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Canada Goose Production and Population Stability, Ogden Bay Waterfowl Management Area, Utah

Norman H. Dey
Utah State University

CANADA GOOSE PRODUCTION AND POPULATION STABILITY, OGDEN BAY WATERFOWL MANAGEMENT AREA, UTAH

by

Norman H. Dey

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Head of Department

Dean of Graduate Studies

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Norman H. Dey

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INTRODUCTION

Since the development of Ogden Bay Waterfowl Management Area in 1937, the Canada goose (Branta canadesis moffitti) population increased to a peak in 1949 and then declined slightly. Nelson (1954) noted that the decrease in population was probably due to either a change in habitat or increased hunting pressure. In recent years, direct band returns have indicated a high mortality rate in the population. This project was initiated to determine the relative stability of the Canada goose population and to measure, as closely as possible, the effect of a high mortality rate upon the nesting population.

To estimate the stability of a goose population, three factors must be known: (1) the production rate, (2) the mortality rate, and (3) the faithfulness of homing and degree of dispersal of the population. Through knowledge of these three factors, it is possible to estimate the stability of the population, but if any management changes must be undertaken to stop the declining population, the factors that are causing the downward trend must also be understood.

The specific objectives of this study were:

1. To determine the annual production during the two nesting seasons, 1959 and 1960.

2. To determine the stability of the goose population.

STUDY AREA

The study area included all of Ogden Bay Waterfowl Management Area including the Howard's Slough addition, Figure 1. The study area will be referred to as Ogden Bay. Ogden Bay which is located in northern Utah, 12 miles west of Ogden, Utah, on the delta of the Weber River, is managed by the Utah Department of Fish and Game as a waterfowl management area.

The area was developed in 1937 to provide a control for botulism (western duck sickness), to furnish nesting, feeding, and resting area for waterfowl and other marshland birds, and to supply a public shooting area for sportsmen.

Ogden Bay and the Howard's Slough addition, which was completed in 1958, are composed of 16,000 acres of interspersed waterways and emergent vegetation. The major emergent vegetation consists of alkali bulrush (Scirpus paludosus) and cattail (Typha spp.) with a steadily increasing amount of hardstem bulrush (Scirpus acutus). Primary submersed aquatic vegetation is sago pondweed (Pontamogeton pectinatus) Nelson (1954).

The area is at 4,210 feet mean sea level and is situated in flat unbroken terrain less than 15 miles west of the Wasatch Mountains. Average rainfall is 14 inches and the climate is considered arid. For a more complete description of the area see Nelson (1954).

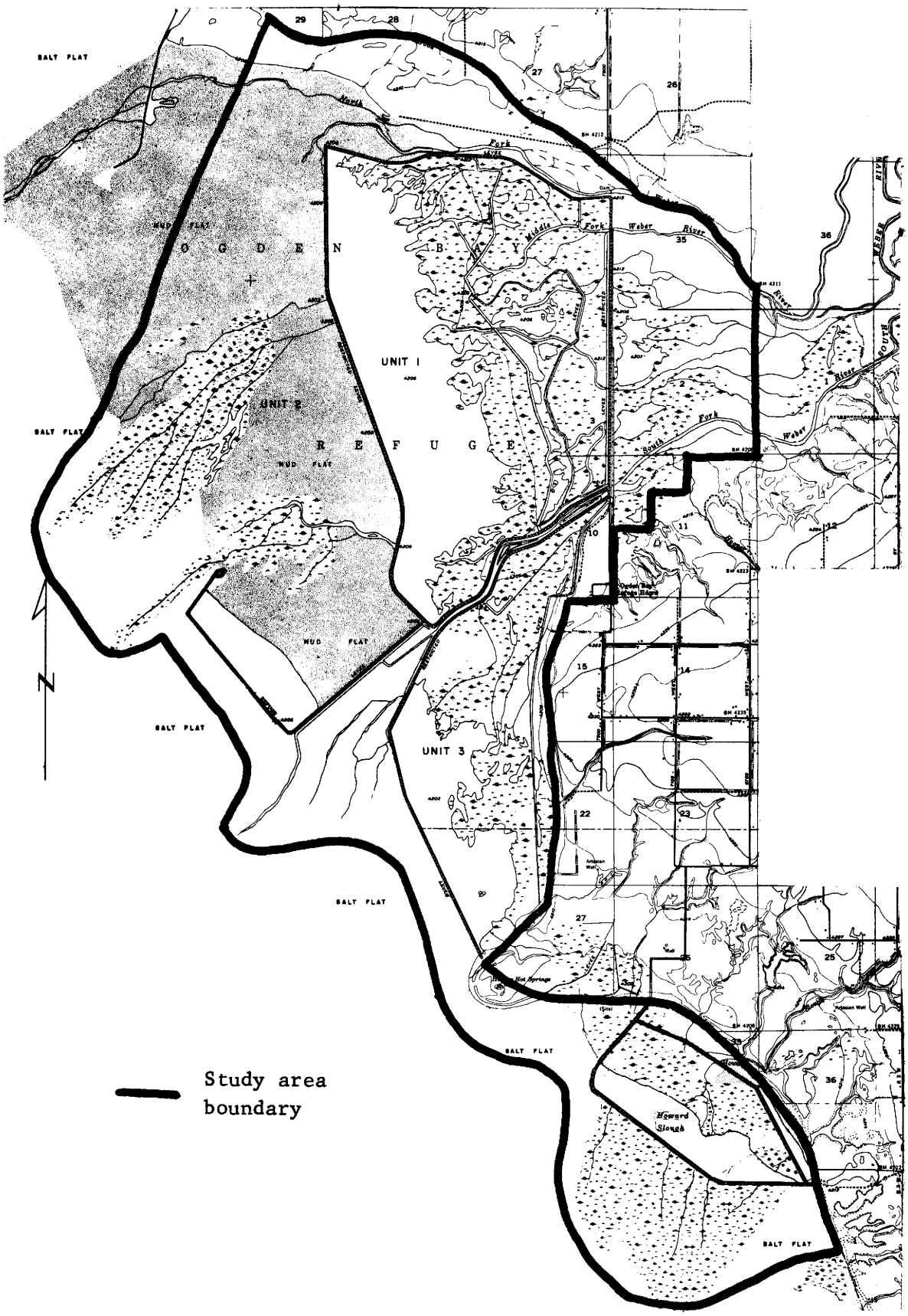

Figure 1. Ogden Bay waterfowl management area, Utah

METHODS AND PROCEDURES

Nesting Study

During each of the two seasons 1959 and 1960, the entire study area was searched in April and May to locate as many goose nests as possible. Nests were marked 20 to 30 feet to one side. Nests were visited at five-day intervals until the fate of each nest had been determined.

Nests were located by (a) observing a breeding pair in an area prior to the nesting season, (b) observing males on loafing sites during the nesting season, and (c) searching along transects that contained likely nesting habitat. To aid in nest searching, the study area was divided into five areas: (a) Unit 1, (b) Unit 2 (south), (c) Unit 2 (north), (d) Unit 3, and (e) Howard's Slough. These areas were searched in rotation throughout the nesting season. While visiting previously located nests in the areas, an attempt was also made to locate new nests. Martin (1963) used two systematic searches a year to locate nests. During the second nesting season of the study many nests were found by returning to the site of old nests located the previous year. With experience and by employing these methods of locating nests it is believed that a high percent of the nests were located.

Brood Counts

As soon as broods started appearing on the large lakes, counts conducted from the dikes were made at least once per week to determine the total number of broods and goslings produced in the area. A 20 power spotting scope and 16 X 20 field glasses were used. Counts were made systematically at different hours of the day to obtain as nearly a complete a count as possible.

In 1959, an aerial census was taken to determine the number of broods on the area. Results of the survey were considered inaccurate. The geese were not frightened off the heavily weeded dikes by the airplane. The aerial census was discontinued in 1960.

Receding water levels usually occur during June making the large lakes the only open water in the area. Since the geese require a brooding habitat of open water and resting banks for loafing and roosting, it is possible to accurately count them by frightening them off the dikes where they can easily be counted as they move out on the large water areas.

Marking Methods

The geese were captured for leg banding and collar marking at the time the adults were flightless and before the young had reached the flight stage. At this time the geese were concentrated on the large lakes and were easily captured by pursuing them in air-thrust boats. Colored plexiglass collars were affixed to the geese at the time they

were leg banded, Figure 2. Each bird was marked in such a way as to denote its age at the time it was marked. The birds were either marked as (1) locals, birds that were raised in the area, or (2) as adults with broods. Just prior to the time of marking, the yearlings and non-breeding geese leave the area to molt at some unknown location, leaving mainly the locals and breeding adults in the area.

Mortality

The mortality rate of the goose population was determined by the recovery of bands on Ogden Bay birds and analyzing the returns by three methods: (1) time specific, (2) dynamic life table, and (3) William's method.

The time specific method was used when there was not a complete band return for the banding year (Hickey, 1952). The dynamic life table (Hickey, 1952) and the William's method (Ballou, 1955) were used to determine the survival series for a given cohort segment of the population.

Since the goose population at Bear River Refuge, Utah, is controlled by the same hunting regulations and subject to nearly the same hunting pressure as at Ogden Bay, the data on the geese banded at Bear River Refuge were combined with data on geese banded at Ogden Bay to increase the sample size for banding analysis.

Figure 2. Collar marked Canada geese at Ogden Bay, Utah

RESULTS

Production

Site selection

A total of 124 nests was located at Ogden Bay from which nesting data were obtained during the 1959 and 1960 nesting seasons.

Of the 124 nests, 38 percent were in alkali bulrush and 33 percent were in cattail, Table 1. Of the 44 nests found in alkali bulrush, 23 percent were on muskrat houses, while 87 percent of the nests in cattail were on muskrat houses, Table 1. Nests on muskrat houses in emergent vegetation accounted for 43 percent of the nests at Ogden Bay during 1959 and 1960, Table 1.

During the two years (1959 and 1960), 42 percent of the nests were within five yards of open water. The mean distance of the nests from open water was a little over 10 yards, while the median distance of the nests from open water was slightly more than five yards, Table 2.

All six of the "marked" females nesting during both the 1959 and 1960 seasons nested in 1960 within 100 yards of their 1959 nesting site. Not only did the geese return to nest in the same section of the area, but they also selected nesting sites that were similar to the previous year's sites.

Table 1. Vegetative cover and nesting sites of Canada geese at Ogden Bay, Utah, 1959 and 1960

Vegetative cover	Nesting sites: Muskrat house	Emergent vegetation	Upland vegetation	Total
Alkali bulrush	10	34	0	44
Cattail	34	5	0	39
Saltgrass	1	3	9	13
Hardstem bulrush	6	6	0	12
Upland	0	0	7	7
Olneyi bulrush	2	1	0	3
Other	1	3	2	6
Total	54	52	18	124

Table 2. Distance of the nests from open water and the nesting sites of Canada geese at Ogden Bay, Utah, 1959 and 1960

Distance from open water (yd.)	Nesting sites: Muskrat house	Emergent vegetation	Upland vegetation	Total
0 - 5	25	18	9	52
5 - 10	16	16	3	35
10 - 15	5	9	2	16
15 - 20	3	4	1	8
20 - 25	2	3	2	7
25 - 50	2	0	0	2
50 -100	1	0	0	1
100 plus	0	2	1	3
Total	54	52	18	124
(percent)	(43.5)	(41.9)	(14.6)	
Mean distance from open water (yd.)	8.2	10.9	17.5	

Between the 1959 and 1960 nesting seasons considerable habitat change took place in some parts of Ogden Bay because of low water. Where the changes were extreme, the geese that had nested in the area the previous year moved to a nearby location that afforded nearly the same type of habitat as had been present in the previous year's nesting site. For example, in 1959, a "marked" female nested on a muskrat house in a thick stand of cattail. Late in the summer of 1959, the area where she had nested was extremely dry and most of the cattail died. In 1960, the same female nested on a muskrat house 100 yards away from her 1959 nest, where the cattail had not died.

Therefore, it appears that the Canada geese nest at Ogden Bay in nearly the same part of the marsh year after year and that they prefer to nest in the same vegetative cover and use the same type of nesting platform.

An attempt was made to determine whether the females raised at Ogden Bay returned to nest to the same part of the area where they were reared. No reports of "marked" females from the area appearing in other nesting populations were received. However, sighting of males that were marked in the area were reported in the Bear River Refuge, Utah, nesting population. In 1960, a two-year old male marked at Ogden Bay appeared with a brood on the brooding area of Bear River Refuge.

Of the 228 "marked" juvenile males reared at Ogden Bay Refuge, only one (0.4 percent) nested in the area. Seven (3.9 percent) of the

178 "marked" juvenile females reared in the area nested at Ogden Bay, Table 3.

Table 3. The number of "marked" juvenile geese that were raised in the area in 1956-1958 and the number that were observed nesting at Ogden Bay, Utah, in 1959 and 1960

Sex	"Marked" geese raised in the area 1956 to 1958 (number)	"Marked" geese nesting in the area 1959 and 1960 (number)	(percent)
Males	228	1	0.4
Females	178	7	3.9

Some evidence that the female leads the way to the nesting site was noted. A "marked" female nested at Ogden Bay in 1957. During the 1957 hunting season her mate, a "marked" male, was killed. In the spring of 1958, the female returned to the area with a new mate but did not nest. In 1959, the female nested with her new mate in the approximate vicinity of her 1957 nesting site.

Martin (1963) indicated the female selected the nesting site. The preceding observations and data would indicate that the female selects the nesting area as well.

Time of nesting

Only the "marked" females were used to determine the time of nesting because the "marked" males may have paired with older birds.

The only "marked" male of known age that was observed nesting in the area was paired with a "marked" female. Both of these geese were marked the same year. The male was marked as a local and the female as an adult with a brood.

Of the 178 local females marked, from 1956 to 1958, only seven (3.9 percent) were observed nesting successfully at Ogden Bay Refuge during the two-year period 1959 and 1960. Of the 65 adult females marked, 14 (21.0 percent) were observed to have successfully hatched a clutch in the area. Only the successful nests were considered here because time of nesting could be determined only from successful nests.

All of the geese whose exact age was known nested during the second half of the season. The geese which were marked as adults with brood and whose minimum age would be two years at the time of banding, all nested during the first half of the season. Data indicated that during the second half of the season the geese nested in the approximate reverse order of their age. Any sequence of nesting during the first half of the season would be assumed since the definite age of the "marked" females during that period were unknown, Table 4.

Geese nesting for the first time appear to nest later in the season than birds with previous nesting histories. Martin (1963) noted that nearly all birds known to be adults nested one or two weeks earlier than two-year-olds nesting for the first time.

Table 4. Relative time of nesting and the age of "marked" female Canada geese that nested successfully at Ogden Bay, Utah, in 1959 and 1960

Relative time of nesting	1959 Years of age	1960 Years of age
1st	A* (4)**	A (5)
2nd	A (5)	A (5)
3rd	A (3)	A (3)
4th	A (4)	A (3)
5th	A (5)	A (4)
6th	A (3)	A (4)
7th	A (4)	A (4)
----------Median***----------		
8th	3****	4
9th	3	4
10th		3
11th		2
12th		4

* Adult females with broods.
** Minimum age of females marked as adults with broods.
*** The half way point in the nesting season.
**** Females marked as locals.

Clutch size

The clutch size varied from two to seven eggs in the Canada goose nests at Ogden Bay. In 1959, the average clutch size was 5.2 eggs per nest and the clutch varied from two to seven eggs. In 1960, the average clutch size was 5.3 eggs per nest and the clutch size varied from three to seven eggs. Approximately 37 percent of the nests had six eggs while 27 percent of the nests contained five eggs, Table 5.

Although the variation in clutch size and the mean clutch size remained fairly constant at Ogden Bay in 1959 and 1960, other studies

have shown a greater variation in clutch size, Table 6. Martin (1963) showed a variation in clutch size from two to eight eggs at Ogden Bay. There were no nests found during this study with more than seven eggs.

Table 5. Frequency of clutch size found in Canada goose nests at Ogden Bay, Utah, 1959 and 1960

	Clutch size (no. of eggs)							
	1	2	3	4	5	6	7	8
Frequency (No. of nests)	0	1	10	18	34	46	15	0
Frequency (percent)	0	1	8	15	27	37	12	0

Table 6. A comparison of clutch size for Canada geese nesting at Ogden Bay, Utah, and other nesting areas

Nesting area		Clutch size	
		Extremes	Averages
Ogden Bay	1959	2 to 7	5.2 ± .15
	1960	3 to 7	5.3 ± .14
Ogden Bay*	1956	2 to 8	5.2 ± .2
	1957	2 to 8	5.6 ± .1
	1958	2 to 8	5.7 ± .1
Bear River Refuge**	1937	2 to 8	4.9 ± .03
Flathead Valley***	1953	2 to 10	5.5 ± .11
	1954	3 to 10	5.2 ± .08

* Martin (1963).
** Williams and Marshall (1937).
*** Geis (1956).

The sample of known age females was too small to determine whether the younger geese laid fewer eggs than the older ones. However a difference of over half an egg per nest occurred between the mean number of eggs per nest during the first half and the second half of the season, Table 7.

Table 7. Change in clutch size between the first half and the second half of the season for Canada geese nesting at Ogden Bay, Utah, 1959 and 1960

Year	Nests (number)	First half of the season Number eggs per nest	Second half of the season Number eggs per nest
1959	62	$5.6 \pm .22$	$5.0 \pm .24$
1960	62	$5.6 \pm .21$	$4.9 \pm .20$

No significant difference in the average clutch size between the two halves of the nesting season.

Since there was no significant difference between the average clutch sizes during the two halves of the nesting season, it can be assumed that there was no variation in clutch size between the different aged geese. This, however, may have been influenced by the small sample size.

Nesting success

During each of the nesting seasons, 1959 and 1960, 62 nests were found at Ogden Bay. There was no significant difference in the

percentage of success, desertion, or destruction of nests between the two years, Table 8.

Table 8. Fate of the Canada goose nests found at Ogden Bay, Utah, in 1959 and 1960

	1959	1960	Total
No. nests found	62	62	124
No. nests successful	50 (80)*	52 (84)	102 (82)
No. nests deserted	9 (14)	7 (11)	16 (13)
No. nests destroyed	3 (5)	3 (5)	6 (5)

The percentage of nests destroyed remained constant at five percent for the two years. This would indicate that between the two years, the small differences in nesting success came from the number of females that deserted their nests.

Nesting success at Ogden Bay appears to be consistently higher than most other goose nesting areas, Table 9. The higher nesting success at Ogden Bay was due primarily to a lower percentage of nests destroyed by predators. Nest desertion was relatively constant for all areas compared.

Renesting during the study period was unimportant. Only one case is known where a female could have renested. In 1960, the first nest

Table 9. A comparison of Canada goose nesting success at Ogden Bay, Utah, and other nesting areas

Area		Nests		
		Successful (percent)	Deserted (percent)	Destroyed (percent)
Ogden Bay	1959	80	14	5
	1960	83	11	5
Flathead Valley*		73	11	16
		51	17	32
Susan River**		79	9	12
Honey Lake**		65	14	21
Hanford Reservation***		71	11	16
Ogden Bay****		80	12	7

* Geis (1956).
** Naylor and Hunt (1954).
*** Hanson and Browning (1959).
**** Martin (1963).

was located 20 yards from the site of a nest located in 1959. The loafing site of the male indicated that this pair had nested in the area the previous year. The nest was found on a platform in cattail. After the first visit to the nest the female deserted. This same pair remained in the area, and about 20 days after the desertion a nest was found on a muskrat house used as a nesting site the previous year (1959). The loafing site of the male and the actions of the female indicated that they were the same pair that had deserted their nest earlier in the season. The clutch size was the same as that in the deserted nest.

Atwater (1959) found that Canada geese usually renest in the approximate vicinity of their first nest and that the second nest usually contains as many eggs as the first one.

Other nests were deserted or destroyed too late in the nesting season for any possible renesting. Atwater (1959) found that in order for goose renesting to occur the nests must be either destroyed or deserted relatively early in the nesting season. Table 10 presents the nesting data that shows there was only one possibility of a renest.

Brood production

During the two year study, 655 eggs were laid in the Canada goose nests in the study area. A total of 74.5 percent of the eggs hatched representing 3.9 eggs per nest. Eggs that were either destroyed or deserted accounted for 18.1 percent of the total number laid. Infertile eggs and the ones containing dead embryos accounted for 7.4 percent of the total, Table 11.

In the successful nests, 89.9 percent of the eggs hatched, 4.3 percent were infertile, 4.7 percent contained dead embryos, and 1.1 percent were destroyed by predators or were knocked out of the nest by the females, Table 12. Table 13 presents the hatching success of Canada Goose eggs from other areas compared to Ogden Bay.

Total production of Canada geese at Ogden Bay was determined by taking brood counts after the nesting season. A total of 155 broods was observed in the area during the two years. In 1959, average size

Table 10. Date incubation began on successful nests and the date of destruction or desertion of unsuccessful nests of Canada geese in 1959 and 1960 at Ogden Bay, Utah

	1959		1960	
Date of initiation destruction or desertion	No. of successful nests	No. of unsuccessful nests	No. of successful nests	No. of unsuccessful nests
March 28	1			
29	2			
30	4			
April 3	3		1	
4	1		2	
5	1			
6	2			
7	5		2	
8	1		2	
9	6		4	(1**)
10	5		11	
11	3		7	
12	3		5	
13	2		4	
14	3		5	
15			2	
16	2		4	
17	2			
18			1	
19	1			
20	1			
21			1	2*
24	2	1*		
25		1*		
28				1**
29			1	1*
May 1		1**		
4				1**
5		1**		1**
8		1*		1**
10		2**		
16		1**		
25		4**		2**
Total	50	12	52	10

* Nest destroyed
** Nest deserted
() Only possible renest

Table 11. Fate of the eggs laid by Canada geese at Ogden Bay, Utah, 1959 and 1960

	1959 (62 nests)	1960 (62 nests)	Total (124 nests)
No. of eggs laid	325	330	655
No. of eggs hatched	235 (72)*	252 (76)	487 (74)
No. of eggs destroyed	65 (20)	54 (16)	119 (18)
No. of eggs infertile	11 (3)	12 (4)	23 (3.5)
No. of eggs containing dead embryo	14 (4)	12 (4)	26 (4)

* Percentage of the eggs laid.

Table 12. Fate of the eggs laid by Canada geese in successful nests at Ogden Bay, Utah, 1959 and 1960

	1959 (50 nests)	1960 (52 nests)	Total (102 nests)
No. of eggs laid	266	276	542
No. of eggs hatched	235 (88.3)*	253 (91.5)	488 (89.9)
No. of eggs destroyed	6 (2.4)	--	6 (1.1)
No. of eggs infertile	11 (4.1)	12 (4.5)	23 (4.3)
No. of eggs containing dead embryo	14 (5.2)	11 (4.0)	25 (4.7)

* Percentages.

Table 13. Canada goose hatching success at Ogden Bay, Utah, and other nesting areas. (Successful nests only.)

Area		Eggs		
		Hatched (percent)	Dead embryos (percent)	Infertile (percent)
Ogden Bay Refuge	1959	88.3	5.2	4.1
	1960	91.5	4.0	4.5
Gray's Lake*		86	4	7
Klamath Lake**		87	9.4	1.9
Hanford Reservation***		93	5	1
		91	7	2
Ogden Bay****		91	4.6	2.7

* Steele, Dalke and Bizeau (1957).
** Miller and Collins (1953).
*** Hanson and Browning (1959).
**** Martin (1963).

for 76 broods was 4.3 goslings per brood and in 1960, 79 broods averaged 5.3 young per brood, Table 14. The higher brood size in 1960 resulted from the adults deserting their broods and leaving the area with the non-breeding geese.

Table 14. Canada goose brood counts at Ogden Bay, Utah, 1959 and 1960

Year	No. of broods	No. of goslings	Average brood size
1959	76	327	4.30
1960	79	419	5.30
Total	155	746	4.81

The total number of breeding pairs in the area was calculated by dividing the nesting success into the number of broods in the area. For both years of the study the calculated number of breeding pairs was the same, 95 pairs.

Mortality of the goslings from the time they left the nest until it was impossible to distinguish them from the adult geese was 0.4 goslings per brood in 1959. This figure was derived by subtracting the average number of eggs hatched per successful nest from the average brood size late in the brooding period. In 1960, the gosling mortality could not be calculated since the average brood size exceeded the average number of eggs that hatched per successful nest. Martin (1963) showed an increasing number of broods from 1956 to 1958 at Ogden Bay. Variations in technique and areas censused prevented any comparison of data.

When brood counts were taken it was frequently difficult to distinguish one brood from another. Broods were often flocked so tightly together that only a total count of adults and a complete count of goslings was made. The average brood size was determined by dividing the number of adult pairs in a flock into the total number of goslings observed. Occasionally a brood would appear separated from the main flock. During brood counts there were never less than two goslings observed per brood while in one brood there were 22 goslings with one adult pair.

Population Stability

Mortality rates

An annual Canada goose banding program has been carried out at Ogden Bay from 1952 to 1960. During this period the daily bag limit decreased from three to one goose per hunter.

No difference was noted in the average first year return of bands between the three- and the two-goose daily bag limits, Table 15. When the daily bag limit was decreased from two- to one-goose per hunter, a significant drop occurred in the first year return of bands (Chi square test).

Table 15. First year band returns of Canada geese under three different bag limits at Ogden Bay, Utah, 1952 through 1959

Daily bag limit	Year of banding	First year returns (percent)	Mean first year returns (percent)
3 bird	1952	27.5	
	1953	30.4	27.4
	1954	24.5	
2 bird	1955	28.4	
	1956	27.4	27.9
1 bird	1957	22.3	
	1958	24.6	23.1
	1959	22.4	

To increase the size of the sample, the data from the Canada geese banded at Bear River Refuge, Utah, were added to the data from the geese banded at Ogden Bay during the period 1952-1959. The combined data showed a significant difference between the first year return of bands from the three- and two-goose limit and also between the two- and the one-goose limit, Table 16.

Table 16. First year band returns of Canada geese under three different bag limits combining the Ogden Bay and Bear River Refuge, Utah, banding, 1952 through 1959

Daily bag limit	Year of banding	First year returns (percent)	Mean first year returns (percent)
3 bird	1952	26.0	
	1953	27.0	26.0
	1954	25.0	
2 bird	1955	22.0	
	1956	22.0	22.0
1 bird	1957	15.6	
	1958	20.7	18.6
	1959	19.6	

Mortality for the first year following banding was calculated from the combined data from Ogden Bay and Bear River Refuge, Table 17. Time specific method of determining mortality was used to calculate the first year mortality (Hickey, 1952). A difference in mortality of 9.5 percent occurred between the three- and two-bird limits but it was not significant (Chi square). The difference of 15.5 percent

between the first year mortality between the two- and the one-goose limit was not significant (Chi square). A regression test indicated a relationship between the mortality rate for the different bag limits at the .05 level of significance.

Table 17. First year mortality for Canada geese under different bag limits for geese banded at Ogden Bay and Bear River Refuge, Utah, 1952 through 1958

Daily bag limit	Year of banding	First year mortality (percent)	Mean first year mortality (percent)
3 geese	1952	69.0	
	1953	77.0	74.0
	1954	76.0	
2 geese	1955	60.0	
	1956	71.0	65.5
1 goose	1957	39.0	
	1958	61.0	50.0

Approximately a 10 percent decrease in adult mortality occurred each time the daily bag limit was reduced one goose.

A survival series was calculated for the Canada geese banded in 1952 at Ogden Bay, Table 19. The series summarizes the survival of a given cohort (or age class) over a period of years (Hickey, 1952, p.7). Two methods were employed to calculate the survival of the Canada geese: (1) dynamic life table (Hickey, 1952) and (2) the Williams method (Ballou, 1955). By employing the Williams method a

Table 18. Mortality rates for the geese that survive the first year after banding under different bag limits for Canada geese banded at Ogden Bay and Bear River Refuge, Utah

	Mortality (percent) age intervals			
Limits	1-2	2-3	3-4	4-5
3 goose	58	53		
	50			
2 goose	6	35	33	
	51	47	54	67
1 goose	37	29	53	
	28	24		

first year survival of 27 percent was noted, while the dynamic life table method indicated a 34 percent first year survival. Other than the seven percent discrepancy between the two methods for the first year survival, there was little difference between the two methods of calculation. Both indicated that six years after banding only one or two percent of the birds were still alive.

The survival series plotted on semi-logarithmic paper showed a slight decrease between the 3-4 and the 4-5 year age interval, Figure 3. This probably resulted from the decrease in bag limit for those years.

Hanson and Smith (1950) estimated the first year mortality of Canada geese wintering in the Mississippi Valley at 65.4 percent. They also calculated the mortality rate for the first three years of adult life (1 1/2 to 4 1/2 years old) at 39.3 percent. Table 20 shows

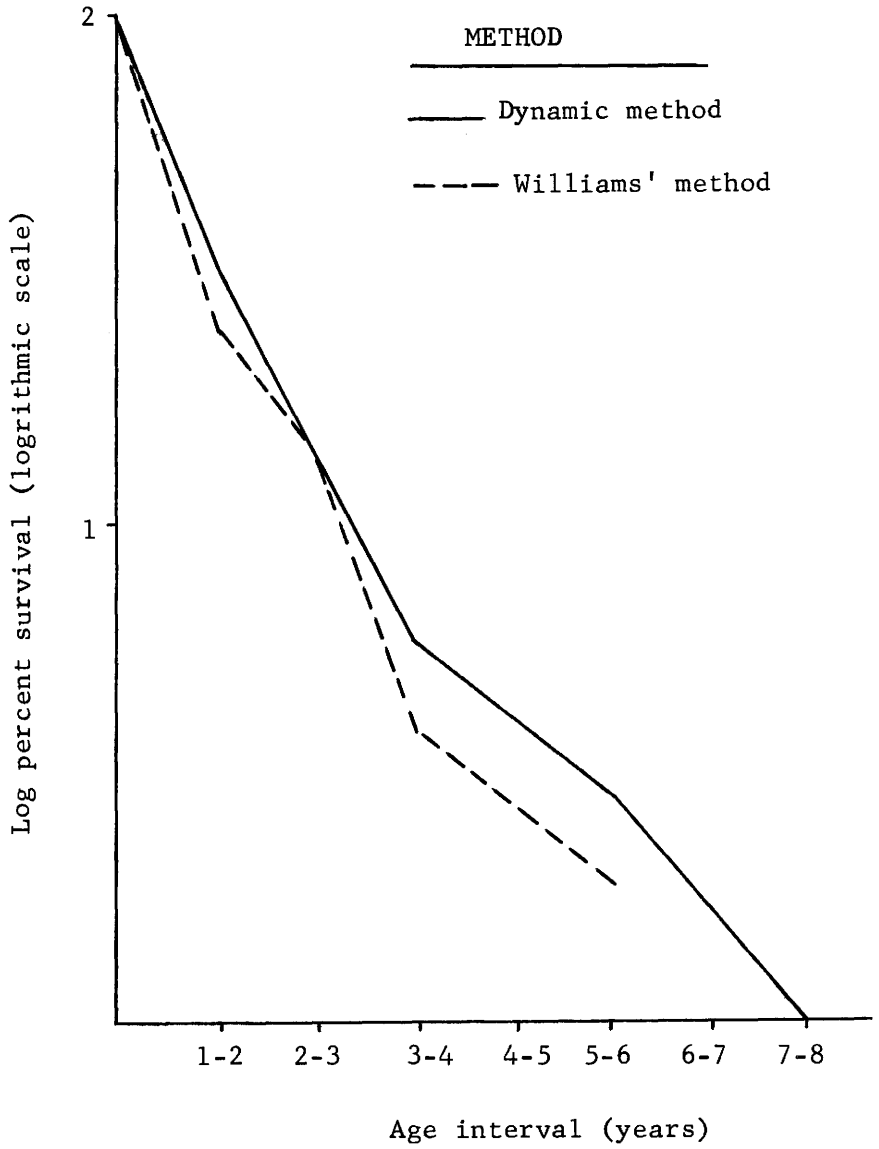

Figure 3. Survival of Canada geese banded at Ogden Bay, Utah, in 1952

Table 19. The percent survival of a given age class over a period of years using the dynamic life table and Williams methods of calculation for the Canada geese banded in 1952 at Ogden Bay, Utah

Age interval year	Percent survival	
	Dynamic life table	Williams method
0-1	34	27
1-2	14	14
2-3	6	-
3-4	-	4
4-5	3	-
5-6	-	2
6-7	1	2

Table 20. Canada goose mortality rates for Ogden Bay and the Mississippi Valley

	First year mortality	Adult mortality
Ogden Bay Refuge		
3-goose limit	74.0	53.7
2-goose limit	65.5	42.0
1-goose limit	50.0	34.0
Mississippi Valley*	65.5	39.3

* Hanson and Smith (1950).

the probable mortality rates for the geese at Ogden Bay compared to those estimated by Hanson and Smith for the geese wintering in the Mississippi Valley. Mortality rates by Hanson and Smith are approximately the same as was found at Ogden Bay when the daily bag limit was two geese per hunter.

Population dynamics

The effect each bag limit had upon the Canada goose population at Ogden Bay was determined by using the mortality rates calculated for each bag limit. Production was assumed to be constant for all three bag sizes and was based on four young per nest. This was assuming that all adults and half of the two-year-old birds nest. The assumption that half of the two-year-olds nest was used by Ballou (1955) and indicates the maximum productivity of this age class.

Tables in this section pertain to the Canada goose population at Ogden Bay only when the percentage increase or decrease of the population number is considered. Population figures used in the tables are hypothetical with the same mortality rates and production rates as were present at Ogden Bay. The numbers in the tables indicate trends and not actual numbers in the population of Canada geese.

When the daily limit was three geese per hunter, the average first year mortality rate was 74 percent. Following the first year the average annual mortality rate was 54 percent. During the three-goose limit, the population would decrease an average of 25 percent per year. Within a five-year period, the population would be reduced to about a third of its original size, Table 21.

The Canada goose population would also decrease in numbers under the mortality rates that were present at Ogden Bay when the daily bag limit was two geese per hunter. Mortality during the first year was 65 percent and following this the average annual mortality was 42

Table 21. A hypothetical trend of a goose population during seasons with a three-goose limit

Year	Age classes				Total population at end of each year
	Goslings	Yearlings	2-year-olds	Adults	
1st	51	17	13	19	90
2nd	38	13	8	15	74 (-18)*
3rd	28	10	6	11	55 (-26)
4th	21	7	5	8	41 (-26)
5th	15	5	3	6	29 (-29)

* Percentage change from previous year.

percent. A decrease of seven percent per year would appear in a population under these mortality rates. Within a five-year period, the population would decrease approximately 26 percent, Table 22.

Table 22. A hypothetical trend of a goose population during seasons with a two-goose limit

Year	Age classes				Total population at end of each year
	Goslings	Yearlings	2-year-olds	Adults	
1st	172	60	46	63	341
2nd	161	59	35	63	318 (-7)*
3rd	148	55	34	57	294 (-8)
4th	138	51	32	53	274 (-7)
5th	128	48	30	49	255 (-7)

When the mortality rates were decreased by the reduction from the two-goose limit to the one-goose bag, the population would show an average yearly increase of 13.0 percent. When the bag limit was

one-goose per hunter per day, the first year mortality rate was 50.0 percent and following the first year the average yearly mortality rate was 34.0 percent. Under these mortality rates, the population would increase 60.0 percent within a five-year period, Table 23.

Table 23. A hypothetical trend of a goose population during seasons with a one-goose limit

Year	Age classes				Total population at end of each year
	Goslings	Yearlings	2-year-olds	Adults	
1st	478	199	144	167	988
2nd	541	239	131	205	1,116 (+13)*
3rd	602	270	158	222	1,252 (+12)
4th	680	301	178	251	1,410 (+13)
5th	765	340	199	283	1,587 (+13)

The information presented in this section indicates that as a result of the reduction in bag limit to one-goose per hunter per day, as occurred in 1959 and 1960, the Canada goose population at Ogden Bay should be increasing at a rate of 13 percent per year.

DISCUSSION

The nesting Canada geese at Ogden Bay appear to have many characteristics of other Canada goose populations. The only major difference from other areas is the nesting success. Ogden Bay has 10 to 20 percent higher nesting success than most other areas where nesting occurs.

The high nesting success at Ogden Bay Refuge can be attributed to one, or possibly a combination, of five factors. (1) Ogden Bay Refuge is relatively free of predators. The major mammalian predator in the area is the skunk. Since most of the Canada geese nest in areas that are completely surrounded by water, skunks have little chance to destroy nests. Mammalian (probably skunk) predation did occur in two Canada goose nests in an area that due to reduced water levels were accessible by dry land. (2) Water levels on the main part of the refuge are constant during the nesting season. No flooded nests were found during the two years. However, flooding is a major cause of low nesting success in some other Canada goose nesting areas. (3) During the nesting season, human traffic on the study area is limited to employees. The investigator and other employees in the area caused no noticeable disturbance to the nesting geese. (4) Since the Canada geese at Ogden Bay do appear to have a compensatory

mechanism by which production is increased under high mortality rates, the geese may be more stimulated to produce a brood than in other areas. (5) There was no indication that over crowding caused nest failure.

The mortality of the Canada geese at Ogden Bay appears to be directly related to the daily bag limit. There are two factors that could influence the calculated mortality rates and bias the data. (1) Since all mortality rates were calculated from band returns, a bias in return of bands due to the continual reduction in bag limit would affect the mortality rates. One of the main reasons hunters return bands is to find out where the bird which they bagged was banded. After returning so many bands and finding that all of the birds come from approximately the same vicinity, the novelty wears off and the bands may then not be turned in by the hunters. (2) As the number of hunters increases and the hunting pressure goes up, the geese may become more leery and harder to bag, thus reducing the mortality rate naturally instead of with the reduction in the bag limit.

The mortality of the adult Canada geese at Ogden Bay is approximately 30 percent less than the mortality of the juvenile geese. This supports other studies where the young were found to be more susceptible to hunting than the older birds. Hanson and Smith (1950) found slightly less than a 30 percent difference in mortality of young and adult Canada geese and Hanson and Nelson (1957) found a 25 percent difference in Brant. The difference of 30 percent between

the mortality of the juveniles and the adults remained the same with the three differing bag limits, thus indicating that an increase or decrease of the bag limit does not change the age ratio of the birds bagged.

The Canada geese at Ogden Bay are susceptible to heavy hunting pressure. This area is located in the center of the Utah waterfowl hunting area. Approximately 80 percent of the Ogden Bay geese that are harvested each year are shot in Utah (Martin 1963). Since most of the hunting pressure occurs within the state, regulations might profitably be made on a state level instead of a flyway basis. This would insure the safety of the Canada goose population in Utah.

Data indicates that the Canada goose at Ogden Bay has as high if not a higher production rate than the geese on any other production area in the United States. Since little can be done to increase production by habitat improvement emphasis should be placed on preserving the population by controlling the mortality caused by hunters.

SUMMARY

1. Canada geese returning to Ogden Bay nest in approximately the same area that they used during the previous season. There appeared to be individual preference for nesting sites and vegetative cover. The female leads the way to the nesting site.

2. Canada geese nesting for the first time nested later in the season than the geese that had previously nested. During the second half of the season geese nested in approximate inverse order of their age.

3. There was no relationship between the time of nesting and the number of eggs laid per nest. The average clutch size was 5.28 eggs per nest with a variation of two to seven eggs in a nest.

4. Nesting success appears to be independent of the nesting area. Factors that affect nesting success are the nesting sites, vegetative cover, and the distance from open water. Nests that had the greatest success were located on muskrat houses in cattail cover and were within five yards of open water.

5. Canada geese at Ogden Bay had a nesting success of 82.3 percent and produced an average of 3.79 (1959) and 4.08 (1960) goslings per nesting pair. Renesting was not an important factor in production. A total of 746 goslings was produced in the two years with an average brood size of 4.8 goslings per brood.

6. Changing the daily bag limit from three to one goose per hunter decreased the first year mortality rate 24 percent and the mortality for the geese that survived the first year after banding 19.7 percent.

7. Since the reduction in daily bag limit to one goose per hunter, the Canada goose population at Ogden Bay should be increasing at a rate of 13 percent per year. During both the three and the two goose limits the Canada goose population was decreasing.

8. It is recommended that continual emphasis be placed on controlling the mortality caused by hunting. With the high production rate it appears unlikely the goose population could be increased significantly by any habitat improvement.

LITERATURE CITED

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

Ballou, R. M. 1955. Decline of the Utah-Imperial flyway Canada goose in Wyoming. Mimeographed release. Wyoming Game and Fish Commission.

Blair, W. F., A. P. Blair, P. Brodkorb, F. R. Cagle and G. A. Moore. 1957. Vertebrates of the United States. McGraw-Hill Book Company, Inc. New York.

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

Dow, J. S. 1943. Nesting Canada geese in Honey Lake Valley, California. California Fish and Game. 29:3-18.

Fassett, N. C. 1957. A Manual of Aquatic Plants. The University of Wisconsin Press, Madison, Wisconsin.

Geis, M. B. 1956. Productivity of Canada geese in Flathead Valley, Montana. J. Wildl. Mgmt. 20:409-419.

Hansen, H. A. and U. C. Nelson. 1957. Brant of the Bering sea-migration and mortality. N. Amer. Wildl. Conf. Trans. 22:237-254.

Hanson, W. C. and R. L. Browning. 1959. Nesting studies of Canada geese on the Hanford Reservation 1953-1956. J. Wildl. Mgmt. 23:129-137.

Hanson, H. C. and R. H. Smith. 1950. Canada geese of the Mississippi flyway with special reference to an Illinois flock. Bulletin Illinois Natural History Survey. 25(3):67-210.

Hickey, J. J. 1952. Monthly distributions of mallard hunting mortality. J. Wildl. Mgmt. 16:32-38.

Johnson, C. S. 1947. Canada goose management, Seney National Wildlife Refuge. J. Wildl. Mgmt. 11:21-24.

Kortright, F. H. 1953. Ducks, Geese and Swans of North America. The Stackpole Company, Harrisburg, Penn. and Wildlife Mgmt. Institute, Washington, D. C.

Martin, F. 1963. Behavior and survival of Canada geese in Utah. Ph. D. dissertation, Utah State University Library, Logan, Utah.

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 39:385-396.

Moffit, J. 1955. Waterfowl shooting losses indicated by banding returns. American Game Conference Transactions. 21:305-308.

Naylor, A. E. 1953. Production of the Canada goose on Honey Lake Refuge, Lassen County, California. Calif. Fish and Game 40:5-16.

Nelson, N. F. 1954. Factors in the development and restoration of waterfowl habitat at Ogden Bay Refuge, Weber County, Utah. Utah Dept. of Fish and Game, Fed. Aid Div. Publ. 6. 87 p.

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

Williams, C. S. and W. H. Marshall. 1937. Goose nesting studies on Bear River Migratory Waterfowl Refuge. J. Wildl. Mgmt. 1:77-86.

Williams, C. S. and M. C. Nelson. 1943. Canada goose nests and eggs. Auk 60:341-345.