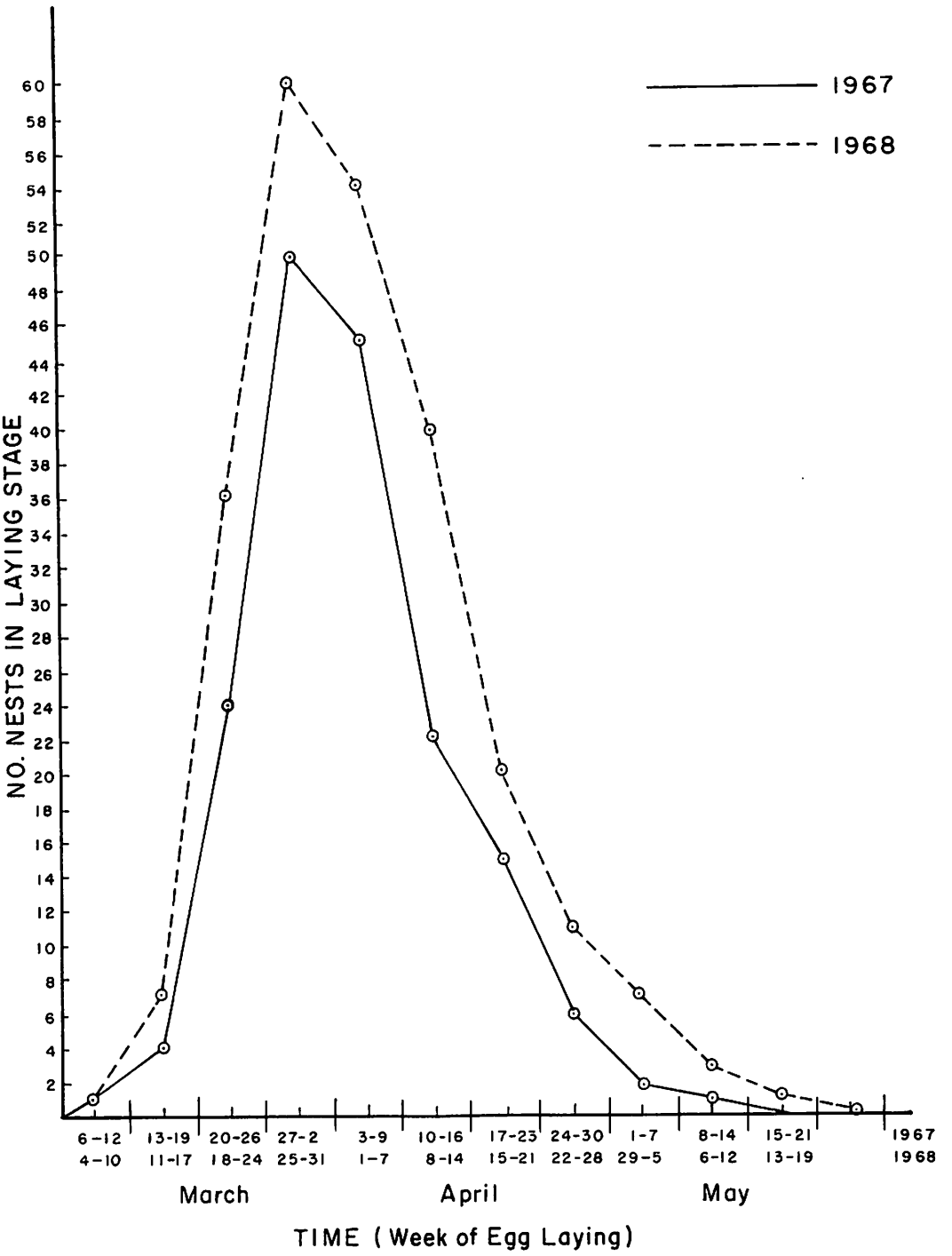

Fig. 7. Distribution of egg-laying activity by weekly intervals (based on 89 successful nests in 1967 and 125 in 1968).

reached by the Denver flock in 1966 during the first full week of April (Szymczak 1967).

The greatest number of nests was in the incubation stage during nearly the same 7-day period in both 1967 and 1968. The peaks occurred between April 24 and 30 in 1967 and between April 22 and 28 in 1968 (Fig. 8).

In 1967, the first goslings hatched in Larimer County on April 16. In 1968, the first goslings appeared on April 10, almost a week earlier. The 7-day-peak period of hatching occurred during the week of May 1 in 1967 and during the week of April 22 in 1968, a week earlier (Fig. 9). Most nests, however, hatched during the same 3-week period during both years. The last successful nest hatched on June 7 in 1967 and on June 14 in 1968. Similar results for the peak of hatching were found by Kossack (1950) in Illinois, Naylor and Hunt (1954) in California, Geis (1956) in Montana, Hanson and Browning (1959) in Washington, and Martin (1964) in Utah. Szymczak (1967) found that the Denver flock reached a peak of hatching at the beginning of the second full week of April.

The length of the nesting period in Larimer County, from the laying of the first egg to the hatching of the last successful nest, was 88 days in 1967 and 100 days in 1968. The length of the nesting period for other populations of Canada geese have ranged from 53 days in Manitoba (Klopman 1958), to 79 days in Missouri (Brakhage 1965),

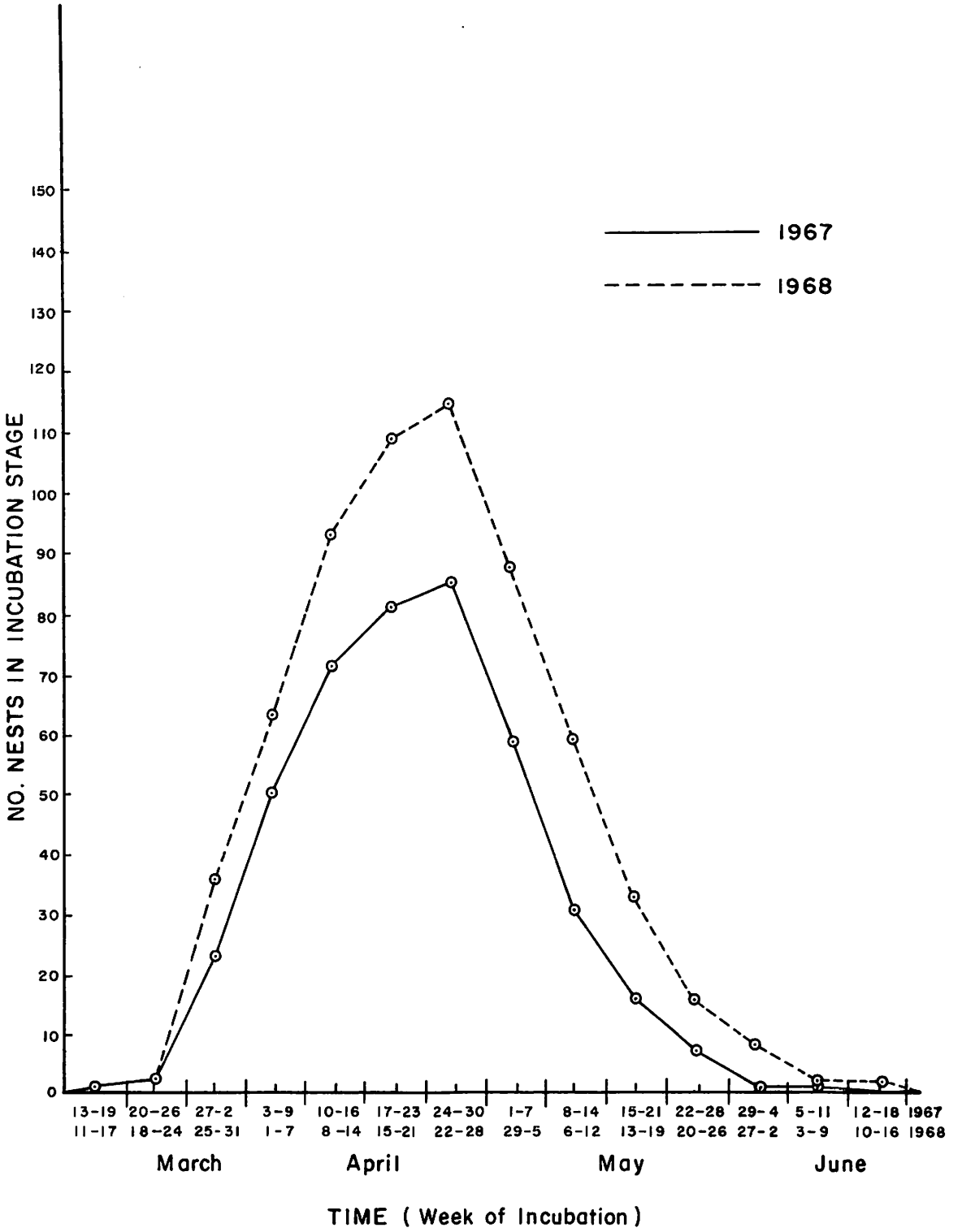

Fig. 8. Distribution of nests in the incubation stage by weekly intervals (based on 89 successful nests in 1967 and 125 in 1968).

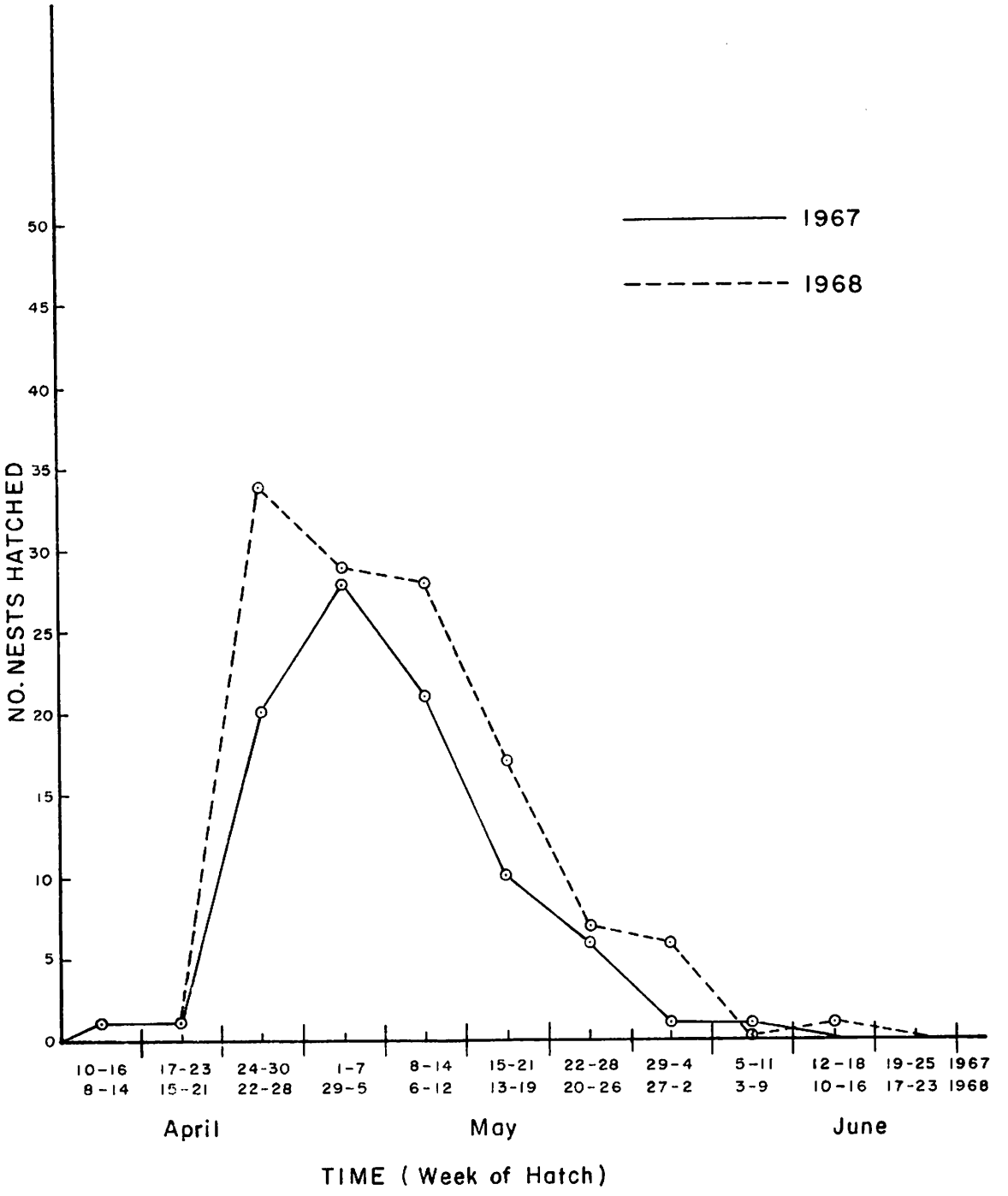

Fig. 9. Distribution of hatching of nests by weekly intervals (based on 89 successful nests in 1967 and 125 in 1968).

and 91 days in Colorado (Szymczak 1967). In Larimer County, I believe renesting is more significant than weather in governing the length of the nesting season. Late winter and early spring weather conditions in both 1967 and 1968 were probably not severe enough to inhibit nesting activity. I found no evidence to indicate that renesting influenced the length of the 88-day nesting period in 1967; Szymczak (1967) reported similar results for the Denver flock in 1966. The 91-day nesting period which he reported was not affected by renesting, although one goose which renested was still incubating on July 1. The nest failed to hatch, so it did not affect the length of the nesting period. Renesting did occur in Larimer County in 1968 and was directly responsible for extending the nesting period. A neck-banded goose renested twice; her third nest, which was successful, was initiated on approximately May 17.

Although the overall peak of laying, incubation, and hatching occurred almost during the same period in both 1967 and 1968, nesting and hatching began nearly a week earlier in 1968. I believe the reason for the similarities in nesting chronology between the 2 years was due primarily to weather. Weather conditions, especially temperature, throughout the two prenesting and early nesting periods were nearly identical (Fig. 10).

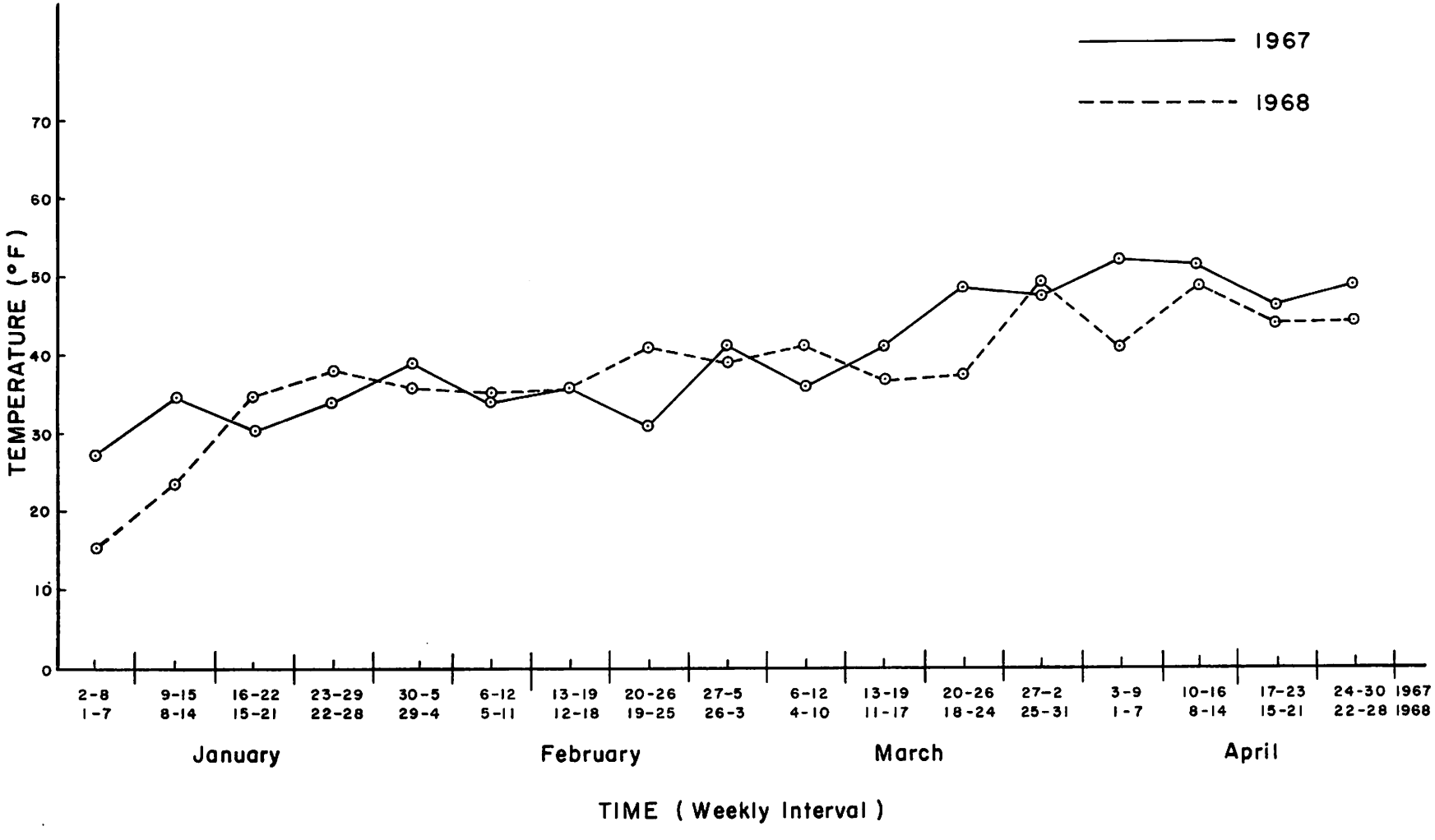

Fig. 10. Mean weekly temperatures recorded at Fort Collins, Colorado, during the prenesting and nesting periods (1967-1968).

Primary Nesting Areas

College Lake and Terry Lake have been the two primary goose nesting areas in Larimer County. These key areas, serving as nuclei for the entire flock, were created early in the developmental stage of the population through the release of goslings and adults, feeding programs, complete protection, and an abundance of nesting sites. A large number of geese have pioneered from College and Terry lakes to nest on adjacent water areas. "Pioneering" geese have been wholly responsible for making Watson Lake the third most important nesting area.

In 1967, 50 percent of the nests were on College Lake and Terry Lake alone, with 25.4 percent on Terry and 24.2 percent on College. The remaining 50 percent were established by "pioneering" geese on 29 different water areas. Among these was Watson Lake, with 13.9 percent of the nests. Of the 123 water areas studied, only 31 (25 percent) supported goose nests.

During the breeding season of 1968, 18.4 percent of the nests were on College Lake and 21.3 percent on Terry Lake, for a total of 39.7 percent. "Pioneering" geese established 60.3 percent of the nests on 46 different bodies of water, with 14.6 percent on Watson Lake. I found nests on 17 water areas not previously used. Of the 123 areas studied, 48 (39 percent) supported nests.

The number of nests established by "pioneering" geese suggests that there is a rapid dispersal of breeding pairs to utilize all available

habitat in Larimer County. These geese were responsible for 50 percent of the nests in 1967, but for more than 60 percent in 1968, an increase of more than 10 percent. Further evidence of dispersal is found in the number of areas utilized by the "pioneering" geese. This number increased from 29 in 1967 to 46 in 1968, an increase of more than 50 percent. Still other evidence comes from the number of nests established in each study area. In 1967, 98 percent of all nests were in the Fort Collins Study Area and only 2 percent were in the Loveland Study Area. In 1968, 6 percent of all nests were established in the Loveland Study Area.

Periodically throughout the study I observed small groups of geese and what appeared to be mated pairs on 38 water areas which failed to produce nests. The majority of these geese were probably searching for suitable nesting sites, were unsuccessful, and moved to other areas. These observations are significant and can be important in future management because they indicate that additional lakes, ponds, and reservoirs, although lacking natural nesting habitat, are still attractive to local geese (Table 17). With the addition of artifical nesting sites, these areas could add significantly to the nesting potential in Larimer County. Conversely, a number of water areas apparently were not attractive, for local geese were never observed on them during the two breeding seasons (Table 18). They apparently offer little or no nesting potential, even if nesting structures were to be made available.

Table 17. Water areas in Larimer County on which geese were observed during the breeding seasons of 1967 and 1968, but which failed to produce nests.

Water Area	Year Geese Observed		Degree of Use		
	1967	1968	Frequent	Infrequent	Rare
Andrijeski Marsh[a]		X		X	
Benson Lake	X				X
Blehm Pond		X			X
Boxelder No. 3	X	X		X	
Boyd Lake	X			X	
Deadman Lake	X			X	
Demere Pond[b]		X	X		
Douglas Lake	X	X	X		
Dyekman Reservoir [b]		X		X	
Equalizer Lake[a]	X	X		X	
Ervin Pond[a]		X			X
Greeley Water Works[a]	X	X			X
Greenwalt Reservoir[a]	X	X		X	
Hagen Pond[a]	X	X	X		
Hinkley Reservoir[a]	X	X		X	
Hoffman Reservoir[a]		X		X	
Horseshoe Lake[a]	X			X	
Hutchinson Pond	X		X		
Hyatt Gravel Pits[a]		X		X	
Ish Lake[a]	X	X			X
Lonetree Reservoir[a]		X			X
North Poudre No. 3[a]		X		X	
North Poudre No. 6[a]		X	X		
Novak Reservoir[a]		X		X	
Reed Pond		X			X
Reinick Gravel Pit	X	X			X
Richard Lake		X			X
Rist Benson Reservoir[a]	X			X	
Schuelke Reservoir[b]	X	X		X	
Scott Pond	X	X		X	
Sipes Pond		X			X
Spitzer Lake	X	X		X	
Warren Reservoir[a]		X		X	
Wassen Reservoir[a]		X			X
Water Supply & Storage No. 1[a]	X				X
Water Supply & Storage No. 3[a]	X				X
Westerdoll Reservoir		X			X
Winick Ponds[a]	X				X

[a]Sites which could offer some nesting potential with the addition of nesting structures.

[b]Nesting structures present.

Table 18. Water areas in Larimer County on which geese were not observed during either the 1967 or 1968 breeding seasons.

Water Area	Study Area	
	Fort Collins	Loveland
Bacon Reservoir		X
Baker Reservoir	X	
Berthoud Water Works		X
Blue Lake	X	
Blue Mountain Reservoir		X
Boxelder No. 1	X	
Boxelder No. 2	X	
Bubbles	X	
Cattail Reservoir		X
Chapman Reservoir		X
Cobb Lake Management Area	X	
Coleman Reservoir		X
Donath Lake	X	
Duck Lake	X	
Fisher Pond	X	
Heinricy Lake	X	
Kluver Reservoir	X	
Lake Loveland	X	
Loveland Reservoir		X
Lower Ryan Gulch Reservoir		X
Mariana Reservoir		X
Mountain Supply Reservoir	X	
Mud Lake	X	
North Poudre No. 4	X	
North Poudre No. 12	X	
North Poudre No. 15	X	
Portner Reservoir	X	
Stewart Pond	X	
Stink Lake		X
Upper Ryan Gulch Reservoir		X
Vottier Reservoir		X
Wellington Management Area	X	

Number of Nests Established

In 1967, a total of 173 Canada goose nests were established in Larimer County. This figure includes all possible dump nests and renests. Of the 173 nests, 169 were located in the Fort Collins Study Area and 4 in the Loveland Study Area (Table 19). During the breeding season of 1968, 267 nests were established. Two hundred fifty of the nests were in the Fort Collins Study Area and 17 were in the Loveland Study Area (Table 19).

The increase in the number of nests from 1967 to 1968 was 94, or 54 percent. In general, all areas showed a substantial increase in production in 1968. The apparent 54-percent increase in nesting attempts in 1968 is probably slightly higher than the actual increase in the flock's productivity, and could be partially due to a failure on my part to locate all nests in 1967. The belief that some nests were never found during both nesting seasons is substantiated by the number of "extra" broods of unknown origin which appeared on brooding areas. Nests which produced 17 broods (5 in 1967 and 12 in 1968) were never located, although their general locations were known (Table 19). I accepted the presence of these "extra" broods as representing 17 nesting attempts, and added them to the number of known nests in order to determine total productivity.

Because no one was permitted to trespass on Terry Lake in 1968, I determined the number of nests established by applying 1967

Table 19. Location and number of nests established in Larimer County (1967-1968).[a]

Location	No. Nests Established 1967	1968	% Increase
FORT COLLINS STUDY AREA			
Anderson Pond	3	3	0
Annex No. 8	2	4	100
Bureau Standards Pond 1	1	2	100
Bureau Standards Pond 2	0	1	100
Cache La Poudre River	0	3 (1)[b]	300
Claymore Lake	5	7 (1)[b]	40
College Lake	42	49 (1)[b]	17
Country Club Pond	0	1	100
Curtis Lake	0	1	100
Dale Pond	0	1	100
Dean Acres	5	8	60
Deines Reservoir	1	1	0
Divide No. 8	7 (1)[b]	9	29
Dry Creek Reservoir	2	2	0
Elder Reservoir	4	4 (1)[b]	0
Flatiron Gravel Pits	2	5	150
Fort Collins Gravel Pit	0	1	100
Fossil Creek Reservoir	2	10 (3)[b]	400
Herring Lake	4	4	0
Kitchel Reservoir	1	1	0
Launer Pond	0	1	100
Lindenmeier Lake	3	3	0
Long Pond	1	1	0
North Grey Reservoir	0	1	100
North Poudre No. 1	1	1	0
North Poudre No. 2	1	0	decrease
North Poudre No. 5	0	2 (1)[b]	200
North Poudre No. 10	1	1	0
Parkwood Lake	0	1	100
Peterson Ponds	0	1	100
Romily Gravel Pit	1	1	0
South Grey Reservoir	1	1	0
Specht Ponds	2	2	0
Sterling Gravel Pits[c]	1	1	0
Sterling Gravel Pits[d]	4 (1)[b]	8	100
Takes Pond	1	1	0
Terry Lake	44	57[e]	30
Timnath Reservoir	2	7	250
VanSant Pond	1	1	0
Water Supply & Storage No. 4	0	1	100
Watson Lake	24	39 (1)[b]	63
Wolaver Pond	0	1 (1)[b]	100
Wood Pond	0	1	100
Subtotal	169 (2)[b]	250 (10)[b]	48
LOVELAND STUDY AREA			
Big Thompson River	0	2 (1)[b]	200
Boedeaker Reservoir	3 (3)[b]	8 (1)[b]	167
Flatiron Gravel Pits	0	2	200
Flatiron Reservoir	0	1	100
McNeil Reservoir	0	2	200
Welch Reservoir	1	2	100
Subtotal	4 (3)[b]	17 (2)[b]	325
Total	173 (5)[b]	267 (12)[b]	54

[a]Includes all possible dump nests and renests.

[b]Represents the number of nests not found. These nests were known to exist because of "extra" broods which appeared on brooding areas.

[c]Prospect Street.

[d]Taft Hill Road.

[e]Computed from 1967 data.

production figures for the area to brood-count data obtained in 1968. A simple proportion using the number of goslings surviving to flight at the end of each nesting season and the number of nests discovered in 1967 resulted in an estimated 57 nests established in 1968, 13 more than in the preceding season.

The actual number of nests found and observed until termination was 168 in 1967 and 255 in 1968, a total of 423. In my estimation, these nests, in addition to the 17 which were not found, represented more than 98 percent of all production in Larimer County during both years.

Nest Sites

The most important environment to any population of Canada geese is that required for breeding. Hanson (1965) pointed out that the giant Canada goose has shown a greater adaptability to a variety of nesting environments than any other race of Branta canadensis. He stated that the only common denominators requisite in all habitat types are that they be available in large blocks and include bodies of water of moderate to large size, having a depth of at least 30 inches, and preferably containing islands. Hanson added that perhaps one of the more important factors determining whether prairie marshes and lakes are attractive and suitable to nesting giant Canada geese is the presence of muskrat houses. On many prairie lakes, muskrat houses offer the ecological equivalent of islets and islands, which are preferred nesting sites, but often lacking.

Based on these observations, it is evident that Larimer County, with its large number of lakes, ponds, and reservoirs, offers that type of nesting environment which is both required and preferred by the giant Canada goose.

Hanson and Browning (1959) reported that cover type, in relation to nest site location, is apparently incidental to other factors such as availability and visibility from the nest. Based on their studies of B. c. moffitti in Utah, Williams and Nelson (1943) outlined the major characteristics an area must possess in order to be rated as good breeding habitat. Nesting sites which provide: (1) excellent visibility, (2) a firm foundation, and (3) isolation from interference, were among their requirements. Most investigators generally agree that availability, visibility, a firm nest foundation, isolation from disturbance, and nearness to water are probably the most important elements. All of these environmental factors are qualities which exist throughout much of eastern Larimer County, primarily associated with artificial nesting sites and to a lesser degree with naturally occurring sites.

Approximately 59 percent of the 440 nests in Larimer County in 1967 and 1968 were on man-made nesting structures (Table 20). The remaining 41 percent were on natural nest sites which were located primarily on the ground. The percent of nests on natural sites increased from 36 in 1967 to 44 in 1968, which was followed by a corresponding decrease in the percent of nests on structures. About

35 percent of all nests studied were on islands, and only 2 percent were located on muskrat houses.

Table 20. General location of 440 nest sites (173 in 1967 and 267 in 1968).

Site	1967 No. of Nests	1967 % of Nests	1968 No. of Nests	1968 % of Nests	1967-1968 No. of Nests	1967-1968 % of Nests
Man-made nesting structure	111	64.2	149	55.8	260	59.1
Natural site[a]	62	35.8	118	44.2	180	40.9
Island[b]	60	34.7	96[c]	36.0	150	34.1
Lake or river margin[b]	117	67.6	177	66.3	294	66.8
Muskrat house	4	2.3	6	2.3	10	2.3

[a]Includes one nest in a cottonwood tree.
[b]Estimate; includes nests on structures and on natural sites.
[c]Includes 47 island nests on Terry Lake (calculated from 1967 data).

Use of Man-Made Nesting Structures. -The success of goose propagation in Larimer County can be attributed directly to the availability of a large number of man-made nesting structures. These structures are readily accepted as legitimate nesting sites and offer the ecological equivalent of natural sites such as muskrat houses and islands, where these are inadequate or nonexistent.

Cover type, in relation to structures, was probably not a significant element in determining whether or not a specific site was accepted. Geese apparently selected artifical sites for other reasons, such as availability of, and visibility from, the nests.

Of the 186 nesting structures available in 1967, 109 or 58.6 percent were utilized. The number of nests on structures was 111, and represented 64.2 percent of all nests established that season. Some structures supported more than one nest in a single season. As expected, College, Terry, and Watson lakes, with the largest number of nesting structures, also supported the largest number of structure nests. Thirty-seven (74 percent) of the 50 structures on College Lake, 21 (78 percent) of the 27 on Terry Lake, and 17 (68 percent) of the 25 structures on Watson Lake were utilized; 88 percent, 48 percent, and 71 percent of all nests on these three areas, respectively, were on nesting structures. The utilization of structures by geese in 1967, by area, appears in Table 21.

In 1968, 137 or 68.2 percent of the 201 available nesting structures were accepted by geese. During that season, 149 nests (55.8 percent of all nests established) were on structures. Forty-one (80 percent) of the 51 structures at College Lake supported nests, and accounted for 85 percent of all nests established there. Twenty-two (85 percent) of the 26 structures at Watson Lake were used, and they produced 80 percent of the nests. All six structures on Terry Lake supported nests. The number of structures used by geese in 1968, by area, appears in Table 22.

An average of 193.5 artificial nesting sites was available in Larimer County each year of the 2-year period, of which an average

Table 21. Number of man-made nesting structures which supported nests in 1967.

Location of Structures	No. Available	No. Used	% Used	% of Nests on Structures
Anderson Pond	5	3	60.0	100.0
Annex No. 8	12	2	16.6	100.0
Bureau Standards Pond 1	2	1	5.0	100.0
Claymore Lake	4	3 (1)[a]	75.0	80.0
College Lake	50	36 (1)[a]	72.0	88.1
Dean Acres	5	5	100.0	100.0
Divide No. 8	15	4	26.7	57.1
Dry Creek Reservoir	1	0	0.0	0.0
Elder Reservoir	12	3	25.0	75.0
Flatiron Gravel Pits	7	2	28.6	100.0
Herring Lake	5	4	80.0	100.0
Lindenmeier Lake	4	3	75.0	100.0
North Poudre No. 1	1	1	100.0	100.0
Peterson Ponds	1	0	0.0	0.0
Schuelke Reservoir	2	0	0.0	0.0
Sterling Gravel Pits[b]	1	1	100.0	100.0
Sterling Gravel Pits[c]	2	1	50.0	25.0
Terry Lake	27	21	77.8	47.7
Timnath Reservoir	4	1	25.0	50.0
VanSant Pond	1	1	100.0	100.0
Watson Lake	25	17	68.0	70.3
Total	186	109	58.6	64.2

[a]Number of structures which supported two nests.
[b]Prospect Street.
[c]Taft Hill Road.

Table 22. Number of man-made nesting structures which supported nests in 1968.

Location of Structures	No. Available	No. Used	% Used	% of Nests on Structures
Anderson Pond	5	3	60.0	100.0
Annex No. 8	12	4	33.3	100.0
Boedeaker Reservoir	4	3	75.0	37.5
Bureau Standards Pond 1	1	1	100.0	100.0
Bureau Standards Pond 2	1	1	100.0	100.0
Claymore Lake	6	5	83.3	71.4
College Lake	51	41 (1)[a]	80.4	85.7
Dale Pond	2	1	50.0	100.0
Dean Acres	7	7	100.0	87.5
Demere Pond	1	0	0.0	0.0
Divide No. 8	11	6 (2)[a]	54.5	77.8
Dry Creek Reservoir	2	1	50.0	50.0
Dyekman Reservoir	1	0	0.0	0.0
Elder Reservoir	13	3	23.1	75.0
Flatiron Gravel Pits	7	5	71.4	100.0
Flatiron Reservoir	2	1	50.0	100.0
Fossil Creek Reservoir	6	4	66.7	40.0
Herring Lake	5	4	80.0	100.0
Kitchel Reservoir	4	1	25.0	100.0
Lindenmeier Lake	4	3	75.0	100.0
North Grey Reservoir	2	1	50.0	100.0
North Poudre No. 1	2	1	50.0	100.0
Parkwood Lake	2	1	50.0	100.0
Peterson Ponds	1	1	100.0	100.0
Schuelke Reservoir	1	0	0.0	0.0
South Grey Reservoir	2	1	50.0	100.0
Sterling Gravel Pits[b]	1	1	100.0	100.0
Sterling Gravel Pits[c]	3	2	66.7	25.0
Takes Pond	1	1	100.0	100.0
Terry Lake	6	6	100.0	10.5
Timnath Reservoir	3	3	100.0	42.9
VanSant Pond	1	1	100.0	100.0
Watson Lake	26	22 (7)[a](1)[d]	84.6	79.5
Welch Reservoir	4	2	50.0	100.0
Wolaver Pond	1	0	0.0	0.0
Total	201	137	68.2	55.8

[a]Number of structures which supported two nests.

[b]Prospect Street.

[c]Taft Hill Road.

[d]Number of structures which supported three nests.

of 63.4 percent was used. Structure utilization by geese of the Denver area was reported by Szymczak (1967) to be slightly higher, although the number of structures available was relatively small. He found that 67 percent of 39 structures were occupied during a single breeding season. Researchers in other states have reported percentages of structure utilization considerably lower than those of Colorado. In Montana, Craighead and Stockstad (1961) found that over a 5-year period, an average of 73 structures was available, of which 13.4 percent were used. Over a 6-year period in Wyoming, where an average of 76.7 structures was available, Wrakstraw (1965) discovered an average yearly utilization of 31.1 percent.

It is interesting to compare the degree of use of each type of nesting structure in Larimer County with that of island structures and that around lake and pond margins (Table 23). In 1967, 84 percent of all island structures were occupied, while 52 percent of those around lake margins were used. Eighty-seven percent of the four-pole structures, 68 percent of the floating structures, and 30 percent of the single-pole structures supported nests. In 1968, 91 percent of all island structures and 67 percent of those around lake margins were occupied. Seventy-one percent of the four-pole structures, 82 percent of the floating structures, and 56 percent of the single-pole structures were used.

Utilization of the four-pole structures was exceptionally high in both years, and stems from the fact that they were the first to be

Table 23. Use of man-made nesting structures, by type and location (1967-1968).

	1967			1968		
	No. Available	No. Used	% Used	No. Available	No. Used	% Used
STRUCTURE TYPE						
Four-pole	70	60	86.7	49	35	71.4
Single-pole	69	21	30.4	97	54	55.7
Floating	31	21	67.7	33	27	81.8
STRUCTURE LOCATION						
Island[a]	31	26	83.9	21	19	90.5
Lake margin[b]	124	64	51.6	147	98	66.7

[a]Does not include floating structures.
[b]Includes structures standing in water.

erected, and thus have been available to geese longer than other types. Of major importance in future management is the increase in utilization of single-pole and floating structures over the 2-year period. The majority of these were located outside the three primary nesting areas, and generally indicate a dispersal of breeding pairs throughout the county. The use of single-pole structures increased from 30 percent in 1967 to 56 percent in 1968, while the use of floating structures increased from 68 to 82 percent.

Of primary importance is the 1968 utilization of 31 single-pole structures which were erected late in 1967. These were established on water areas used by geese in the 1967 breeding season, and in some cases they were located directly over or near old nests which were either flooded or destroyed by predators. Of the 31 erected, 16 (51.6

percent) were accepted in 1968. Of the six structures which were placed directly over or near old ground nests, five (83.3 percent) were accepted.

A number of nesting structures supported more than one goose nest in a single breeding season. Two structures each supported two nests in 1967. In 1968, two nests were built on each of 10 different structures while three were built on another. In each case, the second or third nest was initiated soon after the previous one was terminated. Only in two cases (1968), was more than one brood produced on a single structure. These structures, one at Watson Lake and the other at College Lake, each produced two broods. Sheldon (1958) reported a similar instance at Denver, where two broods hatched on the same structure during one breeding season.

Use of Man-Made Nesting Structures by Other Wildlife Species.- Periodically, wildlife species other than Canada geese used nesting structures. I discovered six mallard (Anas platyrhynchos) nests containing eggs on structures during the two seasons, two in 1967 and four in 1968. Four of the nests were on floating structures and two were on single-pole structures. The nests were all established in late May and June, after the majority of Canada goose nests had terminated, so they did not interfere with goose nesting. Enyeart (1964), Bednarik (1965), and Brakhage (1966) also found mallards nesting in elevated goose nesting structures. On several occasions,

I saw female common mergansers (Mergus merganser) on floating structures at both Claymore and Watson lakes, but I did not check the structures for eggs, nor did I observe any young mergansers on these bodies of water. The number of duck nests found was relatively low compared with the large number of available structures; the majority of them probably went unnoticed because I made no special effort to locate every duck nest.

Other species which used nesting structures were muskrats (Ondatra zibethica) and great blue herons (Ardea herodias). Muskrats generally carried aquatic vegetation to floating structures where it was eaten. In some cases, the piles of vegetation became so deep and heavy that the structures were partially submerged. The presence of muskrats did not appear to disturb incubating geese. One floating structure served as a nest for a female muskrat which gave birth to five young. All types of structures were used by herons for feeding and loafing sites.

In Missouri, Brakhage (1962) found that raccoons frequently used vacant elevated tubs for scat stations, and owls used them for nesting purposes and feeding sites; however, I found no evidence of such use in Larimer County.

Use of Natural Sites.-Cover-type data were recorded for 89 nests on naturally occurring sites, 34 nests in 1967 and 55 in 1968 (Table 24). Because of poor plant development in the early spring,

Table 24. Location of 89 nests on natural sites, by cover type and special features (1967-1968).

Nest Site Location	1967 No. of Nests	1967 % of Nests	1968 No. of Nests	1968 % of Nests	1967-1968 No. of Nests	1967-1968 % of Nests
COVER TYPE						
Grass-forb	19	55.9	36	65.5	55	61.8
Emergent	6	17.6	10	18.2	16	18.0
Woody perennial	3	8.8	5	9.1	8	9.0
Barren ground	5	14.7	3	5.5	8	9.0
Debris	1	2.9	1	1.8	2	2.2
Total	34	99.9	55	100.1	89	100.0
SPECIAL FEATURES						
Lake or river margin	19	55.9	18	32.7	37	41.6
Island	11	32.4	30	54.5	41	46.1
Muskrat house	4	11.8	6	10.9	10	11.2
Tree (in water)	0	0.0	1	1.8	1	1.1
Total	34	100.1	55	99.9	89	100.0

only five basic cover types were recognized. These types were (1) grass-forb, (2) emergent, (3) woody perennial, (4) debris, and (5) barren ground.

The most frequently selected cover type in Larimer County was the grass-forb, in which 62 percent of the 89 nests were found (Table 24). The grass-forb type is by far the most dominant vegetation bordering water areas, and explains the large number of nests found there. This differs considerably from Szymczak's (1967) findings at Denver. He observed that emergent vegetation (cattail--Typha spp.), was the dominant cover type, and it contained 33 percent of 188 nests sampled, more than any of the other four types. In Larimer County, cattails and other emergent vegetation suitable for nesting are not abundant. Only 16 nests (18 percent) on natural sites were found in emergents. These figures may not be completely representative because some nesting structures which were available in emergent vegetation supported nests which may have otherwise been established on the ground. Of the 16 nests in emergent vegetation, 10 (11.2 percent) were on muskrat houses. In the remaining cover types, eight nests (9 percent) were in woody perennials, and another eight nests were on barren ground. Two nests (2 percent) were located in debris.

One of the eight nests found in woody perennial vegetation was in a tree. The fact that Canada geese often nest in trees, especially in abandoned osprey and hawk nests, and at varying heights above

the ground has been widely documented by Allen (1876), Davison (1925), Skinner (1928), Yocum (1952), Ballou (1954), and Bailey and Niedrach (1965). In Larimer County in 1968, I found a Canada goose nesting in a small cottonwood tree at McNeil Reservoir. The tree was completely surrounded by water and approximately 10 feet from shore. The goose occupied an abandoned magpie nest that was nearly 6 feet above the water, and she was successful in hatching her clutch. Only one other case of a goose nesting in a tree has been reported in Colorado. This nest, also in a cottonwood tree, was 50 feet above the ground along the Yampa River (Bailey and Niedrach 1965).

Of the 89 nests found on natural sites, 46 percent were on islands. Including nests on islands, muskrat houses, and in trees, 55 percent were completely surrounded by water. Twenty-one nests (24 percent) were located on steep banks overlooking the water, and 18 (20 percent) were on narrow peninsulas or less distinct projections of the bank. The extensive use of peninsulas, banks, and islands as nesting sites has also been reported by other investigators (Dow 1943, Collins 1953, Miller and Collins 1953, Ballou 1954, Geis 1956, Nelson 1963, Caldwell 1964, and Williams 1967).

The distance from the nest to the nearest water is an important element and greatly influences nesting success. The mean distance from the 89 nests located on natural sites to nearest water was 32 feet, with a range of 0 to 352 feet (Table 25). The mean distance for

nests in grass-forb vegetation was 42 feet; in emergents, 25 feet; on barren ground and in the woody perennial type, 7 feet; and in debris, 2 feet. The greatest distance (352 feet) was recorded in the grass-forb vegetation. Both Geis (1956) and Hunt and Jahn (1966) found distances in the 300-foot range, but to my knowledge, only Szymczak (1967) has reported greater distances, some of which exceeded 1,000 feet.

Table 25. Mean distance from 89 nests on natural sites to nearest water, by cover type (1967-1968).

Cover Type	No. of Nests	Mean Distance From Water (ft)	Range
Emergent	16	24.9	1 to 249
Grass-forb	55	42.1	1 to 352
Barren ground	8	6.9	1 to 16
Woody perennial	8	6.5	0 to 21
Debris	2	2.0	1 to 3
Total	89	31.7	0 to 352

Use of Old Nests. -It has long been established that Canada geese frequently use their old nest sites or ones in the near vicinity, whether or not they were successful in the preceding year (Kossack 1950, Naylor 1953, Balham 1954, Naylor and Hunt 1954, Geis 1956, Hanson and Browning 1959, Martin 1964).

Of the 109 man-made nesting structures occupied in Larimer County in 1967, 81 (74.3 percent) were used again the following season. A number of natural sites were also used during both seasons, while in other cases, new nests were found within several feet of

sites used the previous year. In 1968, seven nests were established directly on sites used in 1967, three were within 10 feet of old sites, three were within 20 feet, and two were within 30 feet. By combining the number of natural sites and man-made nesting structures reused, 36 percent of all nests established in 1968 were either on the same location or within 30 feet of nests occupied in 1967. By comparison, Geis (1956) reported that 45 percent of the nests on Flathead Lake, Montana, were on old sites or within 25 feet of old sites. Naylor (1953), in California, found that only 6 nests out of 360 were built on old sites.

Factors Influencing Nest Site Selection. -Grieb, Sheldon, and Neff (1961), Martin (1964), and Williams (1967) have emphasized the fact that breeding pairs of Canada geese which migrate generally return to the same nesting environment each year and frequently nest in the same portion of it. The strong behavioral characteristic of individual families to migrate as a single unit and return to their ancestral breeding grounds in the spring has been described by Elder and Elder (1949), Balham (1954), and Sherwood (1966, 1967). In nonmigrating populations such as the one found in Larimer County, the urge to remain near the original nest site and the prevalence of rigid family ties is even stronger. Young birds, upon reaching breeding age, select mates and attempt to nest in the general vicinity of their parents, perhaps on the same type of nest site. This is the

primary reason for the large buildup of breeding pairs on many areas in the county. This condition eventually generates factors which have an effect on every pair in their search for a nest site. The ultimate factor is expressed in competition for the most favorable nest sites, which forces the young and less dominant pairs to either accept poor sites with little or no protection, not nest at all, or pioneer to new areas. The acceptance of poor sites was especially noticeable at College Lake, where I found several nests in open fields more than 300 feet from water. Evidence which indicates that competition forced some pairs to pioneer to new areas was seen in the increase in number of water areas nested on in 1968 over the number used in 1967.

Another factor which influences nest site selection is a type of "imprinting" on a particular set of nesting conditions. Goslings hatched in nests far from water, on islands, or in a certain cover type may seek similar surroundings when they reach breeding age (Szmyczak 1967). This would partially explain the distribution of some nests in Larimer County.

"Imprinting" is particularly evident in geese which use artificial nesting sites. Grieb and Crawford (1967) stated that when goslings are hatched from a nest on a structure, they are "imprinted" to the structure and will select a similar site in which to breed in later years. Although "imprinting" is a major factor, other elements make structures preferred nesting sites. Among these are availability,

visibility, and protection--all of which tend to explain why artificial sites are used so extensively in Larimer County.

Egg Production

Clutch Size. -The average clutch laid by most Canada geese is usually 5 eggs, with some clutches containing as few as 1 and others as many as 10 (Williams 1967). Average clutches ranging from 4.5 to 6.3 eggs have been recorded by some authors (Dow 1943; Kossack 1950; Geis 1956; Klopman 1958; Hanson and Browning 1959; Brakhage 1962, 1965; Martin 1964; Bednarik 1965; Hunt and Jahn 1966; Szymczak 1967; Weigand, Pollok, and Petrides 1968). As expected, the average clutch size of the giant Canada goose throughout the United States also falls within this range. In Colorado, B. c. maxima of the Denver area were reported by Szymczak (1967) to average 4.88 $\pm$ 0.09 (mean $\pm$ standard error of the mean) eggs per nest. In Larimer County, the mean clutch size for all nests, including successful and unsuccessful nests but excluding dump nests, was 4.92 $\pm$ 0.11 in 1967, 4.62 $\pm$ 0.11 in 1968, and 4.74 $\pm$ 0.08 for both years combined (Table 26). The mean number of eggs found in successful nests only was 5.29 $\pm$ 0.10 in 1967, 5.05 $\pm$ 0.11 in 1968, and 5.15 $\pm$ 0.08 for both years. Very similar results for successful B. c. maxima nests were obtained by Bednarik (1965), Brakhage (1965), and Szymczak (1967).

Two standard errors were applied to each side of the mean to compute confidence intervals on the mean clutches for 1967 and 1968

Table 26. Mean clutch size in 218 successful and 91 unsuccessful nests (1967-1968).

	1967			1968			1967-1968		
Type of Nest	Sample Size	Mean	Confidence Interval[a]	Sample Size	Mean	Confidence Interval	Sample Size	Mean	Confidence Interval
Successful	88	5.29	5.09-5.49	130	5.05	4.83-5.27	218	5.15	4.99-5.31
Unsuccessful	33	3.94	3.48-4.40	58	3.65	3.17-4.13	91	3.75	3.41-4.09
Successful & unsuccessful	121	4.92	4.70-5.14	188	4.62	4.40-4.84	309	4.74	4.58-4.90

[a] Two standard errors were applied to each side of the mean.

(Table 26). The intervals for successful and unsuccessful nests do not overlap and suggest a significant difference in mean clutch size. Intervals computed for all nests, successful and unsuccessful, overlap and suggest no significant difference in mean clutch size between 1967 and 1968.

Egg production in both successful and unsuccessful nests, as indicated by mean clutch size, was very similar on the three major nesting areas, College, Watson, and Terry lakes, and only slightly higher on all other areas combined (Table 27). The mean number of eggs in successful nests for both years was 4.85 ± 0.13 at College Lake and 5.17 ± 0.19 at Watson Lake; means for all nests, successful and unsuccessful, for the same period were 4.57 ± 0.14 and 4.59 ± 0.21 eggs for College and Watson lakes, respectively. The only data obtained from Terry Lake were for all nests in 1967, and they indicated a mean clutch size of 4.90 ± 0.18 eggs. In comparison to egg production on the major breeding areas, the average clutch size for all of the other nesting areas combined was 4.89 ± 0.11 eggs for all nests and 5.33 ± 0.11 for those that were successful. Two

standard errors were applied to each side of the mean to compute confidence intervals on the mean clutches for the major breeding areas and for all other areas combined (Table 27). All intervals overlap and suggest no significant difference in mean clutch size.

Table 27. Mean clutch size on major breeding areas (1967-1968).

Area and Type of Nest	1967 Sample Size	1967 Mean	1967 Confidence Interval[a]	1968 Sample Size	1968 Mean	1968 Confidence Interval	1967-1968 Sample Size	1967-1968 Mean	1967-1968 Confidence Interval
SUCCESSFUL									
College Lake	30	4.93	4.55-5.31	39	4.79	4.45-5.13	69	4.85	4.59-5.11
Watson Lake	18	5.50	4.98-6.02	22	4.90	4.36-5.44	40	5.17	4.79-5.55
Terry Lake									
All other areas combined	40	5.47	5.21-5.73	69	5.24	4.92-5.56	109	5.33	5.11-5.55
SUCCESSFUL & UNSUCCESSFUL									
College Lake	42	4.52	4.12-4.92	47	4.61	4.21-5.01	89	4.57	4.29-4.85
Watson Lake	24	5.20	4.62-5.68	37	4.18	3.60-4.76	61	4.59	4.17-5.01
Terry Lake	44	4.90	4.54-5.26						
All other areas combined	55	5.10	4.80-5.40	104	4.77	4.47-5.07	159	4.89	4.67-5.11

[a]Two standard errors were applied to each side of the mean.

Of major importance concerning overall egg production in Larimer County was the mean clutch size in nests located on all types of man-made nesting structures combined, elevated structures, natural sites and ground sites. Based on successful nests only for both 1967 and 1968, those built on elevated structures contained an average of 5.30 ± 0.09 eggs, while those built on all types of structures contained 5.20 ± 0.09. Clutches on ground sites (including ground structures) averaged 4.95 ± 0.14, and clutches on natural sites averaged 4.95 ± 0.17.

Confidence intervals were applied to the mean clutches computed for each type of nest site (Table 28). All intervals overlap and suggest no significant difference in mean clutch size.

Table 28. Relationship between nest site and clutch size in successful nests (1967-1968).

	1967			1968			1967-1968		
Nest Site	Sample Size	Mean	Confidence Interval[a]	Sample Size	Mean	Confidence Interval	Sample Size	Mean	Confidence Interval
Four-pole structure	30	5.30	4.90-5.70	34	5.08	4.68-5.48	64	5.18	4.90-5.46
Single-pole structure	18	5.16	4.82-5.55	40	5.35	5.03-5.67	58	5.43	5.19-5.67
Ground structure	7	5.14	4.52-5.76	8	4.75	3.99-5.51	15	4.93	4.43-5.43
Floating structure	16	5.18	4.54-5.82	20	4.80	4.04-5.56	36	4.97	4.47-5.47
All structures	71	5.33	5.09-5.57	102	5.10	4.86-5.34	173	5.20	5.02-5.38
Elevated structure	48	5.41	5.13-5.69	74	5.22	4.98-5.46	122	5.30	5.12-5.48
Ground site[b]	24	5.12	4.80-5.44	36	4.83	4.41-5.25	60	4.95	4.67-5.23
Natural site	17	5.11	4.71-5.51	28	4.85	4.35-5.35	45	4.95	4.61-5.29
Bank	50	5.28	5.02-5.54	80	5.13	4.89-5.37	130	5.19	5.01-5.37
Island[c]	38	5.31	4.95-5.67	50	4.92	4.50-5.34	88	5.09	4.81-5.37

[a]Two standard errors were applied to each side of the mean.

[b]Includes nests on ground structures and natural sites.

[c]Includes nests on floating structures.

There seemed to be no difference in mean clutch size among nests found on each of the different types of nesting structures. Based on successful nests only, the mean clutch size was 5.43 ± 0.12 on single-pole structures, 5.18 ± 0.14 on four-pole structures, 4.97 ± 0.25 on floating structures, and 4.93 ± 0.25 on ground structures. Confidence intervals were applied to each of the means; all intervals overlap and suggest no significant difference (Table 28).

Similarly, no difference in clutch size existed between all nests established on the bank and all nests on islands, including floating structures. The mean clutch size for successful bank nests was 5.19 ± 0.09 eggs, and the mean for island nests was 5.09 ± 0.14 eggs.

The number of eggs laid in individual nests ranged from 1 to 10. The frequency distribution of clutches found in successful and unsuccessful nests appears in Table 29. Based on a sample of 309 nests, 30 percent of the clutches contained five eggs; 23 percent, four eggs; 22 percent, six eggs; 8 percent, seven eggs; and 7 percent, three eggs. Only three clutches of 8 eggs and one of 10 were found, each of which was believed to be the efforts of a single female. Clutches of 10 eggs were also reported by Everman (1919), Miller and Collins (1953), Barraclough (1956), and Geis (1956); while Kossack (1950), Naylor (1953), Hanson and Browning (1959), and Rienecker and Anderson (1960) reported larger clutches, but none exceeding 13 eggs.

Table 29. Frequency distribution of 309 clutches in successful and unsuccessful nests (1967-1968).

Clutch Size	Frequency (No. of Clutches)	% of Nests
1	13	4.2
2	14	4.5
3	23	7.4
4	70	22.7
5	93	30.1
6	68	22.0
7	24	7.8
8	3	100.0
9	0	0.0
10	1	0.3
Total	309	100.0

Total egg production for the county was approximately 857 in 1967 and 1256 in 1968. These figures represent only those eggs laid in nests and do not include "dropped eggs," which were laid at random on the bank. Egg production for 1967 and 1968, by individual areas, appears in Tables 30 and 31, respectively.

Dump Nests. -Dump nests or compound nests are defined as those in which several birds contribute eggs. They are seldom found among geese in the wild, but are not uncommon in domestic and semi-wild flocks (Williams 1967). Kossack (1950), studying a semi-wild flock in Illinois, found a dump nest containing 12 eggs, and Brakhage (1965) reported the possibility of dump nests when he studied tub-nesting geese in Missouri. Dump nests seem to be common in the semi-wild flock of B. c. maxima at Denver, as indicated by Grieb (1964) and Szymczak (1967). Grieb found a nest containing 23 eggs which was being incubated by a single female, and Szymczak described five dump nests which were established during one season.

In examination of over 400 nests in Larimer County, I found only two dump nests, both in 1968. Both nests were on floating structures, one on College Lake and the other on Watson Lake. One nest contained 9 eggs and the other 11. The eggs in each nest could be divided into two or more groups by color, suggesting combined efforts of more than one female.

"Dropped Eggs."-Randomly scattered and undamaged eggs found on the ground, usually in areas of high nesting density, are referred

Table 30. Egg production in 1967, by area.

Area	No. of Nests	No. of Eggs	Mean Clutch Size
FORT COLLINS STUDY AREA			
Anderson Pond	3	15	5.00
Annex No. 8	2	10	5.00
Bureau Standards Pond 1	1	7	7.00
Claymore Lake	5	25	5.00
College Lake	42	190	4.52
Dean Acres	5	25	5.00
Deines Reservoir	1	3	3.00
Divide No. 8	7	35[a]	5.00
Dry Creek Reservoir	2	10[a]	5.00
Elder Reservoir	4	22[a]	5.50
Flatiron Gravel Pits	2	12	6.00
Fossil Creek Reservoir	2	11	5.50
Herring Lake	4	20	5.00
Kitchel Reservoir	1	2	2.00
Lindenmeier Lake	3	18	6.00
Long Pond	1	6	6.00
North Poudre No. 1	1	4	4.00
North Poudre No. 2	1	5[a]	5.00
North Poudre No. 10	1	2	2.00
Romily Gravel Pit	1	5	5.00
South Grey Reservoir	1	6	6.00
Specht Ponds	2	7	3.50
Sterling Gravel Pits[b]	1	4	4.00
Sterling Gravel Pits[c]	4	25[a]	6.25
Takes Pond	1	5	5.00
Terry Lake	44	218	4.95
Timnath Reservoir	2	12	6.00
Watson Lake	24	125	5.20
VanSant Pond	1	6	6.00
Subtotal	169	835[a]	4.94
LOVELAND STUDY AREA			
Boedeaker Reservoir	3	17[a]	5.66
Welch Reservoir	1	5	5.00
Subtotal	4	22[a]	5.50
Total	173	857[a]	4.95

[a]To determine total egg production, the mean number of five eggs per clutch (obtained for all nests) or the number of goslings which appeared soon after hatching (in cases where the number exceeded five) were used to estimate the number of eggs in nests which were not found.

[b]Prospect Street

[c]Taft Hill Road.

Table 31. Egg production in 1968, by area.

Area	No. of Nests	No. of Eggs	Mean Clutch Size
FORT COLLINS STUDY AREA			
Anderson Pond	3	14	4.66
Annex No. 8	4	19	4.75
Bureau Standards Ponds 1 & 2	3	14	4.66
Cache La Poudre River	3	14[a]	4.66
Claymore Lake	7	36[a]	5.14
College Lake	49	231[a, b]	4.71
Country Club Pond	1	6	6.00
Curtis Lake	1	4	4.00
Dale Pond	1	7	7.00
Dean Acres	8	40	5.00
Deines Reservoir	1	5[a]	5.00
Divide No. 8	9	39[a]	4.33
Dry Creek Reservoir	2	9	4.50
Elder Reservoir	4	22[a]	5.50
Flatiron Gravel Pits	5	22	4.40
Fort Collins Gravel Pit	1	6	6.00
Fossil Creek Reservoir	10	40[a]	4.00
Herring Lake	4	21	5.25
Kitchel Reservoir	1	6	6.00
Launer Pond	1	2	2.00
Lindenmeier Lake	3	19	6.33
Long Pond	1	5	5.00
North Grey Reservoir	1	6	6.00
North Poudre No. 1	1	6	6.00
North Poudre No. 5	2	12[a]	6.00
North Poudre No. 10	1	5[a]	5.00
Parkwood Lake	1	5	5.00
Peterson Ponds	1	4	4.00
Romily Gravel Pit	1	6	6.00
South Grey Reservoir	1	6	6.00
Specht Ponds	2	7[a]	3.50
Sterling Gravel Pits[c]	1	5	5.00
Sterling Gravel Pits[d]	8	37[a]	4.62
Takes Pond	1	7	7.00
Terry Lake	57[e]	264[c]	4.63
Timnath Reservoir	7	27	3.85
VanSant Pond	1	6	6.00
Water Supply & Storage No. 4	1	5[a]	5.00
Watson Lake	39	171[a, b]	4.38
Wolaver Pond	1	5[a]	5.00
Wood Pond	1	5	5.00
Subtotal	250	1170[a]	4.68
LOVELAND STUDY AREA			
Big Thompson River	2	11[a]	5.50
Boedeaker Reservoir	8	40[a]	5.00
Flatiron Gravel Pits	2	9	4.50
Flatiron Reservoir	1	4	4.00
McNeil Reservoir	2	10	5.00
Welch Reservoir	2	12	6.00
Subtotal	17	86[a]	5.05
Total	267	1256[a]	4.70

[a]To determine total egg production, the mean number of five eggs per clutch (obtained for all nests) or the number of goslings which appeared soon after hatching (in cases where the number exceeded five) were used to estimate the number of eggs in nests which were not found.

[b]Includes one dump nest.

[c]Prospect Street.

[d]Taft Hill Road.

to as "dropped eggs." Both Munro (1958) and Collias and Jahn (1959) reported the presence of such eggs on their study areas and suggested that they are laid by birds unable to defend a nest site.

During the entire study period, I found only 13 "dropped eggs" in Larimer County, 10 on College Lake, and 3 on Watson Lake. Although they were known to exist on Terry Lake, an accurate count was not possible.

Undersized Eggs.-Canada goose eggs vary considerably in size, but apparently only Kossack (1950) and Brakhage (1962) have recorded atypically small or undersized eggs. Kossack (1950), studying B. c. maxima in Illinois, discovered four of these eggs, one of which measured 71 by 50 mm. Brakhage (1962), studying tub-nesting B. c. maxima in Missouri, found two small eggs, each of which was about one-third normal size. One of the eggs contained both yolk and albumen, but was infertile. The other contained albumen only.

I found four undersized eggs in Larimer County, all in 1968. Two of the eggs were intact; one contained both yolk and albumen, the other contained albumen only. The other two eggs, found broken in the nest, each contained a yolk. The shells of all four eggs were considerably thinner than those of normal eggs. The eggs were similar in size to those found by Kossack and Brakhage, although I did not take measurements. All of the eggs were laid in nests on man-made nesting structures.

Nesting Success

Nesting success in this study is defined as the percent of nests in which at least one egg hatched, regardless of whether the gosling or goslings survived long enough to leave the nest. The overall nesting success in 1967 and 1968 was 71 and 68 percent, respectively, and 69 percent for both years combined. These percentages are based on a total of 321 nests of known fate; 124 in 1967 and 197 in 1968. The success of nests by area is presented in Table 32. The total number of successful nests was estimated at 124 in 1967 and 185 in 1968. Larimer County geese are as successful (or more successful) in their nesting attempts as geese of most other populations. Nesting success of the Denver flock was very similar in 1966, with 71 percent success (Szymczak 1967). Other free-flying flocks of B. c. maxima have not been as successful. Brakhage (1965) reported 65 percent; Kossack (1950), 57 percent; and Klopman (1958), 46 percent.

Factors Influencing Nesting Success. -

Nest Site--The specific location of a nest site seems to determine (at least partially) the success of that nest. Based on 321 nesting attempts in Larimer County, nests on man-made structures were more successful than nests on natural sites, elevated nests were more successful than ground nests, and island nests were slightly more successful than bank nests (Table 33). Seventy-six percent of all nests established on nesting structures were successful, but only 51 percent

Table 32. Success of 321 nesting attempts, by water area (1967-1968).

Water Area	1967			1968			1967-1968		
	No. of Nests	No. Successful	% Successful	No. of Nests	No. Successful	% Successful	No. of Nests	No. Successful	% Successful
Anderson Pond	3	3	100.0	3	2	66.6	6	5	83.3
Annex No. 8	2	2	100.0	4	1	25.0	6	3	50.0
Big Thompson River				1	1	100.0	1	1	100.0
Boedeaker Reservoir				7	3	42.8	7	3	42.9
Bureau Standards Pond 1	1	1	100.0	2	1	50.0	3	2	66.6
Bureau Standards Pond 2				1	1	100.0	1	1	100.0
Cache La Poudre River				2	2	100.0	2	2	100.0
Claymore Lake	5	3	60.0	6	3	50.0	11	6	54.5
College Lake	42	30	71.4	48	40	83.3	90	70	77.7
Country Club Pond				1	1	100.0	1	1	100.0
Curtis Lake				1	1	100.0	1	1	100.0
Dale Pond				1	1	100.0	1	1	100.0
Dean Acres	5	5	100.0	8	7	87.5	13	12	92.3
Deines Reservoir	1	0	0.0	1	0	0.0	2	0	0.0
Divide No. 8	6	4	66.6	9	2	22.2	15	6	40.0
Dry Creek Reservoir	2	1	50.0	2	2	100.0	4	3	75.0
Elder Reservoir	4	2	50.0	3	3	100.0	7	5	71.4
Flatiron Gravel Pits[a]	2	1	50.0	5	5	100.0	7	6	85.7
Flatiron Gravel Pits[b]				2	1	50.0	2	1	50.0
Flatiron Reservoir				1	1	100.0	1	1	100.0
Fort Collins Gravel Pit				1	0	0.0	1	0	0.0
Fossil Creek Reservoir	2	1	50.0	7	1	14.3	9	2	22.2
Herring Lake	4	3	75.0	4	4	100.0	8	7	87.5
Kitchel Reservoir	1	0	0.0	1	1	100.0	2	1	50.0
Launer Pond				1	0	0.0	1	0	0.0
Lindenmeier Lake	3	2	66.6	3	2	66.6	6	4	66.6
Long Pond	1	1	100.0				1	1	100.0
McNeil Reservoir				2	2	100.0	2	2	100.0
North Grey Reservoir				1	1	100.0	1	1	100.0
North Poudre No. 1	1	1	100.0	1	1	100.0	2	2	100.0
North Poudre No. 2	1	0	0.0				1	0	0.0
North Poudre No. 5				1	0	0.0	1	0	0.0
North Poudre No. 10	1	0	0.0	1	0	0.0	2	0	0.0
Parkwood Lake				1	1	100.0	1	1	100.0
Peterson Ponds				1	1	100.0	1	1	100.0
Romily Gravel Pit	1	1	100.0	1	1	100.0	2	2	100.0
South Grey Reservoir	1	1	100.0	1	1	100.0	2	2	100.0
Specht Ponds	2	0	0.0	2	0	0.0	4	0	0.0
Sterling Gravel Pits[c]	1	0	0.0	1	0	0.0	2	0	0.0
Sterling Gravel Pits[d]	3	3	100.0	8	7	87.5	11	10	90.9
Takes Pond	1	1	100.0	1	1	100.0	2	2	100.0
Timnath Reservoir	2	2	100.0	7	4	57.1	9	6	66.6
VanSant Pond	1	1	100.0	1	1	100.0	2	2	100.0
Water Supply & Storage No. 4				1	0	0.0	1	0	0.0
Watson Lake	24	18	75.0	38	23	60.5	62	41	66.1
Welch Reservoir	1	1	100.0	2	2	100.0	3	3	100.0
Wood Pond				1	1	100.0	1	1	100.0
Total	124	88	70.9	197	133	67.5	321	221	68.8

[a]Fort Collins Study Area.
[b]Loveland Study Area.
[c]Prospect Street.
[d]Taft Hill Road.

of the nests on natural sites were successful. Of importance is the fact that nests on natural sites were less successful than nests on each of the four different types of man-made structures. Elevated nests showed 77 percent success, while ground nests showed only 55 percent. Success of nests on the four major types of nesting structures varied considerably. Nests on four-pole structures were the most successful with 80 percent success, and those on ground structures were the least successful with 68 percent success. Nesting success on single-pole and floating structures was nearly the same with 75 and 73 percent success, respectively.

Table 33. Relationship between nesting success and nest site (based on 321 nesting attempts, 1967-1968).

Site	No. of Nests	No. Nests Successful	% Successful
Four-pole structure	80	64	80.0
Single-pole structure	79	59	74.7
Floating structure	52	38	73.1
Ground structure	22	15	68.2
All structures	233	176	75.5
Natural site	88	45	51.1
Elevated structure[a]	159	123	77.4
Ground site[b]	110	60	54.5
Island[c]	125	90	72.0
Bank[d]	196	131	66.8

[a]Includes nests on four-pole and single-pole structures.
[b]Includes nests on ground structures and natural sites.
[c]Includes nests on floating structures.
[d]Includes nests on structures and natural sites.

My results compare favorably with those of other researchers who have also studied the use of man-made nesting structures. Craighead and Stockstad (1961) found that 73 percent of nests located on nesting platforms over a 5-year period in Montana were successful. Brakhage (1965) reported that 73 percent of tub nests were successful in Missouri, but only 47 percent of ground nests were successful. Szymczak (1967) described nests on elevated structures as being over 90 percent successful, but he found only 21 nests on structures.

Szymczak (1967) found a relationship between the distance of nests from the water and nesting success. The relationship suggested that among nests located in the major vegetative types, those closer to the water had a better chance of success. I found the same relationship in Larimer County (Table 34). Except for the two nests found in debris, nests in the woody perennial type of vegetation had the highest success (88 percent) with the shortest mean distance to water (7 feet). Nests in the grass-forb type were only 49 percent successful and averaged 42 feet from water. Nests in the emergent type were least successful (27 percent), but averaged only 10 feet from water.

Age of the Female--There appears to be some evidence that nest success is influenced by age of the female. Both Dutcher (1885) and Brakhage (1965) discovered that older females laid larger clutches,

Table 34. Relationship between nesting success and cover type (based on 88 nesting attempts, 1967-1968).

Cover Type	No. of Nests	No. Successful	% Successful	Mean Distance to Water (ft)
Debris	2	2	100.0	2.0
Woody perennial	8	7	87.5	6.5
Barren ground	8	5	62.5	6.9
Grass-forb	55	27	49.1	42.1
Emergent	15	4	26.7	9.9

and Geis (1956), Brakhage (1965), and Szymczak (1967) all reported that nests containing large clutches were more successful than nests with small clutches. I also found large clutches to be more successful (Table 35). Over 91 percent of the six-egg clutches were successful, while five-, four-, and three-egg clutches were 74, 70, and 57 percent successful. Assuming that older females in Larimer County generally lay the larger clutches, then older females are more capable of bringing their nest to a successful termination. Brakhage (1965) suggested that older birds have had previous nesting experiences which contribute to their improved success in hatching their clutches.

Decimating Factors--Predation, flooding, and desertion can greatly influence nesting success. Other decimating factors of less importance are: (1) failure of the goose to keep the eggs warm, resulting in death of all the embryos; (2) failure in egg fertilization, resulting in sterile clutches; and (3) nest destruction by wind and other elements.

In 100 nesting attempts known to be unsuccessful, causes of failure were varied (Table 36). Twenty-two percent of the nesting

Table 35. Relationship between nesting success and clutch size (based on 308 nesting attempts, 1967-1968).

Clutch Size	No. of Nests	No. Successful	% Successful
1	13	1	7.7
2	14	1	7.1
3	23	13	56.5
4	70	49	70.0
5	92	68	73.9
6	68	62	91.2
7+	28	24	85.7

Table 36. Cause of failure in 100 unsuccessful nesting attempts (1967-1968).

Cause of Failure	No. of Nests	% of Nests
Desertion	55	55
Predation	22	22
Flooding	6	6
Vandalism and poaching	6	6
Clutch of dead embryos	6	6
Clutch of infertile eggs	2	2
Refused to accept moved nest[a]	2	2
Wind	1	1
Total	100	100

[a]Nests threatened by flooding were placed on floating structures.

failures were caused by egg destruction or goose mortality as a result of predation, but only in 11 cases could I attribute predation directly to a particular animal. Of the 11 losses, the coyote was responsible for only one destruction. In this case, the goose, nesting on a muskrat house, was killed on the nest and devoured along with several of her

eggs. Domestic dogs destroyed four nests; red foxes (Vulpes fulva), one nest; and raccoons (Procyon lotor), two nests. A goose which had been incubating eggs on a single-pole structure was found dead a short distance from the nest. Flesh was stripped from the head and upper neck and teeth marks were visible, probably those of a longtail weasel (Mustela frenata) or mink (Mustela vison). One other incubating female was found dead near the nest site, but I could not determine the cause of mortality. The common crow (Corvus brachyrhynchos) was responsible for only two losses. Of the 22 nests destroyed by predators, 18 (82 percent) were located on the ground, while only 4 (18 percent) were on nesting structures.

Flooding was the direct cause of failure in 6 percent of the unsuccessful nests (Table 34). Three additional nests were threatened and I attempted to salvage them. In each case, I placed the nest on a floating structure, camouflaged it with vegetation, and anchored it directly over the original nest site. Only one of these nests was successful; the other two failed because the geese refused to accept the new nest sites. Klopman (1958) had considerable success in moving nests at Dog Lake, Manitoba. Out of six nests that he moved 3 to 12 feet, all but one were accepted.

Desertion amounted to 55 percent and was the major cause of failure in the 100 unsuccessful nesting attempts. Seven nests were deserted due to disturbance by predators--five by dogs, one by a

raccoon, and one by an unknown predator. The eggs and nests were not molested. Tracks of predators left in and around the nests were evidence which indicated that nests were abandoned because of the mere presence of the predators. Four nests were deserted (all in 1968) during either the laying stage or early incubation period because of snow and below-normal temperatures. Investigator disturbance was not considered to be an important factor because I visited each nest site only twice, once to confirm the start of egg laying and once to count the entire clutch. I believe the greatest cause of desertion was intraspecific strife on areas of high density, i.e., College, Watson, and Terry lakes. Based on visual observations, conflicts between nesting pairs were known to be responsible for failure of at least 44 percent of the unsuccessful nests, and for 80 percent of all desertions. Based on 321 nests of known fate, nearly 14 percent were unsuccessful because of intraspecific friction.

Nest desertion on areas of relatively high nesting density is not uncommon, as pointed out by Doe (1943), Klopman (1958), Munro (1958), Collias and Jahn (1959), Rienecker and Anderson (1960), and Brakhage (1962). Szymczak (1967) found, however, that desertion and density were not major factors in retarding production in the Denver flock. Only 5 percent of his original nests were deserted, and only 2.8 percent were attributed to intraspecific competition. Hanson and Browning (1959) and Wood (1964) found no relationship between nesting density

and desertion, suggesting that the effect of density on nest success might vary between populations, and that some populations can tolerate higher density than others.

I found no evidence to indicate a difference in the amount of desertion between geese that nested on man-made nesting structures and geese that nested on natural sites. Nest desertion amounted to approximately 18 percent for nesting structures, and 17 percent for natural sites. This disagrees with Craighead and Stockstad (1961) who found that nesting platforms significantly increased desertion in Montana.

Of less significance are the number of nesting failures resulting from clutches of dead embryos and infertile eggs, wind, poaching, and vandalism. Six nests failed because of dead embryos, two because of infertile eggs, one because of wind, and six because of poaching and vandalism. All these factors combined amounted to only 15 percent of all nesting failures (Table 36).

Renesting

Minor renesting of Canada geese has been reported by Balham (1954), Klopman (1958), Atwater (1959), Martin (1964), Brakhage (1965), Szymczak (1967), and others. Only Geis (1956) has reported a significant amount of renesting in a free-flying population, which amounted to 30 to 40 percent by unsuccessful pairs in Montana. Weigand, Pollok, and Petrides (1968) reported that renesting averaged 70 percent when eggs were removed from birds in captivity. The

interval between loss of the original nest and start of the renest has been reported to range from 3 to 24 days, with mean intervals ranging from 11 to 16.7 days (Brakhage 1965, Szymczak 1967, Weigand, Pollok, and Petrides 1968). Females which have lost their clutches during the early laying period or early in the incubation period are considered capable of renesting (Balham 1954, Atwater 1959). Klopman (1958) suggested that females incubating for longer than 10 days are incapable of renesting.

I found only two renests in Larimer County, both in 1968. Although both females wore neck bands, positive verification of renesting was possible in only one case. This goose began incubating her first clutch of five eggs on structure No. 23 at Watson Lake on approximately March 28. She deserted the nest, possibly because of snow and cold, on April 20. On April 22, the same female was observed on structure No. 15, which was located 83 feet from structure No. 23. Both structures were in the center of the lake between two islands which prevented examination of the nests until April 29. At this time, nest No. 23 contained five cold eggs covered with down, and nest No. 15 contained two eggs, but no down. The clutch in nest No. 15 was obviously not complete. On or before May 1, the goose deserted nest No. 15; it contained two eggs at termination. On May 17, I found the same goose incubating a new clutch of five eggs on the original nest site, structure No. 23. This nest was initiated on about May 10, and all eggs hatched on June 14. The interval between desertion

of the first nest and intiation of the second was 2 to 3 days; the interval between the second and third was 8 or 9 days. The first nest was incubated for nearly 20 days, but the second was never incubated. Examination of eggs in the first two nests showed dead embryos in a very early stage of development. Only Atwater (1959) and Brakhage (1965) have reported three nesting attempts by a single goose during one breeding season. Brakhage described the occurrence as "not unusual" in Missouri.

Only circumstantial evidence verified the second renesting attempt. This nest, which contained six eggs, was initiated on about May 4, considerably later than any of the original nests. Based on initiation date alone, I classified the nest as a renest. All eggs hatched on June 10.

Hatching Success

The hatching success of eggs in successful nests was 81 percent in 1967, 79 percent in 1968, and 80 percent for both years combined (Table 37). The results were based on 218 nests; 88 in 1967 and 130 in 1968. The percent of eggs hatched by the Larimer County flock was comparable to rates reported for other free-flying B. c. maxima. Hatching success in the Denver area was also reported at 80 percent (Szymczak 1967). Bednarik (1965) reported 80 and 82 percent, and Klopman (1958) found rates over 90 percent.

Table 37. Fate of eggs in 218 successful nests (1967-1968).[a]

Fate	1967 No. of Eggs	1967 % of Eggs	1968 No. of Eggs	1968 % of Eggs	1967-1968 No. of Eggs	1967-1968 % of Eggs
Hatched	377	80.9	518	78.8	895	79.7
Embryonic death	60	12.9	111	16.9	171	15.2
Infertile	25	5.4	16	2.4	41	3.7
Destroyed and missing	4	0.9	12	1.8	16	1.4
Total	466	100.1	657	99.9	1123	100.0

[a]Dump nests not included.

The percent of eggs hatched in large clutches was only slightly greater than the percent in smaller clutches (Table 38). If the older females layed larger clutches, they may have been more capable of bringing their nest to a successful termination, but they were no more efficient in hatching a greater proportion of their eggs than were the younger females. Szymczak (1967) found a similar relationship.

Table 39 shows the relationship between the percent of eggs hatched in successful nests and the type and location of the nest site. The hatching success of eggs varied for each of the four major types of man-made nesting structures. Success was highest for single-pole structures (85 percent) and lowest for ground structures (73 percent). Hatching success for natural sites was slightly higher (84 percent) than for all nesting structures combined (79 percent). There was very little difference in hatching success between ground sites (81 percent) and elevated structures (80 percent). Hatching success was the same on islands as it was on the bank. Only a slight difference in hatching

Table 38. Relationship between hatching success in 218 successful nests and clutch size (1967-1968).[a]

Clutch Size	% of Eggs Hatched		
	1967	1968	1967-1968
3 or less	100.0	72.7	78.6
4	84.4	75.8	78.6
5	73.8	82.8	78.6
6	85.8	78.6	81.7
7 or more	80.3	78.4	79.1
All clutches	80.9	78.8	79.7

[a]Dump nests included.

success was detected among nests on College Lake (75 percent), Watson Lake (79 percent), and all other areas combined (83 percent).

The mean number of eggs hatched per successful nest was 4.31 $\pm$ 0.13 (mean $\pm$ standard error of the mean) in 1967, 4.00 $\pm$ 0.13 in 1968, and 4.11 $\pm$ 0.09 for both years, with a range of 1 to 8. The relationship between the mean number of eggs hatched and site location appear in Table 40. The mean number hatched was greatest on single-pole structures (4.53 $\pm$ 0.15) and lowest on ground structures (3.60 $\pm$ 0.44). There seemed to be no difference between the mean number hatched on natural sites (4.15 $\pm$ 0.23) and the mean number hatched on all types of man-made structures combined (4.35 $\pm$ 0.10). Similarly, the mean number of eggs hatched on elevated structures was only slightly higher than the mean number hatched on ground sites (4.29 $\pm$ 0.12 and 4.01 $\pm$ 0.21, respectively). The mean number of eggs hatched on all areas of low nesting density combined (4.22 $\pm$

Table 39. Relationship between percent of eggs hatched in 218 successful nests and nest site (1967-1968).[a]

Site	% of Eggs Hatched		
	1967	1968	1967-1968
Four-pole structure	80.5	69.9	75.0
Single-pole structure	79.2	87.4	84.8
Floating structure	77.1	77.1	77.1
Ground structure	77.8	68.4	73.0
All structures	79.2	78.3	78.7
Natural site	88.5	80.9	83.9
Elevated structure[b]	80.0	79.6	79.8
Ground site[c]	85.4	78.2	81.1
Island[d]	79.2	80.9	79.7
Bank[e]	82.2	77.6	79.4
College Lake	81.1	69.5	74.6
Watson Lake	79.8	77.8	78.7
All other areas combined[f]	81.3	84.0	83.0

[a]Dump nests not included.
[b]Includes nests on four-pole and single-pole structures.
[c]Includes nests on ground structures and natural sites.
[d]Includes nests on floating structures.
[e]Includes nests on structures and natural sites.
[f]Terry Lake not included.

Table 40. Relationship between nest site and mean number of eggs hatched in successful nests (1967-1968).[a]

Nest Site	1967 Sample Size	1967 Mean	1967 Confidence Interval[b]	1968 Sample Size	1968 Mean	1968 Confidence Interval	1967-1968 Sample Size	1967-1968 Mean	1967-1968 Confidence Interval
Four-pole structure	30	4.26	3.72-4.80	34	3.67	3.43-3.91	64	3.95	3.59-4.31
Single-pole structure	18	4.44	3.88-5.00	40	4.57	4.21-4.93	58	4.53	4.23-4.83
Ground structure	7	4.00	2.80-5.20	8	3.25	2.05-4.45	15	3.60	2.72-4.48
Floating structure	16	4.00	3.38-4.62	20	3.85	3.07-4.63	36	3.91	3.39-4.43
All structures	71	4.22	3.90-4.54	102	4.02	3.74-4.30	173	4.35	4.15-4.55
Elevated structure[c]	48	4.33	3.93-4.73	74	4.16	3.86-4.46	122	4.29	4.05-4.53
Ground site[d]	24	4.37	3.85-4.98	36	3.77	3.19-4.35	60	4.01	3.59-4.43
Natural site	17	4.52	4.00-5.04	28	3.92	3.26-4.58	45	4.15	3.69-4.61
Bank[e]	50	4.34	4.00-4.68	80	3.98	3.66-4.30	130	4.12	3.88-4.36
Island[f]	38	4.28	3.86-4.70	50	4.04	3.58-4.50	88	4.14	3.82-4.46
College Lake	30	4.00	3.52-4.48	39	3.33	2.91-3.75	69	3.23	2.91-3.55
Watson Lake	18	4.38	3.70-5.06	22	3.95	3.27-4.63	40	4.15	3.67-4.63
All other areas combined[g]	40	4.45	4.05-4.85	69	4.40	4.04-4.76	109	4.22	3.96-4.48
All sites[a]	88	4.31	4.05-4.57	130	4.00	3.74-4.24	218	4.11	3.93-4.29

[a] Dump nests not included.
[b] Two standard errors were applied to each side of the mean.
[c] Includes nests on four-pole and single-pole structures.
[d] Includes nests on ground structures and natural sites.
[e] Includes nests on structures and natural sites.
[f] Includes nests on floating structures.
[g] Terry lake not included.

0.13) was slightly higher than on areas of high nesting density (College Lake, 3.23 ± 0.16; Watson Lake, 4.15 ± 0.24). Confidence intervals were applied to each of the means; all intervals overlap and suggest no significant difference in mean number of eggs hatched in nests on various sites (Table 40).

The estimated number of eggs on each area and the total hatched during each year appear in Table 41. Of the 857 eggs laid in all nests in 1967, 537 (63 percent) hatched. In 1968, 739 (59 percent) of the 1256 eggs hatched.

Extremes in weather conditions, especially low temperatures, can have an effect on hatching success in individual nests if the eggs are not kept warm and covered. Freezing temperatures can be most harmful if they occur during the period when a majority of nests are in the egg-laying stage, before incubation begins. At this time the eggs are merely covered with nesting material. Heavy snow and freezing temperatures occurred on April 3 and 4, 1968, shortly following the peak of egg laying, and again on April 17. Although most of the nests were being incubated, a large number were not. The result was frozen eggs. I found five slightly cracked eggs in five different nests either during incubation or after hatching occurred. The eggs were decomposed, and I attributed the loss to freezing. Embryonic death probably occurred in other eggs that were frozen but failed to crack. Low temperatures may have been partially responsible for

Table 41. Estimated number of eggs hatched (1967-1968).

Area	1967 No. of Eggs	1967 No. Hatched	1967 % Hatched	1968 No. of Eggs	1968 No. Hatched	1968 % Hatched
FORT COLLINS STUDY AREA						
Anderson Pond	15	13	86.7	14	8	57.1
Annex No. 8	10	6	60.0	19	5	26.3
Bureau Standards Pond 1	7	4	57.1	9	4	44.4
Bureau Standards Pond 2[a]				5	5	100.0
Cache La Poudre River[a]				14	14	100.0
Claymore Lake	25	15	60.0	36	19	52.8
College Lake	190	120	63.2	231	137	59.3
Country Club Pond[a]				6	6	100.0
Curtis Lake[a]				4	2	50.0
Dale Pond[a]				7	7	100.0
Dean Acres	25	17	68.0	40	33	82.5
Deines Reservoir	3	0	0.0	5	0	0.0
Divide No. 8	35	21	60.0	39	7	17.9
Dry Creek Reservoir	10	5	50.0	9	9	100.0
Elder Reservoir	22	12	54.5	22	15	68.2
Flatiron Gravel Pits	12	6	50.0	22	18	81.8
Fort Collins Gravel Pit[a]				6	0	0.0
Fossil Creek Reservoir	11	5	45.4	40	12	30.0
Herring Lake	20	13	65.0	21	18	85.7
Kitchel Reservoir	2	0	0.0	6	6	100.0
Launer Pond[a]				2	0	0.0
Lindenmeier Lake	18	9	50.0	19	9	47.4
Long Pond	6	4	66.7	5	0	0.0
North Grey Reservoir[a]				6	5	83.3
North Poudre No. 1	4	3	75.0	6	4	66.7
North Poudre No. 2[b]	5	0	0.0			
North Poudre No. 5[a]				12	6	50.0
North Poudre No. 10	2	0	0.0	5	0	0.0
Parkwood Lake[a]				5	5	100.0
Peterson Ponds[a]				4	4	100.0
Romily Gravel Pit	5	5	100.0	6	6	100.0
South Grey Reservoir	6	6	100.0	6	6	100.0
Specht Ponds	7	0	0.0	7	0	0.0
Sterling Gravel Pits[c]	4	0	0.0	5	0	0.0
Sterling Gravel Pits[d]	25	20	80.0	37	26	70.3
Takes Pond	5	4	80.0	7	6	85.7
Terry Lake	218	133	61.0	264	160	60.6
Timnath Reservoir	12	11	91.7	27	18	66.7
VanSant Pond	6	4	66.7	6	4	66.7
Water Supply & Storage No. 4[a]				5	0	0.0
Watson Lake	125	79	63.2	171	93	54.4
Wolaver Pond[a]				5	3	60.0
Wood Pond[a]				5	3	60.0
Subtotal	835	515	61.7	1170	683	58.4
LOVELAND STUDY AREA						
Big Thompson River[a]				11	10	90.9
Boedeaker Reservoir	17	17	100.0	40	15	37.5
Flatiron Gravel Pits[a]				9	5	55.6
Flatiron Reservoir[a]				4	4	100.0
McNeil Reservoir				10	10	100.0
Welch Reservoir	5	5	100.0	12	12	100.0
Subtotal	32	32	100.0	86	56	65.1
Total	857	537	62.7	1256	739	58.8

[a]No nests established in 1967.
[b]No nests established in 1968.
[c]Prospect Street.
[d]Taft Hill Road

the increase in the number of dead embryos found in 1968 (16.9 percent) over the number found in 1967 (12.9 percent).

Embryonic Deaths and Egg Fertility

I used Kossack's (1950) method of egg analysis to determine the rate of infertility and frequency of embryonic death in 218 successful nests. I opened all eggs which did not hatch and examined them for signs of embryonic development (Table 37). In 1967, 12.9 percent of the eggs contained dead embryos, 5.4 percent were infertile, and 0.9 percent were recorded as either destroyed or missing. In 1968, 16.9 percent contained dead embryos, 2.4 percent were infertile, and 1.8 percent were destroyed or missing. Embryonic deaths amounted to 15.2 percent for both seasons, while the rate of infertility was only 3.7 percent. Similar rates have been reported for other B. c. maxima populations (Kossack 1950, Klopman 1958, Brakhage 1965, Szymczak 1967).

I only found two dump nests, which contained a total of 20 eggs. Embryonic deaths for these eggs amounted to 25 percent and infertility, 10 percent.

The size range of dead embryos in 111 unhatched eggs which were collected from successful nests in 1968 appears in Table 42. Death occurred when the embryo was less than 50 mm long in 51 percent of the eggs examined. Thirty-five percent of the deaths occurred when the embryo was over 150 mm in length. Over 85 percent of the deaths

took place in either the very early or very late stage of development. This corresponds closely to the findings of Munro (1958), who reported that 88 percent of embryonic deaths occurred during either the first 3 or last 3 days of incubation.

Table 42. Size of embryos found in 111 eggs which failed to hatch in successful nests (1968).[a]

Size of Embryo (mm)	No. of Embryos	% of Embryos
0-49	57	51.4
50-99	3	2.7
100-149	12	10.8
150+	39	35.1
Total	111	100.0

[a]Dump nests not included.

Production by Age Classes

Breeding in 2- and 3-Year-Olds. -The age at which Canada geese begin breeding has interested waterfowl managers for decades. Williams (1967) believes that wild geese begin production in their second year, but confinement or an unbalanced sex ratio may delay the activity in some individuals until the third year or longer. The fact that some 2-year-olds are capable of breeding and contribute some production has been pointed out by Kossack (1950), Balham (1954), Atwater (1959), Craighead and Stockstad (1964), Martin (1964), Sherwood (1966), and Williams (1967). Craighead and Stockstad found that 27 to 36 percent of free-flying 2-year-olds nested, but only 17 percent of 2-year-old captive geese nested. They also discovered

that all free-flying 3-year-olds nested, but only 64 percent of those held captive did so. The percent of 2- and 3-year-olds breeding in Larimer County (where all birds are free flying, but oftentimes found nesting under crowded conditions similar to those in captivity) would probably fall somewhere between the percentages found in captive and free-flying flocks.

Collias and Jahn (1959) were successful in identifying individual geese held captive in an 11-acre enclosure by reading numbers on U. S. Fish and Wildlife Service leg bands with the aid of a 35X telescope. I employed this method in an attempt to determine the productivity (by number of eggs laid and hatched) of 2- and 3-year-olds in the Larimer County flock. I was successful in reading leg band numbers only on nesting geese at College Lake. The majority of these birds were banded. They were relatively unafraid of man, and permitted me to approach within several yards of the nest. I did not flush the goose from the nest in order to hold disturbance and desertion at a minimum. Band numbers were most easily read when the goose stood up to turn her eggs and when she was near the nest grazing. This method of identification was time consuming and not always successful. Mud, badly worn bands, and poor light were hindersome. I obtained 50 numbers and calculated the ages of the birds by referring to banding records. The results showed that all birds were 4 years old or older. No data were obtained on the production of 2- and 3-year-olds.

Because this method of identification proved unsuccessful, this part of the study was not continued in 1968.

I found one 2-year-old nesting in 1968, and verified it by neck band number. The goose was banded in Larimer County as a gosling during the spring of 1966 and was released in Boulder County. In 1968, I found her incubating six eggs on a single-pole structure at Welch Lake. The nest was successful and all eggs hatched. Collias and Jahn (1959) also reported a case where a 2-year-old pair successfully hatched six eggs.

Nesting by Yearlings. -Reproduction by yearlings has never been observed, although some researchers have reported the formation of "pair bonds" between male and female yearlings or between yearlings and other age classes (Balham 1954, Martin 1964). On July 5 and 6, 1967, I neck banded 165 goslings from College, Watson, and Terry lakes for the primary purpose of observing their breeding behavior, if any, during the 1968 nesting season. All but two of the goslings were released in Boulder County to build up that resident flock. The other two were released on Terry Lake.

Fifty of these yearlings were reobserved in Larimer County during 1968; they represented 30 percent of the total number banded. Although none of the 50 yearlings nested, there was some evidence to indicate pairing. I saw each of 18 yearlings, 12 males and 6 females, at least once in the company of another goose in more or

less isolated surroundings and displaying behavior suggesting a "pair bond." Five yearlings were seen with possible mates on two different occasions, and two yearlings were seen with mates on three different occasions. Only in two cases, however, were the male and female neck banded. It is possible that two of the same sex were seen together in some of the other observations.

I saw one yearling male courting another goose, believed to be a female, but wearing no neck band. The courtship occurred on Claymore Lake and lasted for 3 to 4 minutes. Both geese participated in the typical neck stretching and honking, but there was no copulation. Following courtship, the pair moved to the shore where they began feeding.

Remating

Kossack (1950), Balham (1954), and Collias and Jahn (1959) have all reported remating in Canada geese where one member of the pair was killed or separated from the other. Sherwood (1966) has stated that "pair bonds" are permanent so long as both members remain alive. Remating occurred at least twice in Larimer County during this study. In both cases, females lost their mates shortly after nesting successfully in 1967. One of the males suffered a broken wing during the incubation period; he accompanied the female and young for a short time, but eventually disappeared. The female raised the young to the flight stage alone. The other male escorted his mate and young for about

2 weeks, then disappeared. The female was unsuccessful in rearing the brood alone; all goslings were lost before they were 6 weeks old. Each female selected a new mate before the 1968 breeding season. They returned to their old nest sites and were again successful in hatching their clutches.

PREFLIGHT PERIOD

Brood Counts

I began counting broods as soon as the first nests hatched. I made the counts several times a week until goslings could not be distinguished from the adults, usually about the first of July. I used these counts to determine brood movement, gosling mortality, and the number of young which survived to the flight stage. Although minor brood mixing occurred on nearly all areas, broods generally retained their individual identity throughout the brooding period, except at College, Watson, and Terry lakes, where brood grouping and extremely large "gang broods" were common.

Brooding Areas and Gosling Movement

Williams and Nelson (1943) described the major requirements of good Canada goose breeding areas. They included, among others, a brooding environment of open water and banks for resting and feeding. Most breeding areas in Larimer County seem to meet these requirements. In most cases, nesting areas also served as brood-rearing

areas. Although broods were not marked, I detected some minor movement between nesting areas by either an increase or decrease in the total number of broods or goslings which appeared on each location. Neck bands worn by some of the adults helped to identify broods. All areas that attracted broods, as well as areas that "lost" broods, appear in Table 43. Movements were similar in 1967 and 1968. The greatest amount of movement occurred among Annex No. 8, Divide No. 8, Elder Reservoir, and adjacent ponds--Bureau of Standards ponds, Country Club Pond, and Wood Pond. Broods which hatched on the smaller ponds were moved into the large, three-reservoir area, where all broods moved freely from one body of water to the next. Some broods were moved up to 1.5 miles across land to reach permanent brooding areas.

Gosling Mortality

The importance of gosling mortality apparently varies between areas and populations. Williams and Marshall (1938), Craighead and Craighead (1949), Collias and Jahn (1959), and Martin (1964) all reported very little or no gosling mortality. In contrast, Geis (1956), Brakhage (1965), and Szymczak (1967) reported mortality ranging from 16 to 32 percent.

Causes of mortality were difficult to determine in Larimer County. Domestic dogs and cats, coyotes, red foxes, raccoons, great horned owls (Bubo virginianus), California and ring-billed gulls

Table 43. Areas on which brood movement occurred (1967-1968).

Area	Movement of Broods
FORT COLLINS STUDY AREA	
Anderson Pond	Interchange among Anderson Pond, Cache La Poudre River, and Sterling Gravel Pits (Prospect Street).
Annex No. 8	Much interchange among Annex No. 8, Divide No. 8, and Elder reservoirs.
Bureau Standards Ponds 1 & 2	Broods moved permanently into the Annex No. 8-Divide No. 8-Elder reservoir area.
Cache La Poudre River	Interchange between Anderson Pond and Cache La Poudre River; interchange between Cache La Poudre River and Romily Gravel Pit.
Claymore Lake	Interchange between Claymore Lake and small livestock pond to the east.
Cobb Lake	Broods moved permanently from Takes Pond to Cobb Lake.
College Lake	Much interchange between College Lake and Maxwell Pond.
Country Club Pond	Brood moved permanently into the Annex No. 8-Divide No. 8-Elder reservoir area.
Divide No. 8	Much interchange among Annex No. 8, Divide No. 8, and Elder reservoirs.
Dry Creek Reservoir	Broods moved permanently from North Poudre No. 1 to Dry Creek Reservoir.
Elder Reservoir	Much interchange among Annex No. 8, Divide No. 8, and Elder reservoirs.
Flatiron Gravel Pits	Broods moved out of the area permanently; much interchange among Anderson Pond, Cache La Poudre River, and Sterling Gravel Pits (Prospect Street).
Kitchel Reservoir	Brood moved permanently to Timnath Reservoir.
Lindenmeier Lake	Interchange among Lindenmeier Lake, Long Pond, and VanSant Pond.

Table 43. Areas on which brood movement occurred (1967-1968).--Continued

Area	Movement of Broods
Long Pond	Interchange among Lindenmeier Lake, Long Pond, and VanSant Pond.
North Grey Reservoir	Broods moved permanently to South Grey Reservoir.
North Poudre No. 1	Broods moved permanently to Dry Creek Reservoir.
Romily Gravel Pit	Interchange between Cache La Poudre River and Romily Gravel Pit.
South Grey Reservoir	Broods moved permanently from North Grey Reservoir to South Grey Reservoir.
Sterling Gravel Pits (Prospect Street)	Interchange among Anderson Pond, Cache La Poudre River, and Sterling Gravel Pits (Prospect Street).
Takes Pond	Broods moved permanently to Cobb Lake.
Timnath Reservoir	Brood moved permanently from Kitchel Reservoir to Timnath Reservoir.
VanSant Pond	Interchange among Lindenmeier Lake, Long Pond, and VanSant Pond.
Watson Lake	Much interchange among Cache La Poudre River, Watson Lake, and small pond to the southeast.
Wood Pond	Brood moved permanently into the Annex No. 8-Divide No. 8-Elder reservoir area.
LOVELAND STUDY AREA	
Big Thompson River	Interchange between Big Thompson River and Flatiron Gravel Pits.
Flatiron Gravel Pits	Interchange between Big Thompson River and Flatiron Gravel Pits.
McNeil Reservoir	Interchange among Lonetree Reservoir, McNeil Reservoir, and Welch Reservoir.
Welch Reservoir	Interchange among Lonetree Reservoir, McNeil Reservoir, and Welch Reservoir.

(Larus californicus, L. delawarensis), snapping turtles (Chelydra serpentina), northern pike (Esox lucius), and man were all potential predators. I was directly aware of 30 gosling mortalities, 8 in 1967 and 22 in 1968. All eight goslings in 1967 were found dead in the nest; nine similar cases were found in 1968. All of these goslings were completely out of the egg and death probably occurred as a result of trampling or suffocation. I found three 1- to 7-day-old goslings dead on the bank at College Lake; the cause of death could not be determined because the carcasses were badly decomposed. A day-old gosling was found 15 feet from a single-pole structure at Flatiron Gravel Pits. Much of the body had been devoured by birds, probably gulls. I could not determine whether the gosling died in the nest, or on the ground as a result of predation or descent from the nest. One 3- to 4-week-old gosling was found dead at Annex No. 8 and another at Watson. The carcasses were badly chewed, indicating possible predation by either dogs, coyotes, or foxes. Dogs were responsible for killing a week-old gosling at Watson Lake. A gosling was killed by a car near Dean Acres, and another was killed by young boys at Herring Lake. Four goslings apparently died of copper sulfate poisoning at Parkwood Lake. The chemical was used to control aquatic vegetation during the middle of June.

Northern pike have been known to be a serious predator of young ducklings in some areas (Solman 1945). Pike were placed in College Lake in the early 1960's, before the lake was set aside for goose

nesting. Pike were suspected of preying on very young goslings as early as 1961 (Grieb 1962). In 1968, I received one unconfirmed report (by a passer-by) of a large pike that rose partially out of the water and swallowed a 2- to 3-day-old gosling. Although this report could not be proved or disproved, I was aware of no other losses caused by pike, even though mortality at College Lake was high and partially unexplained.

There was no evidence to indicate gosling mortality as a result of descent from elevated nesting structures. I thoroughly searched the ground below each nest after the goslings descended, but failed to find any signs of injury or death. I was present when goslings left the nest on six different occasions. The manner in which they descend was well described by Yocum (1956), Craighead and Stockstad (1958), Vaught (1960), and Brakhage (1962). The young tumbled over the side of the nest one by one as the adults called to them from below. As soon as the first left the nest, the others followed. I watched goslings fall from a height of 7 to 8 feet, strike rocks and hard, dry ground, then bounce 12 to 18 inches into the air. After hitting the ground the second time, they began moving about instantly, apparently unharmed. Only Craighead and Stockstad (1958) actually found signs of gosling mortality below an aerial nest. In this case, a gosling had struck a stick protruding from the sand and died.

I estimated total gosling mortality by comparing the number of young at time of hatching with the number of young present at the end

of the brooding season. Gosling mortality was exceptionally high at College, Watson, and Terry lakes when compared with all others areas (Table 44). College Lake goslings suffered a 49-percent loss in 1967, but only 20 percent in 1968, for an average loss of 33 percent. Twenty-two percent of the Watson Lake goslings died in 1967 and 40 percent in 1968, an average of 31 percent. Mortality at Terry Lake averaged 38 percent, with 40 percent in 1967 and 36 percent in 1968. When all other areas were combined, mortality amounted to only 17 and 15 percent for 1967 and 1968, respectively, with an average of 16 percent. Total gosling mortality for all of Larimer County was approximately 30 percent in 1967 and 24 percent in 1968. Mortality for the entire study was estimated at 26 percent. Based on brood counts, most losses occurred at an early age.

Table 44. Estimated gosling mortality at College, Watson, and Terry lakes compared with all other areas combined (1967-1968).

Area	% Mortality		
	1967	1968	1967-1968
College Lake	49	20	33
Watson Lake	22	40	31
Terry Lake	40	36	38
All other areas combined	17	15	16
All areas	30	24	26

"Gang Broods."-There is a general agreement that brood grouping is a common occurrence in most Canada goose populations which breed in the United States under seminatural conditions (Williams and Marshall

1938, Miller and Collins 1953, Geis 1956, Collias and Jahn 1959, Martin 1964, Brakhage 1965, Sherwood 1967, and others). Raveling (1966) summarized the artificial or unusual situations under which brood grouping occurs. He stated that grouping is common when one or a combination of the following conditions prevail: (1) geese are introduced, captive or semitame; (2) densities of nesting geese are far higher than those associated with most naturally occurring populations; (3) succeeding generations are nesting in close proximity; and (4) much contact between families occurs just after hatching. All of these conditions seemed to be present at College, Watson, and Terry lakes, where large broods were noted. Grouping was rare on other areas.

Adults and their young were most easily observed at College Lake, which made it possible to study "gang broods." In 1968, I kept accurate records of the number of goslings in each brood. The week of April 22 marked the peak of hatching, at which time an average of 3.4 goslings emerged from each successful nest. Based on observations of nearly all young, the mean number of gosling per brood was 4.2 during the week of April 22, and 4.7 during the week of April 29 (Table 45). The average brood contained slightly over five goslings from May 6 to May 20, but increased to nearly six goslings during the weeks of June 3 and 17, and to over seven goslings during the week of June 24. By the end of June, over 40 percent of the broods contained six or more goslings, and 28 percent contained over 10. The increase

in mean brood size indicates that brood grouping began shortly after hatching and continued throughout much of the brooding period. Goslings in "gang broods" ranged in age from less than a week old to the very oldest on the area. Goslings less than 3 weeks old, and particularly those less than 1 week old, were especially vulnerable to adoption by larger broods. Williams and Marshall (1938), Miller and Collins (1953), Collias and Jahn (1959), Martin (1964), Raveling (1966) and Sherwood (1967) also noted a predominance of brood grouping in goslings less than 3 weeks of age. A total of 40 broods hatched at College Lake, but on July 1, only 13 were recognizable. Although I saw as many as four pairs escorting a single brood, a number of successful pairs lost their entire brood to other pairs through adoptions. The size of large broods was not constant and increases and decreases occurred from day to day.

Table 45. Brood-size data for College Lake, by weekly intervals, from the time hatching began until goslings were indistinguishable from adults (1968).

	No. of Broods	Mean		% of Broods With		
Week	Counted	Brood Size	Range	5 or Less	6 or More	10 or More
April 22	10	4.2	2-8	70	30	0
April 29	62	4.7	1-10	69	31	5
May 6	123	5.1	1-25	75	25	14
May 13	92	5.2	1-32	82	18	11
May 20	60	5.1	1-30	55	45	10
May 27	88	5.6	1-32	70	30	19
June 3	98	5.7	1-34	68	32	18
June 10	52	5.2	1-27	71	29	17
June 17	47	5.6	1-29	66	34	15
June 24	29	7.2	1-28	59	41	28

The exceptionally high rate of gosling mortality at College, Watson, and Terry lakes was probably largely due to "gang broods" and the inability of the adults to care adequately for all young, especially those less than 3 weeks old. Broods ranging in size from 1 to 34 goslings were common, and frequently seen up to 1/4 mile from water. Several goslings were found stranded in tall grass, rocks, and ditches, and would have perished without help. Hail storms, heavy rain, extended periods of inclement weather, and predators were believed to be the primary causes of gosling mortality in large broods.

July Census

Census of Goslings. -During the first week of July in both 1967 and 1968, I made a complete inventory of the Larimer County flock and recorded the total number of goslings and adults (including yearlings) for all areas where brooding and molting occurred. I felt this was an accurate census technique because: (1) the locations of all individual flocks and smaller family groups were known; (2) nearly all adults were molting and incapable of flight, which limited movement between water areas; (3) goslings resembled the adults, yet most were incapable of flight and all were easily distinguishable from the adults; and (4) although goslings were of all ages, a majority were developed well enough to be classified as having reached the flight stage. The results of the July census for both 1967 and 1968 appear in Table 46. The total number of goslings which reached the flight stage was 374 in 1967,

Table 46. July census of goslings and adults (including yearlings) (1967-1968).

Breeding or Molting Area	No. Goslings Surviving to Flight Stage		No. Adults	
	1967	1968	1967	1968
FORT COLLINS STUDY AREA				
Anderson Pond[a]	15	23	8	20
Cache La Poudre River	0	6	0	2
Claymore Lake	14	19	25	34
Cobb Lake[b]	4	1	2	6
College Lake	61	110	175	153
Curtis Lake	0	2	0	2
Dale Pond	0	7	0	2
Dean Acres	16	25	12	25
Divide No. 8[c]	58	47	108	159
Dry Creek Reservoir[d]	8	12	4	6
Fossil Creek Reservoir	4	12	2	9
Herring Lake	3	17	12	16
North Poudre No. 5	0	6	0	2
Parkwood Lake	0	1	0	2
Peterson Ponds	0	2	0	2
Romily Gravel Pit	0	10	1	4
South Grey Reservoir[e]	6	10	2	4
Sterling Gravel Pits[f]	18	24	8	23
Terry Lake	80	103[g]	374	344
Timnath Reservoir[h]	11	22	14	34
Watson Lake	62	56	102	98
Wolaver Pond	0	3	0	2
Subtotal	360	518	849	949
LOVELAND STUDY AREA				
Boedeaker Reservoir	14	15	32	28
Flatiron Gravel Pit[i]	0	15	0	6
Flatiron Reservoir	0	4	0	2
McNeil Reservoir[j]	0	12	0	6
Subtotal	14	46	32	42
Total	374	564	881	991

[a]Anderson Pond, Flatiron Gravel Pits, and Sterling Gravel Pits (Prospect Street) treated as one unit because of goose movement.

[b]Cobb Lake and Takes Pond treated as one unit.

[c]Annex No. 8, Bureau Standards Ponds 1 & 2, Country Club Pond, Divide No. 8, Elder Reservoir, Lindenmeier Lake, Long Pond, VanSant Pond, and Wood Pond treated as one unit.

[d]Dry Creek Reservoir and North Poudre No. 1 treated as one unit.

[e]South Grey and North Grey reservoirs treated as one unit.

[f]Taft Hill Road.

[g]Estimate based on 1967 data.

[h]Timnath and Kitchel reservoirs treated as one unit.

[i]Flatiron Gravel Pits and Big Thompson River treated as one unit.

[j]McNeil and Welch reservoirs treated as one unit.

and 564 in 1968. Each year an average of 3.0 goslings survived for every successful nesting attempt.

Census of Adults. -Szymczak's (1967) observations of molting chronology in the adult Denver flock closely resemble mine for the Larimer County flock. A majority of adults began dropping feathers about the middle of June. Approximately 95 percent of the adult population was flightless when the census was taken during the first week of July (Table 46). In July 1967, the adult population, including yearlings, was estimated at 881. In July 1968, adults and yearlings totaled 991. The total number of geese in Larimer County was estimated at 1255 in 1967, and 1555 in 1968.

MOVEMENT OUT OF LARIMER COUNTY

In the spring of 1967 and 1968, Canada geese were live-trapped in Larimer County by the Colorado Division of Game, Fish and Parks and released in Alamosa, Boulder, and Weld counties in an attempt to build up other resident flocks. In July of 1967, 177 neck-banded goslings were released in Boulder County, leaving 881 adults (including yearlings) and 197 goslings in Larimer County. Following this operation, the total number of geese remaining in Larimer County was estimated at 1078. During July of 1968, 252 geese were trapped and removed from Larimer County. Thirty-eight goslings were released in Alamosa County, and another 210, along with four adults, were

released in Weld County. The total number of geese remaining in Larimer County was estimated at 1303, which included 316 goslings and 987 adults.

Included in the July inventory of 1968 were 50 neck-banded yearlings which had been released in Boulder County in 1967. They returned to Larimer County during February, March, and April, and remained throughout the molting period. These 50 yearlings probably represented only the minimum number that returned. They were frequently seen in small groups which contained other yearlings without neck bands. The unbanded birds apparently lost their neck bands, but were from the original transplanted stock. Neck bands were easily lost and the retention rate for all banded birds over a 1-year period was estimated at less than 60 percent.

In 1968, two neck-banded birds were recovered outside Larimer County. An immature male, captured as a gosling in Larimer County in 1967 and later released in Boulder County, was shot in Mexico during January. This goose lost all family ties as a result of the transplant and apparently joined northern flocks on their migration to wintering grounds. The other goose, an adult male neck banded and released at Terry Lake, was sighted on the Monte Vista National Wildlife Refuge in the San Luis Valley in 1968. The refuge, located in south-central Colorado, is approximately 220 air miles from Fort Collins and across the front range of the Rocky Mountains. The High

Line population commonly crosses into the San Luis Valley (Grieb 1969); this goose apparently joined the migrants.

The Larimer County flock is largely nonmigratory and only in rare cases, such as the ones described, is migration believed to occur. Because of the close association between resident and migratory birds during the winter months, a few residents (if any) may winter to the south with northern flocks and return to breed in the spring. If such movement occurs, there are no data to support it.

CHAPTER VIII

SUMMARY

TAXONOMY

1. Weights, measurements, and notes on white markings of molting adult and yearling Canada geese were taken during July 1968. Measurements included length of exposed culmen, culmen width, and length of middle toe including nail. Weights and measurements of Larimer County geese were compared with those recorded for known populations of giant Canada geese and found to be similar for most sex and age classes (significant at the 5-percent level). Based on these observations, I have assumed that the Canada geese of Larimer County are primarily Branta canadensis maxima.

MAN-MADE NESTING STRUCTURES

2. During 1967 and 1968, an average of 194 man-made nesting structures were available to local geese. Included were elevated structures (74 percent), floating structures (16 percent), and wooden boxes and wash tubs located on the ground (10 percent).

NECK BANDS

3. A total of 396 geese, 231 adults and 165 goslings, was neck banded to aid in the identification of individual birds and nesting pairs. Neck bands were developed from polyvinyl chloride tubing 0.04 inches thick with an inside diameter of 1.92 inches. The tubing was purchased from the B. F. Goodrich Company, Denver, Colorado. Neck bands were easily lost and the retention rate for all banded birds over a 1-year period was estimated at less than 60 percent.

NESTING CHRONOLOGY

4. Weather was the primary factor influencing the distribution of geese during the prenesting period. Geese remained concentrated on six major wintering areas until the spring thaw, which began during the last week of February. By the end of the first week of March, most water areas were free from ice and the resident geese were widely distributed.

5. The first signs of breeding activity were noticed during the week of January 15, when the daily maximum and minimum temperatures for that week reached 48.7 F and 20.4 F, respectively. The general warming trend may have partially triggered the start of the breeding period.

6. The first egg was laid on approximately March 12 in 1967, and on March 7 in 1968. The last nest was initiated on May 3 in 1967 and on May 10 in 1968.

7. The peak period of nest initiation was nearly identical in both years and lasted for approximately 3 weeks. The period extended from March 20 to April 9 in 1967, and from March 18 to April 7 in 1968.

8. The 7-day-peak period of egg-laying activity was March 27 to April 2 in 1967, and March 25 to 31 in 1968.

9. The greatest number of nests was in the incubation stage from April 24 to 30 in 1967, and April 22 to 28 in 1968.

10. The first goslings hatched on April 16 in 1967, and on April 10 in 1968. The 7-day-peak period of hatching was during the week of May 1 in 1967, and during the week of April 22 in 1968. The last successful nest hatched on June 7 in 1967, and on June 14 in 1968.

11. The length of the nesting period was 88 days in 1967, and 100 days in 1968. Renesting occurred only in 1968, and was responsible for extending the nesting period.

PRODUCTION

12. In 1967, 50 percent of the nests were on College Lake and Terry Lake alone. The remaining 50 percent were established by "pioneering" geese on 29 different water areas, including Watson Lake with 14 percent. Of the 123 water areas studied, only 31 (25 percent) supported nests.

13. During 1968, 40 percent of the nests were on College and Terry lakes. "Pioneering" geese established 60 percent of the nests

on 46 different sites, including Watson Lake with 15 percent. Of the 123 areas studied, 48 (39 percent) supported nests. The increase in number of nests established by "pioneering" geese, and the increase in number of areas which supported nests indicates a rapid dispersal of breeding pairs to utilize all available habitat.

14. Small groups of geese and mated pairs were observed on 38 water areas which failed to produce nests, probably because of inadequate nesting cover. With the addition of nesting structures on many of these sites, the nesting potential in Larimer County could be increased signficiantly. Thirty-two other water areas were not attractive to local geese, and offer very little nesting potential, even if structures were to be made available.

15. A total of 173 nests were established in 1967, including dump nests and renests. In 1968, 267 nests were established, an increase of 94 or 54 percent over 1967. At least 98 percent of all nesting attempts were believed to have been included in this study.

16. Fifty-nine percent of all nests studied were on man-made nesting structures. The remaining 41 percent were on natural sites which were located primarily on the ground. Thirty-four percent of all nests were located on islands, and only 2 percent were on muskrat houses. The percent of nests on natural sites increased from 36 in 1967 to 44 in 1968, which was followed by a corresponding decrease in the percent of nests on structures.

17. One goose nested in an abandoned magpie nest located in a cottonwood tree. The tree was completely surrounded by water and was approximately 10 feet from shore. The nest was nearly 6 feet above the water. All eggs hatched.

18. Of all nests found on natural sites, 62 percent were in the grass-forb type of vegetation, 18 percent were in the emergent type, 9 percent were in woody perennials, and 9 percent were on barren ground.

19. Nests on natural sites averaged 32 feet from water, with a range of 0 to 352 feet.

20. Thirty-six percent of all nests established in 1968 were either on the same location or within 30 feet of nests occupied in 1967. This included nests on both natural sites and on man-made nesting structures.

21. The mean clutch size for all nests was 4.92 ± 0.11 in 1967, 4.62 ± 0.11 in 1968, and 4.74 ± 0.08 for both years combined. The mean number of eggs found in successful nests only was 5.29 ± 0.10 in 1967, 5.05 ± 0.11 in 1968, and 5.15 ± 0.08 for both years. Clutch size ranged from 1 to 10 eggs. Clutches of 5 eggs were the most common and represented 30 percent of all clutches. There was no significant difference in mean clutch size among nests located on all man-made structures, elevated structures, natural sites, and ground sites, or between all nests in 1967 and 1968.

22. Only two dump nests were found, one with 9 eggs, and the other with 11.

23. Four undersized eggs were found. Three of the eggs contained both yolk and albumen; one egg contained albumen only. The shells of all four eggs were considerably thinner than those of normal eggs.

24. A total of 13 "dropped eggs" were found, but they were not included in overall egg production.

25. The overall nesting success in 1967 and 1968 was 71 and 68 percent, respectively, and 69 percent for both years. Nests on man-made structures were more successful (76 percent) than nests on natural sites (51 percent), and elevated nests were more successful (77 percent) than ground nests (55 percent). Nests containing six eggs were more successful (91 percent) than nests with fewer eggs (7-74 percent). Among nests located on natural sites, those closest to water were generally the most successful.

26. Nest desertion, probably caused primarily by intraspecific conflict on areas of high nesting density, was the greatest single cause of nesting failure and amounted to 55 percent of all failures. Desertion was no greater on man-made structures than on natural sites. Losses due to flooding and predation were minor.

27. The primary advantage of nesting structures was protection from predators. Of 22 nests destroyed, 18 (82 percent) were located on the ground, while only 4 (18 percent) were on man-made nesting structures. Another obvious advantage of structures was protection from flooding.

28. Only two cases of renesting were known; one goose renested once, another twice.

29. The hatching success of eggs was 81 percent in 1967, 79 percent in 1968, and 80 percent for both years combined. There was little difference in hatching success among nests on all man-made structures (79 percent), elevated structures (80 percent), natural sites (84 percent), and ground sites (81 percent).

30. The mean number of eggs hatched per successful nest was 4.11 ± 0.09. There was no significant difference in mean number hatched among nests on all man-made structures (4.35 ± 0.10), elevated structures (4.29 ± 0.12), natural sites (4.15 ± 0.23), and ground sites (4.01 ± 0.21).

31. The proportion of eggs hatched was no greater in large clutches than in smaller clutches. Assuming older females laid the larger clutches, older geese were more successful in bringing their nest to a successful termination, but they were no more capable of hatching a large proportion of their eggs than were the younger females.

32. In 1967, 12.9 percent of the eggs in successful nests contained dead embryos and failed to hatch; in 1968, 16.9 percent contained dead embryos. Embryonic deaths amounted to 15.2 percent for both seasons. Death occurred primarily during the very early or very late stage of development.

33. Infertile eggs in successful nests averaged only 3.7 percent for both years, 5.4 percent in 1967 and 2.4 percent in 1968.

34. One 2-year-old female laid six eggs and was successful in hatching all of them.

35. Some yearlings established "pair bonds." One yearling male was observed courting a female of unknown age.

36. Remating occurred at least twice. In both cases, females lost their mates shortly after nesting successfully in 1967. Each selected a new mate and returned to their old nest site in 1968, where they were again successful.

37. "Gang broods" were common only on areas of high nesting density. The number of young per brood increased as the brooding period progressed. Broods ranged in size from 1 to 34 goslings. Goslings less than 3 weeks old were most vulnerable to adoption into other broods. Some adults which were successful in nesting lost their entire brood to other adults through adoptions.

38. In general, nesting areas also served as brood-rearing areas. However, some broods were moved up to 1.5 miles across land to reach permanent brooding areas.

39. Total gosling mortality, from the time of hatching until the first of July, was estimated at 26 percent. Mortality was greatest on areas of high nesting density, and ranged from 20 to 49 percent per year. Most mortality was attributed to "gang broods" and the inability of the adults to care adequately for all young.

40. The total number of goslings that survived to the flight stage was 374 in 1967 and 564 in 1968. Each year an average of 3.0 goslings survived for every successful nesting attempt.

LITERATURE CITED

Allen, J. A. 1876. Breeding of the Canada goose in trees. Bull. Nuttal Ornith. Club 1:50.

Atwater, M. G. 1959. A study of renesting in Canada geese in Montana. J. Wildl. Mgmt. 23(1):91-97.

Bailey, A. M., and R. J. Niedrach. 1965. Birds of Colorado. Vol. 1. Denver Mus. Nat. Hist., Denver, Colorado. 454pp.

Balham, R. W. 1954. The behavior of the Canada goose (Branta canadensis) in Manitoba. Unpubl. Ph. D. Thesis, Univ. Missouri, Columbia. 244pp.

Ballou, R. M. 1954. Nesting, distribution, and mortality studies of Canada geese on the Green River. Wyoming Game and Fish Commission. Job Completion Rept., P.-R. Project W-50-R-3. Pp. 68-82.

Barraclough, Mary E. 1956. Biology of Canada geese (Branta canadensis moffitti) in the Flathead Valley of Montana. M.S. Thesis, Montana State Univ., Missoula. 91pp.

Bednarik, K. E. 1965. Canada goose management in Ohio. Game Research in Ohio 3:180-206.

Brakhage, G. 1962. Canada goose nesting and management studies on selected areas in Missouri. Missouri Conserv. Commission. Job Completion Rept., P.-R. Project 13-R-16. 34 pp.

Brakhage, G. K. 1965. Biology and behavior of tub-nesting Canada geese. J. Wildl. Mgmt. 29(4):751-771.

_____. 1966. Tub nests for Canada geese. J. Wildl. Mgmt. 30(4):851-853.

Caldwell, J. R. 1964. Breeding ecology of the Canada goose on the South Saskatchewan River, Progress Report 1963. Dept. Nat. Resources, Regina, Saskatchewan. 21pp.

Collias, N. E., and L. R. Jahn. 1959. Social behavior and breeding success in Canada geese (Branta canadensis) confined under semi-natural conditions. Auk 76(4):478-509.

Collins, B. D. 1953. A nesting study of the Canada goose at Tule Lake and Lower Klamath national wildlife refuges. Proc. Annu. Conf. Western Assoc. Game and Fish Commissioners 33:172-176.

Colorado Division of Game, Fish and Parks. 1958. Banding record. On file at the Northeast Regional Office, Fort Collins, Colorado.

Craighead, F. C. Jr., and J. J. Craighead. 1949. Nesting Canada geese on the upper Snake River. J. Wildl. Mgmt. 13(1):51-64.

Craighead, J. J., and D. S. Stockstad. 1958. Goslings descend from aerial nests. J. Wildl. Mgmt. 22(2):206-207.

_____, and _____. 1961. Evaluating the use of aerial nesting platforms by Canada geese. J. Wildl. Mgmt. 25(4):363-372.

_____, and _____. 1964. Breeding age of Canada geese. J. Wildl. Mgmt. 28(1):57-64.

Davison, D. W. 1925. Nesting of the Canada goose in a tree. Canadian Field-Naturalist 39(9):197-198.

Delacour, J. 1951. Preliminary note on the taxonomy of Canada geese, Branta canadensis. Am. Mus. Novitates 1537. 10 pp.

Dow, J. S. 1943. A study of nesting Canada geese in Honey Lake Valley, California. California Fish and Game 29(1):3-18.

Dutcher, W. 1885. The Canada goose. Auk 2(1):111.

Elder, W. H., and Nina L. Elder. 1949. Role of the family in the formation of goose flocks. Wilson Bull. 61(3):133-140.

Enyeart, G. 1964. Ducks use goose nesting platforms. N. Dakota Outdoors 27(5):1.

Evermann, B. W. 1919. Large set of eggs of the Canada goose. Condor 21(3):126.

Geis, Mary B. 1956. Productivity of Canada geese in the Flathead Valley, Montana. J. Wildl. Mgmt. 20(4):409-419.

Grieb, J. R. 1956a. Preliminary survey of potential goose nesting areas in Colorado. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-1. Pp. 17-19.

_____. 1956b. Experimental studies on improving the status of Canada goose populations in Colorado. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-1. Pp. 21-22.

_____. 1957. Colorado goose flock establishment. Trans. Annu. Conf. Cent. Mtns. and Plains Sect. Wildl. Soc. 2:89-90.

_____. 1958. Experimental studies on improving the status of Canada goose populations in Colorado. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-3. Pp. 105-109.

_____. 1960. Experimental studies on improving the status of Canada goose populations. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-5. Pp 19-22.

_____. 1962. Experimental studies on improving the status of Canada goose populations. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-7. Pp. 39-43.

_____. 1963a. Letter to H. C. Hanson, April 16.

_____. 1963b. Experimental studies on improving the status of Canada goose populations. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-8. Pp. 33-47.

_____. 1964. Experimental studies on improving the status of Canada goose populations. Colorado Game, Fish and Parks Dept. Job Completion Rept., P.-R. Project W-88-R-9. Pp. 35-40.

_____. 1965. Experimental studies on improving the status of Canada goose populations. Colorado Game, Fish and Parks Dept. Job Completion Rept., P.-R. Project W-88-R-10. Pp. 79-85.

_____. 1966. Experimental studies on improving the status of Canada goose populations. Colorado Game, Fish and Parks Dept. Job Completion Rept., P.-R. Project W-88-R-11. Pp. 45-51.

_____. 1967. Canada goose populations of Colorado. Colorado Game, Fish and Parks Dept. Game Information Leafl. 58. 4 pp.

_____. 1969. Personal communication.

_____, and M. G. Sheldon. 1961. Experimental studies on improving status of Canada goose populations. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-6. Pp. 73-78.

_____, _____, and D. F. Neff. 1961. The nesting Canada goose of Moffat County, Colorado. Proc. Annu. Conf. Western Assoc. Game and Fish Commissioners 41:136-146.

_____, and G. I. Crawford. 1967. Nesting structures for Canada geese. Colorado Game, Fish and Parks Dept. Game Information Leafl. 48. 4pp.

Hanson, H. C. 1965. The giant Canada goose. Southern Illinois Univ. Press. Carbondale. 226 pp.

Hanson, W. C., and R. L. Browning. 1959. Nesting studies of Canada geese on the Hanford Reservation, 1953-56. J. Wildl. Mgmt. 23(2):129-137.

Harrison, J. M., and J. G. Harrison. 1959. Establishing Canada geese in West Kint and their use of nesting rafts. Wildfowl Trust 10:89-91.

Hunt, R. A., and L. R. Jahn. 1966. Canada goose breeding populations in Wisconsin. Wisconsin Conserv. Dept. Tech. Bull. 38. 67pp.

Klopman, R. B. 1958. The nesting of the Canada goose at Dog Lake, Manitoba. Wilson Bull. 70(2):168-183.

Kossack, C. W. 1950. Breeding habits of the Canada goose under refuge conditions. Am. Midland Naturalist 43(3):627-649.

Martin, F. W. 1964. Behavior and survival of Canada geese in Utah. Utah State Dept. Fish and Game. Job Completion Rept., P.-R. Project W-29-12-17. 89pp.

Miller, A. W., and B. D. Collins. 1953. A nesting study of Canada geese on Tule Lake and Lower Klamath national wildlife refuges, Siskiyou County, California. California Fish and Game 39(3): 385-396.

Munro, D. A. 1958. Factors affecting reproduction of the Canada goose (Branta canadensis). Proc. Intern. Ornithol. Congr. 12:542-556.

Naylor, A. E. 1953. Production of the Canada goose on Honey Lake Refuge, Lassen County, California. California Fish and Game 39(1):83-94.

_____, and E. G. Hunt. 1954. A nesting study and population survey of Canada geese on the Susan River, Lassen County, California. California Fish and Game 40(1):5-16.

Nelson, J. L. 1963. Canada goose breeding ecology of the South Saskatchewan River, Progress Report. Dept. Nat. Resources, Regina, Saskatchewan. 13pp.

Raveling, D. G. 1966. Probable causation, prevalence, and significance of "gang" broods of Canada geese. Midwest Wildl. Conf. 28:53-55.

Rienecker, W. C., and W. Anderson. 1960. A waterfowl nesting study on Tule Lake and Lower Klamath national wildlife refuges, 1957. California Fish and Game 46(4):481-506.

Rutherford, W. H. 1962. An evaluation of methods for improving goose nesting sites on Colorado breeding grounds. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-7. Pp. 61-66.

_____ (Editor). 1965. Description of Canada goose populations common to the Central Flyway. Cent. Flyway Waterfowl Council Tech. Comm. 17pp.

_____. 1967. Experimental studies on improving status of Canada goose populations. Colorado Game, Fish and Parks Dept. Job Completion Rept., P.-R. Project W-88-R-12. Pp. 49-57.

Sheldon, M. G. 1958. An evaluation of methods for improving goose nesting sites on Colorado breeding grounds. Colorado Game and Fish Dept. Job Completion Rept., P.-R. Project W-88-R-3. Pp. 111-113.

Sherwood, G. A. 1966. Canada geese of the Seney National Wildlife Refuge. Ph.D. Thesis, Utah State Univ., Logan. 321pp.

_____. 1967. Behavior of family groups of Canada geese. Trans. N. Am. Wildl. and Nat. Resources Conf. 32:340-355.

Skinner, M. P. 1928. The Canada goose in Yellowstone National Park. Wilson Bull. 40(3):139-149.

Solman, V. E. F. 1945. The ecological relations of pike, Esox lucius L., and waterfowl. Ecology 26(2):157-170.

Steel, P. E., P. D. Dalke, and E. G. Bizeau. 1957. Canada goose production at Gray's Lake, Idaho, 1949-1951. J. Wildl. Mgmt. 21(1):38-41.

Szymczak, M. R. 1967. Breeding biology of Canada geese of the Metro-Denver area. M.S. Thesis, Colorado State Univ., Fort Collins. 83pp.

U. S. Dept. Commerce, Environmental Science Service Administration, Environmental Data Service. 1967. Climatological Data, Colorado 73(1-4).

_____. 1968. Climatological Data, Colorado 74(1-4).

Vaught, R. W. 1960. Geese by the tub-full. Missouri Conservationist 21(7):6-7, 10.

Weigand, J. P., M. J. Pollok, and G. A. Petrides. 1968. Some aspects of reproduction of Canada geese. J. Wildl. Mgmt. 32(4):894-905.

Weller, M. W. 1964. The reproductive cycle. Pp. 35-79. In J. Delacour, The waterfowl of the world. Vol. IV. Country Life Ltd., London. 364pp.

Williams, C. S. 1967. Honker, D. Van Nostrand Co., Inc., Princeton. 179pp.

_____, and W. H. Marshall. 1938. Survival of Canada goose goslings, Bear River Refuge, Utah, 1937. J. Wildl. Mgmt. 2(1):17-19.

_____, and M. C. Nelson. 1943. Canada goose nests and eggs. Auk 60(3): 341-345.

Wood, J. S. 1964. Normal development and causes of reproductive failure in Canada geese. J. Wildl. Mgmt. 28(2):197-208.

Wrakestraw, G. F. 1965. Studies designed to improve status of Canada goose populations. Wyoming Game and Fish Commission. Job Completion Rept., P.-R. Project W-50-R-14. Pp. 52-55.

Yocum, C. F. 1952. Techniques used to increase nesting of Canada geese. J. Wildl. Mgmt. 16(4):425-428.

_____. 1956. Man-made homes for Canada geese. Audubon Mag. 58:106-109, 127.

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